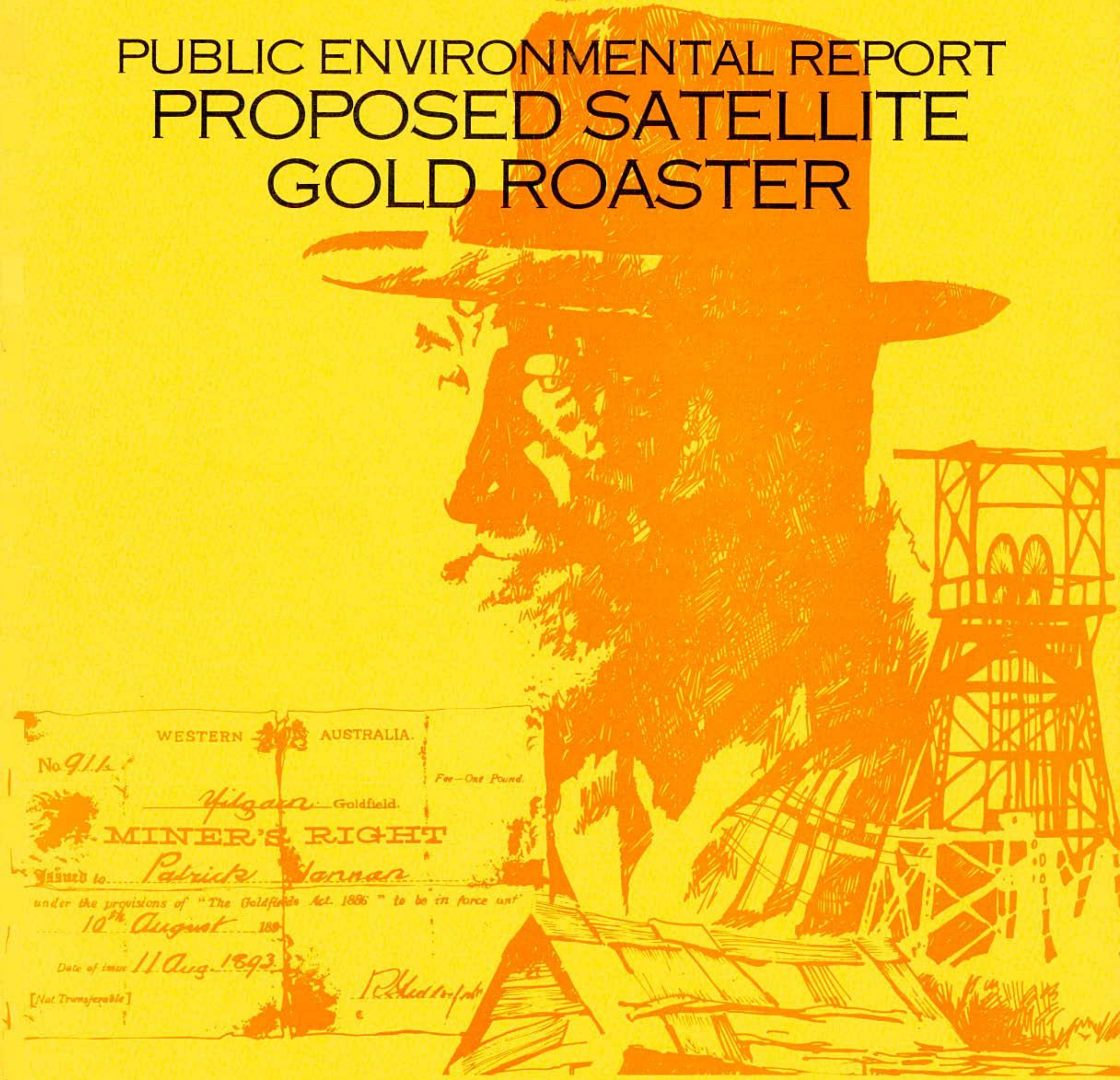
NORTH KALGURLI MINES LIMITED

PUBLIC ENVIRONMENTAL REPORT
PROPOSED SATELLITE GOLD ROASTER



gement Pty. Ltd.

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PUBLIC ENVIRONMENTAL REPORT
PROPOSED SATELLITE GOLD ROASTER

for

North Kalgurli Mines Ltd

Dames & Moore Job No. 16037-002-071

14 December 1987

PUBLIC ENVIRONMENTAL REPORT

PROPOSED SATELLITE GOLD ROASTER

for

North Kalgurli Mines Ltd

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

The Public Environmental Report (PER) for the proposed Satellite Roaster has been prepared by Dames & Moore for Dallhold Resources Management Pty. Ltd. in accordance with Western Australian Government procedures. The report will be available for comment for 8 weeks, beginning on 16 December, 1987 and finishing on– 10 February, 1988.

Comments from government agencies and from the public will assist the EPA to prepare an Assessment Report in which it will make a recommendation to Government.

Following receipt of comments from government agencies and the public, the EPA will discuss the issues raised with the Proponent, and may ask for further information. The EPA will then prepare its Assessment Report with recommendations to Government, taking into account issues raised in the public submissions.

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 will be acknowledged.

DEVELOPING A SUBMISSION

You may agree or disagree, or comment on, the general issues discussed in the PER or with 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 environmentally more acceptable.

When making comments on specific proposals in the PER;

- o clearly state your point of view,
- o indicate the source of your information or argument if this is applicable, and
- o 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 the issues raised are clear. A summary of your submission is helpful. Refer each point to the appropriate section or chapter in the PER. If you discuss sections of the PER, keep them distinct and separate, so that there is no confusion as to which section you are considering.

Attach any factual information you wish to provide and give details of the source. Make sure your information is accurate.

Please indicate whether your submission can be quoted, in part or in full, by the EPA in its Assessment Report.

REMEMBER TO INCLUDE:

Your name, address, date.
The closing date for submission is 10 February 1988.
Submissions should be addressed to:

> The Chairman
> Environmental Protection Authority
> 1 Mount Street
> PERTH WA 6000
> Attention: Ms D. Peggs

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13c) 24-hour
13d) Annual

PUBLIC ENVIRONMENTAL REPORT

PROPOSED SATELLITE GOLD ROASTER

for

North Kalgurli Mines Ltd.

SUMMARY

INTRODUCTION

The Proponent for this proposal, North Kalgurli Mines Ltd (NKML), is a major gold producer from mine leases on the "Golden Mile" at Kalgoorlie. NKML plans to construct and operate a new concentrate roasting facility in the Kalgoorlie area.

The Environmental Protection Authority (EPA) has advised NKML that this proposal should be the subject of a Public Environmental Report (PER). The objective of this document is to fulfil that requirement in accordance with guidelines provided by the EPA.

Due to the nature of the gold roasting process, the major environmental issue for the proposal concerns air quality, particularly the emission of sulphur dioxide and its potentially deleterious effects on human health and vegetation.

NEED FOR THE PROPOSAL

In order to sustain existing levels of gold production and to provide for further expansion of output from existing operations at Fimiston, further roasting capacity will be required as limited reserves of oxide ore are depleted, and production of sulphide ore increases.

The proposal would provide direct benefits at the local, state and national levels in terms of increased gold production and increased employment. Indirect employment would be generated throughout the construction and operational phases of the project, through demand for goods and services. Increased income would flow into the Public Sector in the form of payment for services and a range of taxation measures.

EVALUATION OF ALTERNATIVES

Various process alternatives have been considered by the Proponent with the objectives of increasing gold processing capacity while maintaining air quality in residential areas, including:

- o the recovery of gold from sulphide ores by means other than roasting,
- o the recovery of the sulphur dioxide generated in the roasting process,
- o the construction of a new roaster on the Fimiston area with increased stack height, and
- o the construction of new roasting facilities remote from the Fimiston area.

The preferred alternative would be to locate a new roasting facility remote from the Fimiston area, so as to minimise the impact on air quality in the Kalgoorlie-Boulder residential areas. The proposed location for the roaster is an unpopulated area on the eastern side of Broad Arrow Road, 17km north-north-west of the Kalgoorlie town centre, which has been selected primarily on environmental and economic considerations.

A suitable air dispersion model has been selected and tailored to realistically simulate plume dispersion from the roaster. A validation study has indicated that the model predictions of ground-level concentrations are sufficiently close to actual measured values for the model to be a useful indicator of air quality.

The plume dispersion model has been used to perform an analysis of the sensitivity of air quality to stack height and the predicted ground-level concentrations indicate that a stack height of 120m would be appropriate in terms of achieving air quality objectives in the Kalgoorlie-Boulder residential area.

The expansion of surface mining on the Fimiston leases would necessitate the decommissioning of the Paringa roaster, resulting in a general decrease in ground-level concentrations in the Kalgoorlie-Boulder residential areas even with the addition of the satellite roaster emissions.

THE PROPOSED DEVELOPMENT

The proposed facility would consist of a fluid bed roaster, a carbon-in-leach system, a tailings disposal area, a buried pipeline concentrate delivery system, and associated infrastructure.

Raw materials for the facility (pyrite concentrate slurry) would be transported from Fimiston by pipeline, after primary ore crushing, grinding and concentration. The slurry would then be fed to a fluidised bed roaster where the concentrate would be oxidised. The dry calcine product would be quenched with saline water and then repulped to a suitable density. Roaster off-gases would be cooled and conditioned before being discharged to the atmosphere via a 120m stack.

The calcine slurry from the roaster would be pumped to an on-site carbon-in-leach circuit consisting of a cyanide pre-leaching process followed by a carbon adsorption process. Gold-laden carbon would be removed from the carbon-in-leach circuit and washed prior to transport, by truck, to the Fimiston plant for the recovery of gold. Barren carbon would be transported by truck back to the satellite facility and returned to the carbon-in-leach circuit.

Leached calcines would be disposed of in a tailings pond on-site. The final design of the tailings disposal area is still under consideration. However, standard industrial practice would be followed and environmental management would be consistent with other recent projects in the Kalgoorlie area which involve tailings disposal.

EXISTING ENVIRONMENT

The proposed site is situated on relatively flat terrain, 17km north-north-west of Kalgoorlie town centre. Kalgoorlie, the centre of Western Australia's gold mining industry, lies 597km east of Perth.

Geologically, the site lies in the Eastern Goldfields Province of the Yilgarn Block, and the underlying greenstone belts are of major economic importance to the Eastern Goldfields.

The geomorphology of the site is typical of the Coolgardie Plateau Physiographic Unit. Drainage is in a north-easterly direction, with streams termininating in dry lakes. Relief to the flat landscape is provided by Mt Burges, 45km to the north-east of the site. The soils of the project area are transitional between the loams of the hills and the saline soils of the dry lakes.

The climate of the area is classified as semi-desert mediterranean, characterised by warm winters and hot summers. Forty eight years of meteorological and climatic data for the Kalgoorlie area have been recorded by the Bureau of Meteorology, while the Environmental Protection Authority has been operating air quality and meteorology monitoring stations in Kalgoorlie since 1982.

The groundwater in the area tends to be hypersaline. Water supply requirements would be met from the nearby Gidji Borefield, while fresh water requirements would be piped in from Fimiston, either as slurry medium or by separate pipeline.

The vegetation of the area is classified within the Coolgardie Botanical Districts of the Coolgardie Vegetation System. A survey of the proposed site indicates that the vegetation is principally woodland dominated by salmon gum, with an understorey dominated by bluebush. Many of the woodlands have been degraded by past mining activities and clearing for firewood. None of the flora likely to occur on the site is gazetted as rare. Few, if any, of the fauna are rare or in need of special protection.

The nearest Aboriginal settlement is Kurrawang Mission, 27km south-west of the proposed site, while there are no registered sites in the immediate vicinity of the proposed site.

Land use and social development of the area has been largely associated with the gold industry, although divergence of Kalgoorlie's economic base into nickel and pastoral development has aided the town's continuing growth. There are a number of mines and pastoral stations in the area, however the closest permanent population to the proposed gold roaster site is Kanowna Station, approximately 10km to the north, with a permanent population of two.

ENVIRONMENTAL IMPACTS

The principal impacts of the project would be as follows:

- Air Quality

  Analysis of historic data has indicated that, on past occasions, sulphur dioxide concentrations in the Kalgoorlie-Boulder residential areas have exceeded the criteria of the EPA's Draft Environmental Protection Policy. The plume dispersion simulations have indicated that implementation of the proposed roaster configuration would result in a general reduction in ground-level sulphur dioxide concentrations in the Kalgoorlie-Boulder residential areas.

  The frequency of occurrence of fumigation episodes over the Kalgoorlie-Boulder residential areas is expected to be very low. On an annual basis, less than five percent of winds would actually carry the plume towards Kalgoorlie and very few of these occasions would be associated with conditions conducive to fumigation.

  Particulate matter concentrations contributed from the proposed roaster would be well below suggested guidelines.

  Comparison of calcine and concentrate analysis has indicated that there would be no significant volatisation of heavy metals.

- Water Quality

  Impacts on water quality are expected to be minimal. All process discharges would be directed to the tailings disposal area. Leakages from the dam would be minimised as a result of natural decomposition of cyanide residues, adsorption of heavy metals onto soil particles, and the fine-grained composition of the tailings. In addition, the high gold content of the tailings would provide an economic as well as an environmental incentive for the Proponent to minimise leakages from the dam.

- Flora and Fauna

  There are no species of rare or restricted flora and fauna known from the project area or its vicinity. The limited and localised extent of the project indicates that there would not likely be a significant impact. No significant vegetation damage due to sulphur dioxide concentrations is anticipated.

- Aboriginal Sites

  There are no registered sites present in the immediate vicinity of the proposed development.

- Traffic Impacts

  The impact of increased traffic during construction and operation of the facility would be minimal.

- Social Impacts

  The only permanent population within a 15km radius of the proposed site comprises two persons, who reside 10 km to the north. The expected social impact would therefore be negligible.

ENVIRONMENTAL MANAGEMENT AND MONITORING

NKML is a progressive mining company with considerable expertise gained from the development and successful operation of three significant gold mines in the Kalgoorlie area. NKML has a strong commitment to technical excellence with respect to production, safety, and environmental factors, and the company is commited to undertaking an appropriate level of environmental monitoring and management associated with the proposed roaster development.

NKML would implement an air quality management and monitoring programme for sulphur dioxide. A new continuous sulphur dioxide monitor would be installed and operated by NKML in the northern outskirts of Kalgoorlie. A programme for monitoring the environmental impacts of sulphur dioxide on vegetation would also be implemented. The results of this monitoring programme would be regularly made available to the EPA.

Flora and fauna management would include preserving vegetation and stands of trees during project construction, implementing fire management procedures, and preventing faunal access to the tailings disposal area. Avifaunal use of the pond would be monitored and appropriate management action taken as required.

Rehabilitation management would include progressive revegetation of the tailings disposal area, and rehabilitation of the project site after decommissioning.

Safety measures and controls would include full compliance with all relevant Acts and Regulations.

CONCLUSIONS

The satellite roaster proposal would represent an important development in the Kalgoorlie-Boulder area in terms of ensuring future viability of the gold producing region, while achieving air quality objectives for the residential areas.

There are no known environmental impacts of the proposal which would likely be significant or unmanageable. The Proponent would implement various management programmes designed to monitor and mitigate the effects of the operation. Given the nature of the existing environment, the project as described herein, and these management programmes, the project should produce significant benefits to the region and the State without significant adverse environmental impacts.

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1.0 INTRODUCTION

North Kalgurli Mines Limited (NKML) is a major gold producer from mine leases on the "Golden Mile" at Kalgoorlie. In order to sustain existing levels of production and provide for further expansion, NKML plans to construct and operate a new concentrate roasting facility in the Kalgoorlie area.

The Environmental Protection Authority has advised NKML that this proposal should be the subject of a Public Environmental Report (PER), guidelines for which have been provided by the EPA and are reproduced in Appendix A.

1.1 THE PROPOSAL OBJECTIVES

NKML currently operates two gold roasters located on its Fimiston leases, and, in order to maintain current rates of gold production, further roasting capacity will be required as the limited reserves of oxide ore are depleted, and production of sulphide ore increases. Increased production from both surface and underground mining from the Fimiston leases would reinforce the requirement for additional roasting capacity.

The proposed roaster would be required to treat a maximum throughput of approximately 190,000 tonnes per annum (tpa) of concentrate, resulting in the production of some 16,000 kg/hr of SO_2 (based on an average throughput of 2 Mtpa at 3.5% sulphide ore). Other major stack gas constituents will be oxygen, nitrogen, water vapour and traces of arsenic.

The concentrate would be transported by slurry pipeline from treatment plants on or adjacent to the Fimiston leases to the satellite roaster.

1.2 LOCATION AND EXISTING FACILITIES

The proposed satellite roaster site has been selected based on environmental and economic considerations, as discussed in Section 3.2. The proposed site is located on the eastern side of Broad Arrow Road, 17km north-north-west of Kalgoorlie town centre (Figure 1). Access would be via a 2km length of formed, unsealed road which would be maintained by NKML.

The proposed plant would be situated at the company's tenement holdings on the North Gidji Prospecting Lease P26/1200. The lease is held in the name of Windsor Resources N.L., a company controlled by NKML. Application to convert the Prospecting Lease to a General Purpose Lease is underway.

The plant would occupy about 2 ha, and an additional 36 ha would eventually be utilised for tailings disposal. There are no existing facilities on the proposed site. Figure 2 shows the plan of the North Gidji lease and proposed facilities.

NKML has control of substantial leases at Fimiston, and it is from these properties that the ore and concentrate to be treated at the satellite roaster would be mined. The concentrate would be piped as a thickened slurry to the roaster facility remote from the plant (Figure 3).

1.3 THE PROPONENT

North Kalgurli Gold Mines Limited was formed in 1895 to mine 7 ha of land on the Golden Mile. In 1912, the company was reconstructed as North Kalgurli (1912) Proprietary Limited and, following amalgamation with Croesus Proprietary Limited in 1956, it was renamed North Kalgurli Mines Limited (NKML). It has operated continuously since that time.

In recent years, NKML has been the subject of a number of successful takeover bids. Metals Exploration Limited achieved management control of NKML in 1982 through a partial takeover of the company. In 1984, Dallhold Investments Proprietary Limited, through Mid-East Minerals N.L., obtained control of Metals Exploration Limited, and in turn NKML.

Since 1984, there has been considerable consolidation of gold mining interests in the Kalgoorlie region into the NKML corporate structure. This has included the takeover of Windsor Resources N.L. and the associated Mount Percy Gold Mine, Hampton Gold Mining Areas PLC and Hampton Australia Limited with the associated Jubilee Gold Mine, and other joint venture interests.

NKML has also obtained a controlling shareholding in Gold Mines of Kalgoorlie (GMK). GMK in turn owns 50% of Kalgoorlie Lake View (KLV) which has a 52% interest in Kalgoorlie Mining Associates Partnership (KMA). The KMA Partnership controls mining leases at Fimiston, immediately to the south of the NKML leases. These leases are currently managed by Western Mining Corporation (WMC). Potential exists for the development of large scale open pit mining activities on KMA leases, particularly as an extension of mining on the Eastern Lode series, the subject of NKML's open pit development plans.

Dallhold Resources Management Proprietary Limited (DRM), has been formed to provide corporate management for NKML, however all site management and operations in Kalgoorlie are conducted by NKML employees. Figure 4 shows the relationship between the various companies in which Dallhold Investments Proprietary Limited holds interests.

1.4 LEGISLATIVE CONSIDERATIONS

A broad range of legislation covers this proposed development, as indicated in Table 1. However, due to the nature of the gold roasting process, the major environmental issue concerns air quality, particularly the emission of sulphur dioxide and its potentially deleterious effects on human health and vegetation.

TABLE 1

LEGISLATION COVERING THE PROPOSED DEVELOPMENT

Environmental Protection Act (1986)
Construction Safety Act (1972)
The Mines Regulation Act and Regulations (1946-1974)
The Mining Act (1978)
Explosives and Dangerous Goods Act (1961)
Occupation Health, Safety and Welfare Act (1984)
Aboriginal Heritage Act (1972-1980)
Health Act (1911-1982)

The Clean Air Act has until recently provided the means of regulatory control of air quality, but has been superseded by the Environmental Protection Act which was promulgated in February 1987. The responsibility for air quality is now vested in the Environmental Protection Authority (EPA).

The EPA has prepared a Draft Environmental Protection Policy (EPP) for control of sulphur dioxide produced by existing industry in the air environment of the Kalgoorlie-Boulder residential areas. The purpose of the policy is to achieve and maintain a level of air quality appropriate to the residential areas of a mining town. The Policy proposes acceptable levels for sulphur dioxide over various averaging periods. The objectives of the policy are proposed to be achieved by applying conditions on the operating licenses of existing industries which emit sulphur dioxide. Appendix B contains the Draft EPP. Table 2 presents the ambient air quality objectives for sulphur dioxide referred to in Part IV of the Draft EPP.

TABLE 2
SULPHUR DIOXIDE OBJECTIVES
FOR EXISTING INDUSTRY

OBJECTIVE NUMBER	AVERAGING PERIOD	ACCEPTABLE LEVEL ug/m^3
1	1-hour	2,000
2	3-hours	1,300
3	1-day	365
4	1-year	60

(Extracted from the Draft Protection Policy for the Control of Sulphur Dioxide in the Environment of the Kalgoorlie-Boulder Area)

The EPA advise that the objectives given in the EPP will not apply to emissions generated by new industries in the Kalgoorlie area. However, no guidelines are available for such new industries, although appropriate levels could be expected to lie between those of the EPP and those of the National Health and Medical Research Council (NHMRC). As an instance, comparative levels for the one-hour averaging period are 2,000 ug/m^3 (EPP) and 700 ug/m^3 (NHMRC). The guideline for the annual averaging period is 60 ug/m^3 for both EPP and NHMRC.

1.5 PURPOSE OF PUBLIC ENVIRONMENTAL REPORTS (PERs)

Under the Environmental Protection Act (1986), the EPA sets specific levels of assessment following consideration of a proposal document submitted by the Proponent.

The Public Environmental Report (PER) allows public comment and input to any proposal which might have a potentially significant environmental impact. A public submission may provide information, express an opinion or suggest an alternative approach.

Comments from government agencies and the public will assist the EPA in preparing an Assessment Report which will make recommendations to Government.

2.0 NEED FOR THE PROPOSAL

2.1 LOCAL LEVEL BENEFITS

The long-term viability and profitability of the Kalgoorlie gold mining operations requires increased roasting capacity. This is due to the fact that, as mining moves deeper, an increasing proportion of sulphide ore is mined which, unlike the overlying oxide ore, can only be economically processed by roasting. The Proponent recognises, however, that provision of additional roasting capacity on the Fimiston leases would be unacceptable in terms of achieving air quality objectives in the Kalgoorlie area. As discussed in Section 3.0, a review of process alternatives followed by a site selection analysis have indicated that a roaster facility at a remote location would be the most appropriate means of ensuring the continuity of ore processing.

The provision of increased roasting capacity at a remote location would eventually enable the closure of one of the existing roasters close to town (Paringa), leading to a general reduction in sulphur dioxide ground-level concentrations in the Kalgoorlie-Boulder residential areas, despite the increase in total emissions in the Eastern Goldfields Region.

2.2 NATIONAL AND STATE LEVEL BENEFITS

The project would contribute to the Gross National Product in terms of increased gold production, and increased employment.

The increased roasting capacity would allow processing of 160,000 ounces of gold per year. The capital cost of the satellite roaster is estimated to be about $20 million. It is anticipated that during the construction phase, the major proportion (over 90%) of capital expenditure would be on goods and services originating in Australia - NKML is committed to a "Buy Australia" policy.

Employment would be generated both directly and indirectly by the project. A peak construction workforce of approximately 80 people (mostly in mechanical trades) would stimulate the engineering and construction sectors of the economy. The operational phase would create about 12 full time positions. Indirect employment would be generated throughout the construction and operation phases of the project, through demand for goods and services.

Increased income would flow into the Public Sector in the form of payment for services and a range of taxation measures.

The employment figures mentioned above have not included people already employed in the mining and milling operations at Fimiston. However, it should be noted that acceptance of this proposal would have a positive impact on the long-term viability of these other operations, and the continued security of their employees.

3.0 EVALUATION OF ALTERNATIVES

3.1 ALTERNATIVE PROCESS TECHNOLOGIES

Various process alternatives have been considered by NKML and the local mining industry in conjunction with the Taskforce on Gold Roasting (TASKFORCE, 1987) with the objectives of increasing gold processing capacity while maintaining air quality in residential areas. The following alternatives are discussed below:

- o the recovery of gold from sulphide ores by means other than roasting,
- o the recovery of the sulphur dioxide generated in the roasting process,
- o the location of a roaster near town with increased stack height, and
- o the location of a roaster remote from town.

3.1.1 Gold Recovery

Gold-bearing ores are commonly described as either free-milling or refractory. A free-milling ore contains gold particles which are accessible to the cyanide leach solutions after the ore has been ground in a mill. Refractory ores consist of iron sulphide minerals which contain gold in a very finely divided form "locked up" within the mineral particles. Even after fine grinding of the ore, the gold is not sufficiently liberated to be dissolved by the cyanide solution in sufficient quantity to constitute a viable recovery process.

To extract the gold from such refractory ores, the host iron sulphide mineral must first be chemically broken down. One way to achieve this is to roast the mineral in air at an elevated temperature. This process converts the iron sulphide to a porous iron oxide. The sulphur is driven off as sulphur dioxide gas and the gold-bearing iron oxide product can then be leached in the normal cyanide circuit. This is the gold recovery process which is being used by NKML on the Fimiston leases, and is discussed in more detail in Section 4.1.

One of the alternatives to the roasting process which has been examined by NKML is fine grinding of flotation concentrate. Concentrate would be ground to a 'super-fine' slurry and leached directly to recover gold. Studies have shown that recovery of gold would be significantly lower than that achieved by the roasting process. While fine grinding and leaching tests have been conducted in the laboratory, the many technical problems associated with full scale operation (such as carbon fouling) have not been studied and would not be trivial. Furthermore, the operating costs for power to achieve a finer grind would be high, and overall the process would not currently be economically feasible.

Alternative processes for sulphide refractory ores currently being developed elsewhere, such as acid pressure leaching and bio-oxidation (bacterial) leaching, would have limited application in the Kalgoorlie area, chiefly because of the necessity of using hypersaline (chloride) water in ore processing and the cost of neutralising effluent. Furthermore, acid pressure leaching has only been applied on a commercial scale at the McLaughlin operation in the United States. The pressure leaching operation would have a high capital and operating cost.

No further developments in sulphide ore treatment technology which could affect near-term developments are currently foreseen by NKML.

3.1.2 <u>Sulphur Dioxide Recovery</u>

Several processes have been considered for the recovery of the sulphur dioxide generated by roasting, including the production of sulphuric acid, the production of elemental sulphur, and lime absorption scrubbers.

. Production of Industrial Grade Sulphuric Acid

After cooling and cleaning, the roaster off-gases would be treated in a conventional sulphuric acid production plant. Approximately 98% of the SO_2 would be recovered to produce sulphuric acid prior to the discharge of the gas stream to the atmosphere.

While the process would be technically feasible, the economic viability would be uncertain due to the limited market available for the sale of the acid. The acid market in Western Australia is relatively small, and transportation to remote markets would be economically unviable.

Storage, handling and transport of sulphuric acid would raise a number of environmental and safety issues.

o Production of Elemental Sulphur

This process would also remove approximately 98% of the sulphur dioxide from the roaster gas prior to discharge to the atmosphere.

Only one process is viable and proven, namely the Allied Chemicals Process, which requires hydrocarbons such as natural gas. While elemental sulphur would be safer and easier to store and transport than sulphuric acid, the same market vagaries and other difficulties would still exist.

. Lime Absorption

Sulphur dioxide removal via lime absorption would be uneconomic and would require import of lime, and disposal of large quantities of waste slurry by-product.

The lime absorption process is inefficient because it requires large quantities of lime to absorb the sulphur dioxide. The capital and operating costs required to import the lime and dispose of the gypsum and lime mixture by-product would be too high.

3.1.3 Locate Roaster Near Town but Increase Stack Height

The decision to use proven roasting technology without sulphur dioxide recovery implies that the sulphur driven off the sulphide refractory ore during the roasting process would be discharged to the atmosphere. Provision of additional roasting capacity on the Fimiston leases would be restricted by limitations on sulphur dioxide emissions in the Kalgoorlie-Boulder areas.

Preliminary studies have been carried out to examine the effect of stack height on local ground-level concentrations of sulphur dioxide, on the basis that increased stack height would improve plume dispersion. The EPA has found little variation in ground-level concentrations within 5km of the hypothetical stacks, for stack heights of 150m and 200m (EPA pers. comm., 1987). A CSIRO study (Williams, 1986) has confirmed that higher stack heights may be very effective for areas within 2km of the source but relatively ineffective beyond 4km. Stack height sensitivity analyses have been carried out in the course of this PER, as discussed in Sections 3.3 and 6.1.1.

3.1.4 Locate Roaster Remote from Town

The preferred alternative would be to locate the roasting facility remote from the Fimiston area, so as to minimise the air quality impact on the Kalgoorlie-Boulder residential areas. Section 3.2 summarises the site selection methodology and conclusions for the satellite roaster alternative.

3.2 ALTERNATIVE SITES

3.2.1 Site Selection Methodology

A number of sites would be potentially available for the satellite roasting facility, either on leases presently held by NKML, or on land accessible to NKML.

A detailed plume dispersion modelling analysis has been carried out by Dames & Moore to assess the optimum location for the satellite roaster in terms of air quality impact. The scope of the analysis is summarised below, while final results are summarised in Section 6.1. The modelling efforts have utilised the extensive meteorological and air quality databases which have been established by the EPA and the Gold Industry Air Monitoring Network over recent years, and have reviewed the associated reports (Rosher et al., 1984; Rosher & Pitt, 1985; Pitt & Rosher, 1985; Bell et al., 1985; and Williams, 1986).

The EPA operates three air quality and meteorology stations in the Kalgoorlie-Boulder residential area, at the following locations:

- The Kalgoorlie Regional Hospital (since 16 July 1982),
- The Kalgoorlie Technical School (since 17 February 1983), and
- The South Boulder Primary School (since 17 August 1984).

The first two stations consist of an instrumented 10m tower and an air-conditioned van housing electronic signal conditioning equipment, and a continuous sulphur dioxide monitor and data recording equipment. Since June 1983, meteorological data have been collected only at the Technical School as this site has been shown to be representative of the Kalgoorlie-Boulder area. The South Boulder Primary School base station has new equipment provided by the mining companies. Meteorological parameters recorded at the Technical School include wind speed, wind direction, sigma-theta (wind direction variance), air temperature, dewpoint temperature, solar (short wave) radiation and long wave radiation.

The Victorian Environment Protection Authority's (VEPA) version of the Short-term Industrial Source Complex Model (ISC-ST) has been selected as a suitable dispersion model. Several other regulatory agencies in Australia make use of this version of the model to evaluate air pollution impacts and to determine appropriate heights for stacks for licensing purposes. This flexible model has been tailored to realistically simulate plume dispersion from the roaster.

An hourly meteorological data file has been developed for a two year period, incorporating EPA surface data measurements (wind speed, wind direction, standard deviation of horizontal wind direction, temperature and solar radiation) and upper air data from the EPA and from radiosonde ascents made by the Bureau of Meteorology at Kalgoorlie local airport. Stability class assignment schemes and hourly mixing-height estimation procedures have been evaluated to ensure appropriateness of use in the Kalgoorlie area.

As part of the study, the performance of the dispersion model has been validated. This has been done using meteorological data collected by the EPA at the Kalgoorlie Technical School during 1984, and upper air data from the airport over the same period. The validation study used actual hourly sulphur dioxide emissions from the three existing roasters together with the meteorological data to predict ground-level concentrations of sulphur dioxide. These predictions were then compared with ground-level concentrations which were actually measured over the same period at the three EPA operated sulphur dioxide monitoring stations. The results were used to improve the accuracy of the model and verify the meteorological data processing approaches. The validation study has concluded that the model is conservative (i.e. over-predicts concentrations) for almost all averaging periods and that the model predictions would be a useful indicator of likely air quality.

The impact of the satellite roaster was simulated as a contributer to existing roaster sources. In addition to simulating the ground-level concentrations under normal dispersion conditions, the effects of unusual dispersion conditions (fumigations in particular) were assessed using a state-of-the-art approach as developed by Deardorff and Willis (1982). The results of these simulations are discussed in Section 6.1.1, and briefly summarised below.

3.2.2 Site Selection Conclusions

With a point source of pollution located remote from the Kalgoorlie-Boulder urban area, the highest ground-level concentrations would be experienced in the town when the plume is transported towards the town under "stable" atmospheric conditions. Such conditions would occur predominantly at night when wind speeds are low and skies are clear. Thus, it would be desirable to locate a pollution source in the wind direction with the smallest percentage of stable atmospheric conditions.

Windroses from the EPA data (for the years 1984, 1985 and 1986) have been prepared. A comparison of the 1984, 1985 and 1986 windroses is presented in the Supporting Document (Dames and Moore, 1987) and shows consistency between the three years. 1984 has been arbitrarily selected for plume dispersion modelling purposes, and is shown on Figure 5.

Examination of the EPA windroses has shown a consistent pattern of winds from year-to-year and from season-to-season within different years. These wind patterns indicate that the north-north-westerly direction has the lowest percentage of low wind speeds. This direction also has the advantage of having the lowest percentage of all wind speeds compared to any of the other sectors. The Gidji lease, 17km to the north-north-west of the centre of Kalgoorlie township, would therefore be an appropriate location for the satellite roaster. Plume dispersion simulations have confirmed that the proposed site is very close to optimum in terms of minimising air pollution in Kalgoorlie-Boulder (refer to Section 6.1.1 for details).

3.2.3 Buffer Zone

Plume dispersion modelling has indicated that sulphur dioxide ground-level concentrations reach their maximum between 1km and 2km from the stack in the north to north-west directions. The North Gidji site would therefore be favourable in that the only permanent population within 15km is at Kanowna (about 10km from the stack). While it would be the Government's prerogative to define a non-residential zone around the roaster site, NKML will not house workers on company-held leases in the vicinity of the roaster.

3.3 ALTERNATIVE STACK HEIGHTS

The plume dispersion model has been used to perform an analysis of the sensitivity of air quality to stack height, the results of which are summarised in Section 6.1.1. Plume dispersion was simulated for a range of stack heights between 80m and 200m. The predicted ground-level concentrations indicate that a stack height of 120m would be appropriate in terms of achieving an environmentally acceptable level of air quality in Kalgoorlie-Boulder residential areas.

3.4 ALTERNATIVE ROASTER CONFIGURATIONS

There are three existing roasters in the Kalgoorlie-Boulder area. The Paringa (GR) and Croesus (NKM) roasters are under the control of NKML, while the Oroya (KLV) roaster is under the control of Kalgoorlie Lake View.

The expansion of surface mining on the Fimiston leases would require the decommissioning of the Paringa roaster, resulting in a decrease in overall ground-level concentrations in the Kalgoorlie-Boulder residential areas, even with the addition of the satellite roaster. NKML's Croesus plant and roaster would be operated at current capacity for treatment of underground ore, oxide ore and clean-up of tailings on the Fimiston leases.

3.5 ALTERNATIVE CONCENTRATE TRANSPORT SYSTEMS

It is proposed that the concentrate slurry would be transported from the Fimiston leases to the satellite roaster by pipeline. As an alternative to slurry transport, trucking has been studied and discarded for reasons of cost, logistics, security and adverse environmental impacts. The cost would be higher than transport by pipeline. If trucking took place 24 hours a day, there would be two trucks per hour in each direction passing through the centre of Kalgoorlie. Daytime traffic intensity would increase proportionally if night time operation was excluded.

Not only would pumping involve a lower security risk, but the potential for theft would be reduced because public awareness of a buried pipeline would be less than that of a trucking operation.

The environmental impact of a pipeline system would be less than for a trucking system. In addition to the unobtrusiveness of a buried pipeline, slurry pumps would be electrically driven, whereas the diesel engines of trucks would cause exhaust gas emission, generate increased dust emissions and cause increased traffic levels with associated traffic noise.

4.0 THE PROPOSED DEVELOPMENT

4.1 PROCESS DESCRIPTION

4.1.1 Overview of Process Circuit

Primary ore processing would be undertaken at the proposed Fimiston Plant, located immediately to the east of the town of Kalgoorlie. After crushing, the sulphide ore would be ground in a ball mill and fed to a flotation circuit where the gold-bearing iron sulphide minerals would be collected in a concentrate, typically containing:

- o 27% iron,
- o 33% sulphur, and
- o 35 grams of gold per tonne.

The pyrite concentrate would then be piped as a thickened slurry to the roaster facility remote from the plant. Figures 1, 2 and 3 show the location of the proposed satellite roaster and the concentrate slurry pipeline route. Figure 6 shows the proposed plant layout for the roaster and carbon-in-leach area.

Two concentrate storage tanks with a combined capacity of approximately 1,300,000 litres would hold about 2 days of the roaster concentrate feed requirements. The concentrate would pass from the storage tanks to two pyrite slurry feed tanks, each of 100,000 litre capacity. The slurry would be fed to the fluidised bed roaster where the concentrate would be oxidised to form a dry calcine product. The dry calcine product would be quenched with saline water (to cool the solids down from roaster discharge temperature) and then repulped to a suitable density. SO_2-rich roaster off-gases (at 600°C) would pass through cyclones (to remove calcine solids), would be cooled to 350°C in an evaporative cooling chamber, and would pass through a bank of plate-type electrostatic precipitators (to remove particulates), before discharging to the atmosphere via a 120m stack. The conditioned gases would exit the stack at a flowrate of 60,000 Nm^3/hr and a temperature of 340°C.

The calcine slurry from the roaster would be pumped to an on-site cyanide leaching process and then dosed with lime and cyanide in agitated tanks. After a period of pre-leaching, the slurry would flow to the carbon-in-leach tanks where it would come in contact with activated carbon. Gold-laden carbon would be removed from the carbon-in-leach tanks and washed prior to transport, by truck, to the Fimiston plant for the recovery of gold. Barren carbon would be transported back to the satellite facility by truck and returned to the carbon-in-leach circuit.

Facilities for the mixing and distribution of lime, cyanide and flocculant would be provided at the roaster facility. Approximately 15,000 litres of cyanide and 100,000 litres of hydrated lime would be stored on site. It is estimated that 170,000 tpa of leached calcines would require disposal in a tailings pond on-site.

4.1.2 Fluidised Bed Process

A fluidised-bed process, similar to the proven technology in use at the company's other roaster plants, would be used. A conceptual flow diagram of a typical roasting plant is shown on Figure 7.

The iron sulphide concentrate would enter the roaster as a slurry of finely-ground particles (typically 80% finer than 0.075mm). Air would be blown into the bottom of the roaster through a sieve plate arrangement, and the concentrate particles would be held suspended in the air current. The air also would supply the oxygen needed to react with the iron sulphide to produce iron oxide and sulphur dioxide. This reaction would provide the heat required to maintain the fluidised bed at about 650°C.

Careful design of the roaster would be required to keep the particles "fluidised" in the gas stream. The volume of air blown into the roaster would have to provide sufficient oxygen to react with all the iron sulphide being fed in. The vertical velocity of the air flow through the bed would be equally important. This would be determined by the volume flow of air and the (fixed) area of the roaster.

Should the concentrate feedrate be reduced, the air flowrate would have to be reduced to provide the correct amount of oxygen. Too great an air flow would cool the bed and stop the chemical reaction. Too little an air flow would cause the bed to collapse because of insufficient upward flow to keep the particles fluidised.

For these reasons, the roaster would operate within a narrow range of concentrate feedrates and air flow rates, and a variation of only 15% either side of the design feedrate would normally be the limit.

4.1.3 Carbon-in-Leach Cycle

Leaching would be carried out in mechanically agitated tanks. Sodium cyanide would be added to the first and second leach tanks to provide the required cyanide concentration. Lime would be added to adjust the alkalinity for efficient gold leaching. Pre-leach retention time would be in the order of 50 hours.

After the period of pre-leaching, the slurry would be advanced to the carbon adsorption circuit. Each stage would consist of a mechanically agitated tank, equipped with a carbon retaining screen. A slurry retention time of approximately 50 hours would be required.

The slurry would flow between stages by gravity, the carbon inventory in each stage being retained by the screens. Activated carbon would be advanced from stage to stage by pumping a small stream of slurry plus carbon counter-current to the main slurry flow. Eluted and regenerated carbon would be fed to the last stage. As the carbon advances to the number one stage, it would adsorb soluble gold from the leached ore slurry. The slurry would become progressively depleted of soluble gold as it travels down the adsorption stages. Slurry discharged from the last carbon-in-leach tank would be thickened and then pumped to the tailings disposal area.

The gold-laden carbon would be recovered from the first adsorption stage on an external screen. It would be water-washed to remove ore fines prior to transport, by truck, to the proposed Fimiston plant for the recovery of gold. The reactivated, barren carbon would be transported back to the satellite facility to be reintroduced to the bottom stage of the adsorption circuit.

4.2 SLURRY PIPELINE

The concentrate slurry would be transported by a single underground pipeline. The pipeline route would be located so as to closely follow existing easements, principally that for the water supply pipeline between the Gidji Borefield and Mt Percy Mine. Figure 1 gives an overview of the proposed route from Fimiston to the satellite roaster facility. Figure 2 provides details of the route at the North Gidji Lease, while Figure 3 shows details of the route through the Fimiston leases area (subject to approval by the appropriate authorities).

The selected route would exit the Fimiston plant, follow Black Street north on the east side of the road reserve to the intersection of Black Street and Kanowna Road, and follow Kanowna Road on the east side of the road reserve for about half a kilometre before continuing across country in a north-westerly direction. The pipeline route would circuit the Mt Percy Gold Mine on the east side, and then continue on a north-westerly direction to Broad Arrow Road. From Broad Arrow onwards, the slurry pipeline would run alongside the existing water supply line to Mt Percy, which parallels the road reserve on the east side of Broad Arrow Road before branching off to the south-western corner of the Gidji lease.

4.3 TAILINGS DISPOSAL

The final design of the tailings disposal area is still under consideration. However, standard industrial practice would be followed and environmental management would be consistent with other recent projects in the Kalgoorlie area which involve tailings disposal. Two such projects are:

- The tailings expansion proposal by North Kalgurli Mines Ltd, which is concerned with increasing an existing tailings disposal area associated with the Croesus roaster and gold plant. This proposal is currently under construction, having been approved by the Mines Department.

- The Kalgoorlie Tailings Retreatment proposal (commonly known as the Kaltails Proposal) by Anglo American Pacific Ltd, which is concerned with reprocessing old tailings deposits to extract previously uneconomical residual gold.

It should, however, be noted that the tailings associated with the satellite roaster would differ from those produced from a conventional gold plant in that they would have a higher grade of gold, due to the higher gold content of the concentrate feeding the roaster. The proponent is continuing to address the maximisation of gold recovery from the tailings, and eventual retreatment has not been ruled out. A substantial incentive therefore exists to minimise the potential for any leakage from the tailings disposal area, as any such liquids would be gold-bearing. For similar reasons, water from the tailings pond would be reclaimed using decant towers, a collection sump and reclaim pump and would be returned to the process.

The basic philosophy behind the tailings disposal area design is to provide a storage which would be easily manageable throughout the project life and would have minimal impact on the environment in the long-term. The latter condition would require that the storage satisfy engineering criteria with respect to stability of the embankments and containment of waste water, as well as the retention of gold-bearing leachates.

The tailings dam, which is expected to cover an area of approximately 36ha at project completion, would likely be constructed as a series of 'cells'. The initial cells would cover an area of around 9 ha. This cellular approach would allow progressive rehabilitation of the completed cells, while tailings would continue to be deposited in new sections. The lifespan of the tailing facility would be 15 years.

Rehabilitation of the tailings disposal area would depend on the success of revegetation. The aim of rehabilitation would be to encourage regrowth on the tailings themselves, assisted by the re-use of whatever topsoil resources would be available from pre-stripping of the site. Rehabilitation of the tailings facility is discussed in Section 7.3.

4.4 INFRASTRUCTURE

Figure 2 shows the proposed services at the North Gidji Lease. Details of these services are given below.

4.4.1 Water Requirements

The Gidji lease is associated with a borefield which would be utilised for the roaster project. Saline water requirements would be provided from the Gidji borefield, together with decant water from the tailings area. Bore water would be used to quench the calcine product as it emerges from the roaster, and would also be used in the leaching circuit. Approximately 12,000 litres per hour of bore water makeup would be required.

Fresh process water would be supplied as the carrying medium for the concentrate, and would be retrieved by filtration of the low density slurry to produce clear water and a higher density slurry suitable for feeding to the roaster. The clear water, or filtrate, would be used for cooling and control purposes in the roasting operation. Approximately 25,000 litres per hour of fresh (scheme) water would be used for transporting the concentrates from Fimiston to the roaster.

Alternatively, fresh (scheme) water could be transported by pipeline from the Fimiston lease to meet the roaster processing requirements and to provide potable water for human consumption. Otherwise, potable water would be supplied by truck.

4.4.2 Power Requirements

Power would come from the grid, supplied by the State Energy Commission of Western Australia (SECWA). An existing 33kV powerline runs 2km to the west of the site, as shown on Figure 2.

Emergency power would be available from a stand-by diesel generator.

4.4.3 Communications

Telephone communications would be installed at the facility.

4.4.4 Waste Disposal

Garbage, construction and maintenance wastes would be disposed of into a designated sanitary landfill site excavated for that purpose. The site chosen would be at least 5m above the watertable and away from any natural flow lines which could result in flooding or exposure of rubbish by erosion. Septic wastes would be disposed of via septic tanks.

4.4.5 Workforce Accommodation

The construction and operation workforce would commute daily from Kalgoorlie-Boulder.

5.0 EXISTING ENVIRONMENT

5.1 GEOLOGY

The proposed site is in the Eastern Goldfields Province of the Yilgarn Block (Beard, 1981). The Yilgarn Block is of Archaean age, with most of the predominant granite and gneiss aged between 2,500 and 2,900 million years. Partly metamorphosed igneous and sedimentary assemblages (popularly known as greenstone belts) underlie approximately 30% of the Kalgoorlie area and are of major economic importance to the Eastern Goldfields. They contain valuable minerals, particularly gold and nickel sulphide, and provide a great deal of the area's economic stability and wealth.

The Coolgardie hills and plains are essentially on metamorphics and volcanics, with topography controlled by the harder and more resistant strata among the metamorphics which form low ridges striking NNW-SSE with alluvial flats between them. The hardest strata are banded ironstone formations (BIF), which form the most prominent ridges.

The roaster site lies in an area of predominantly altered mafic and ultramafic igneous Rocks (Geological Survey of Western Australia, 1969).

5.2 GEOMORPHOLOGY AND SOILS

The proposed site is part of the Coolgardie Plateau physiographic unit. The land surface is generally around 350m above sea level. In the west, sandplains with broad valleys drain to the north and south-west and in the east, low hills with broad valleys lead to lake country. Drainage is by sheetwash in a north-easterly direction, with the country being dissected by numerous flood channels, and by creeks terminating in playas (dry lakes). Outstanding bedrock hills, such as Mt Burges, bold granite rocks, low ridges capped by ironstone, sand ridges and low escarpments (breakaways) interrupt the otherwise gently rolling landscape (Geological Survey of Western Australia, 1969).

The terrain in the immediate vicinity of the proposed gold roaster is predominantly flat, and is generally low-lying. Kriewaldt (1969) maps the area as being part of the lake country immediately north of Kalgoorlie.

The soils of the region are typically neutral red earths in the plains areas, calcareous loams and brown calcareous earths in the more hilly portions, with saline soils dominating in and around the salt lakes. The soils of the project site are transitional between the loams of the hills and the saline soils of the playa lakes. They tend to be very calcareous with a pH averaging around 8. The pH may drop to 6 in areas which have a superficial covering of moss and lichen.

5.3 CLIMATE

The climate of the Kalgoorlie area is classified as semi-desert mediterranean (Beard 1972) and is characterised by warm winters and hot summers. Meteorological data are available from Kalgoorlie, 17km to the south of the proposed project site, which are taken as being representative of the area.

Mean annual rainfall for the area is 255mm, with a slight predominance of winter falls; however, rain does occur on a year round basis (over 48 years of records). Winter rainfall is associated with cold fronts moving in from the Southern Ocean while summer falls come mainly from localised thunderstorm activity and are therefore both less regular and less predictable. This is borne out by the larger average number of raindays each month for winter (mean of 8 raindays for the months May to August) versus the more sporadic but heavier falls of summer (mean of 3.6 raindays for October to March). The mean monthly rainfall ranges from 32mm in June to 12mm in December (Bureau of Meteorology data).

The mean annual daily maximum temperature is 25.2^{o}C, with a range of 16.7^{o}C in July to 33.7^{o}C in January. Mean minimum temperatures range from 5.0^{o}C in July to 18.3^{o}C in January, with an annual mean of 11.6^{o}C.

Relative humidity ranges between 76% at 0900 hours in July to 22% at 1500 hours in December.

Windroses for Kalgoorlie (prepared from 48 years of Bureau of Meteorology 0900 hour and 1500 hour observations) show the prevailing winds of autumn and summer to be north-easterly to south-easterly, mainly in the 11-20km/hr range, with few very strong winds. Spring winds are variable in both speed and direction. Winter winds are predominantly westerly to northerly at 11-30km/hr.

In addition to the long-established meteorological data mentioned above, the Environmental Protection Authority operates three air quality and meteorology stations in the Kalgoorlie-Boulder residential area, as described in Section 3.2.1. The Environmental Protection Authority considers that the meteorological data are valid within 50km of the town. Windroses from the EPA data (for the years 1984, 1985 and 1986) have been prepared as part of the site selection phase of the air dispersion study.

The EPA hourly windrose diagrams are far more detailed than those from the Bureau of Meteorology in that they have been prepared from observations throughout the day rather than two observations at 0900 hours and 1500 hours. Since the air pollution sources will operate on a 24-hour basis, the hourly windroses are a more suitable indicator of plume dispersion patterns than the twice daily samples. In addition, the EPA data has been recorded from a more sensitive and accurate anemometer than the Bureau of Meteorology data. A comparison of the 1984, 1985 and 1986 windroses is presented in the Supporting Document (Dames & Moore, 1987) and shows consistency between the three years. 1984 has been arbitrarily selected for plume dispersion modelling. Figure 5 shows windroses for 1984, while the Supporting Document also presents diagrams for 1985 and 1986.

5.4 HYDROLOGY

5.4.1 Surface Drainage

Low rainfall and highly porous sandy soil result in most of the drainage of the area being internal; only after heavy, intense falls will streams flow. These streams are ephemeral and are either absorbed internally or drained into clay or salt pans which are dry for most of the year. These clay and salt pans form chains over ancient river channels that once drained the area in times of higher rainfall.

5.4.2 Groundwater

The prospects of obtaining good quality potable shallow groundwater in appreciable quantities are rated as remote by Kriewaldt (1969), as the groundwater that is available tends to be hypersaline. However, there are some bores in the area that are used for stock purposes, but these these only supplement other supplies. Water supplies for the roaster would be obtained from the Gidji borefield, located approximately 5km south-west of the roaster site.

Details of water quality data at the borefield are as follows:

Total Dissolved Salts (T.D.S.)	170,000 mg/L
pH	5.8
Depth to water table	8 metres

The level of Total Dissolved Salts (T.D.S.) in the Gidji borefield is about 120 times the recommended maximum level of 1,500mg/L T.D.S. for domestic water (World Health Organisation, 1980) and it is, therefore, unsuitable for potable use.

5.5 VEGETATION AND FLORA

The proposed gold roaster site lies within the Coolgardie Botanical District's Coolgardie Vegetation System, in the South Western Interzone, the vegetation of which has been mapped at a scale of 1:250,000 (Beard, 1972). On his map Beard shows the vegetation of the project area as sclerophyll woodland.

The vegetation and flora of selected sites in the Coolgardie Botanical District west and south of the project area have been recently described by Newbey and Hnatiuk (Newbey et al. 1985; Dell et al. 1985). Although the sites are at least 50km from the project area, some of the site descriptions and species lists are relevant.

In the explanatory notes to Beard's map, Beard (1972) notes that while the principal vegetation of the Coolgardie Vegetation System is sclerophyll woodland, the most abrupt ridges have thickets dominated by Acacia quadrimarginea or A. acuminata, with associated species such as A. tetragonophylla, Allocasuarina campestris, Eremophila oldfieldii and Cassia nemophila.

The mixed sclerophyll woodlands shown on Beard's map are principally: Eucalyptus lesoueffi, with E. salmonophloia, E. oleosa and E. campaspe dominating the woodlands on the middle slopes, and E. salmonophloia, in association with E. salubris, E. lesoueffi and E. longicornis, dominating on the lower slopes and flats.

Casuarina cristata, Myoporum platycarpum, species of Acacia and samphires and other succulents are the characteristic species on the lowest salt flats and playa lakes.

Many of the woodlands of the Coolgardie Vegetation System have been degraded by past mining activities and cutting-over for firewood, so it is probable that the existing second growth stands are more open and shorter in stature than the original stands.

5.5.1 Vegetation of the Project Area

Figure 8A illustrates the vegetation of the roaster site. The photograph is taken looking south-west across the proposed roaster site, towards the south-west corner. Figure 8B illustrates the vegetation along the pipeline route. The photograph is taken about midway between the roaster site and Kalgoorlie, near Broad Arrow Road, looking north.

The relatively flat topography of the project site, and the site's position adjoining the salt flats and playas on the eastern side of Broad Arrow Road and to the north, supports woodland dominated by salmon gum (Eucalyptus salmonophloia), often in association with other eucalypts and with an understorey dominated by bluebush (Maireana sedifolia).

The project area's woodlands are less varied in composition and poorer in species than communities on the middle slopes of the Coolgardie Vegetation System and tend to be dominated by single species: either Eucalptus salmonophloia, E. lesoueffi or E. transcontinentalis. Of the vegetation sites studied by Newbey and Hnatiuk, Site JK44 (Dell et al., 1985, p.120) most closely matches the project area site. Site JK44 is Eucalyptus salmonophloia woodland with E. transcontinentalis on red loamy deep calcareous earths having an alkalinity of pH 8 in a broad valley.

The vegetation of the roaster site (Figure 8A) is salmon gum (Eucalyptus salmonophloia) woodland with mallees including E. gracilis. The dominant understorey is bluebush (Maireana sedifolia), with prominent, occasional tall shrubs and small trees of Acacia hemiteles, Casuarina cristata, Santalum acuminatum, Eremophila scoparia, Cassia nemophila, Scaevola spinescens and Daviesia ? benthamii. Smaller shrubs include Cratystylis conocephala, Olearia ? muelleri, Acacia erinacea, A. nyssophylla, Enchylaena tomentosa, Sclerostegia disarticulata, Ptilotus exaltatus, Frankenia ? pauciflora, Mairena sp. and Atriplex vesicarius. Melaleuca pauperiflora and Atriplex nummularia are common nearby.

In some areas, such as north-west of the roaster site, Eucalyptus lesouefii, a mallee, is the dominant species. In others, such as north-east of the roaster site, Eucalyptus transcontinentalis, a tree, is the dominant species. The understoreys of these variations are essentially the same as in the roaster site but with variations in relative densities.

The vegetation in the project area that differs most from the typical roaster site vegetation is a Casuarina cristata shrubland which is similar to Newbey and Hnatiuk Vegetation Site WZ19 (Newbey et al., 1985, p. 111) but with more clumping. Other conspicuous species in the shrubland include Eremophila scoparia, E. oppositifolia, Eremophilia sp., Acacia hemiteles, Exocarpus aphyllus, Alyxia buxifolia, Cassia nemophila, Santalum acuminatum, Scaevola spinescens, Olearia ? muelleri, Zygophyllum ? aurantiacum, Maireana sedifolia, Enchylaena tomentosa, Leichhardtia australis and Ptilotus ? obovatus.

5.5.2 Flora

Principal perennial plant species of the project area are given in Section 5.5.1. Annuals, such as Brachycome ciliata, everlastings and mulla-mullas, would be common at appropriate times following rains.

A specific search for gazetted rare flora has not been undertaken. However, none of the species likely to occur on the site is gazetted as rare; e.g. the two gazetted rare species recorded by Newbey and Hnatiuk (Newbey et al., 1985) during their two published surveys, Eucalyptus brachyphylla and E. kruseana, were found by them only in granite complexes, and most or all of their other significant species were recorded in habitats not represented in the gold roaster project area.

5.6 FAUNA

The habitats of the proposed gold roaster site and surrounding area are described above in Section 5.5. The fauna habitats provided by salmon gum (Eucalyptus salmonophloia) woodlands and other vegetation in the project area are widespread and occur over extensive areas in the Coolgardie Botanical District. The fauna utilising the habitats are also likely to be widespread and few, if any of them, are rare or in need of special protection. Rare species in the broader Kalgoorlie area tend to be associated with heathy vegetation, rock outcrops, sand dunes and fresh-water wetlands, none of which are represented in the project area.

The following gazetted bird species may occur within the Kalgoorlie area, although most range widely over Australia and their conservation statuses would not likely be affected by the project:

- **Peregrine Falcon** - Falco peregrinus. Ranges widely over most of Australia and indeed the world. It is "nomadic, sedentary or partly so and prefers coastal or inland cliffs and gorges, timbered watercourses, generally near rivers and swamps, plains and open woodlands" (Pizzey, 1980). It has been categorised as "J - in need of special protection" (Fisheries & Wildlife 1983).

- **Grey Falcon** - Falco hypoleucos. Ranges widely over most of central Australia, where it prefers "open habitats: semi-deserts, grassy inland plains, timbered watercourses and pastoral land" (Pizzey, 1980). Gazetted as "G - species with widespread distributions but which are very rare" (Fisheries & Wildlife 1983).

- **Major Mitchell Cockatoo** - Cacatua leadbeateri. Occupies much of central and southern Australia, where it occurs in a wide variety of habitats. It is "sedentary and nomadic" (Pizzey, 1980). Gazetted as "C - species with drastically reduced range since European settlement" and "J - in need of special protection" (Fisheries & Wildlife, 1983).

- **Naretha Bluebonnet** - Platycerus haemotogaster narethae. Recorded by Pizzey (1980) as "nearly confined to the Nullabor Plain from east of Kalgoorlie, WA, to Mundrabilla - Eucla, uncommon. The species is probably mostly sedentary". Gazetted "E - species with very restricted geographic range" (Fisheries & Wildlife, 1983).

- **Crested Shrike-tit** - Falcunculus frontatus. The south-western race leucogaster occurs from "Geraldton - Norseman to the south coast east of Albany" (Pizzey, 1980). Its preferred habitat is eucalypt woodland and forests, and timbered watercourses. Gazetted "C - species with drastically reduced range since European settlement" (Fisheries & Wildlife, 1983).

Two gazetted pythons have also been judged as possibly occurring on the area, as follows:

- **Woma** - Aspidites ramsyi. In southern Western Australia, the Woma occupies a large triangle from Shark Bay in the north, to Boddington in the south, to Rawlinna in the east. It appears to prefer sandplains. It has been categorised as "C - species with drastically reduced range since European settlement" and "J - in need of special protection" (Fisheries & Wildlife, 1983).

- **Carpet Python** - Morelia spilotes imbricatus. Distribution is "the south-west of Western Australia, north to Geraldton and Yalgoo, and east to Kalgoorlie, Norseman and Mt Le Grand; also West Wallabi, Garden, North Twin Peak and Mondrain islands" (Storr et al., 1981). Storr also states that Museum collections "suggest a decline in the numbers of this sub-species (at least on the mainland) similar to Aspidites ramsyi in south-west Western Australia". It has been categorised as "J - in need of special protection" (Fisheries & Wildlife, 1983).

The records of the Western Australian Museum indicate that most mammals occurring in the vicinity of the gold roaster are both common and widespread within that area.

One rare mammal of interest, the Bilby (Macrotis lagotis), may possibly occur within the Kalgoorlie area. It is categorised as "C - a species with a considerably reduced range since European Settlement (Fisheries and Wildlife, 1983). The last specimen collected at Kalgoorlie by the Western Australian Museum was taken in 1973. However, Strahan (1983) lists its preferred habitat as "hummock grasslands and acacia shrublands with spinifex and tussock grasses". As none of this type of vegetation is present near the roaster site, it is unlikely that the Bilby would occur there.

In conclusion, the limited and localised extent of the project indicates that there is would not likely be any effect on the status of the above faunal species.

5.7 ABORIGINAL HERITAGE

According to the Department of Aboriginal Sites at the Western Australian Museum, there are no registered sites present in the immediate vicinity of the gold roaster. No surveys have specifically been carried out, however, so it is possible that sites do exist in the area. If any artefact scatters or archaeological sites should become apparent during the life of the project, the Proponent would notify the Department of Aboriginal Sites.

5.8 LAND USE

Kalgoorlie, and adjoining Boulder, both saw their fortunes rise and fall with the prosperity and subsequent diminishing of gold's economic importance. The recent resurgence of the gold industry and divergence of Kalgoorlie's economic base into nickel and pastoral development has aided the town's continuing growth. Tourism has also grown rapidly during the last few years.

Several mines operate in the area, including those owned by NKML and associated companies. Other mines within a thirty kilometre radius of the proposed roaster site are Black Flag Mine, Golden Kilometre, Six Mile, Last Chance/Ballarat, Paddington and Lady Bountiful (Rob Griffiths, Kalgoorlie Mines Department, pers. comm.).

Goongarrie National Park is situated some 63km to the north of Kalgoorlie and 45km north of the proposed project site. There are also a number of smaller reserves and state forests within a 50km radius of Kalgoorlie town centre. King of the West Lakes, about 9km from the site, is known as a local recreation area, although it is not gazetted as such.

5.9 SOCIAL DEVELOPMENT

Kalgoorlie and Boulder, with a combined population of about 23,404 (ABS, 1986 Census) are the major regional centres for the area.

Kalgoorlie-Boulder has a wide range of facilities including:

- o Banks,
- o Public transport,
- o Hotels and motels,
- o Petrol stations,
- o Supermarkets,
- o Hospital and Flying Doctor service,
- o Theatres and night clubs,
- o Government services,
- o Sporting centres, and
- o Schools, including tertiary institutions.

As such, the townships would be able to supply most essential goods and services.

Kanowna Station is the closest permanent population to the proposed gold roaster site, approximately 10km to the north. It has a permanent population of two (Geoff Carter, Kalgoorlie Pastoral Office, pers. comm.).

The nearest mines to the site are Six Mile and Last Chance/Ballarat, both situated within 10km to 15km east of the site. Other mines close to the site are Broad Arrow Mine (Golden Kilometre), and Paddington Mine, situated 16km and 15km to the north-west respectively. Black Flag Mine is situated approximately 22km to the west of the proposed site while Ora Banda Mine is approximately 45km to the north-east of the site. None of these mines is permanently occupied, and their workforce all commute from Kalgoorlie-Boulder.

A regional map indicating areas of interest, particularly within a 15km radius of the roaster site, is shown on Figure 9.

6.0 ENVIRONMENTAL IMPACTS

6.1 AIR QUALITY

6.1.1 Sulphur Dioxide

The air dispersion model described in Section 3.2.1 has been used to estimate the ground-level concentrations that would arise from a variety of different roaster configurations. Some of these scenarios have not been presented in this report because they were essentially part of a lengthy and iterative investigation of possible options. The simulation results have been selected to demonstrate the major factors which have been relevant to the site selection process, and to illustrate the sensitivity of air quality to operating conditions such as stack height, roaster configuration and emission load.

The air dispersion model has been used to illustrate how maximum sulphur dioxide ground-level concentrations for 1-hour, 3-hour, 24-hour and 1-year averaging periods could vary, assuming:

- o stack height variations from 80m to 200m,
- o existing (1984) roaster emissions from the Croesus (NKM), Paringa (GR) and Oroya (KLV) roasters, and
- o satellite roaster in operation with Croesus and Oroya roasters (with Paringa roaster decommissioned).

Roaster sizing and design is such that the selected roaster would be able to accommodate various head grade sulphur levels and head feed rates. The final scenario selected for plume dispersion modelling is presented in Table 3.

TABLE 3

BASE CASE FOR PLUME DISPERSION MODELLING

Parameter	Base Case
Mine throughput, Mtpa	2
Sulphur content, %	3.5
Stack exit velocity, m/s	12.3
Temperature, °C	340
Stack diameter - internal (top), m	2.0
Stack diameter - external (top), m	3.2
Sulphur dioxide flow rate, kg/hr	16,000
Sulphur trioxide flow rate, kg/hr	300
Dust flow rate, kg/hr	15

Two special fixed receptors were defined for modelling purposes:

- o Kanowna, 10km north of the stack, has a permanent population of two persons, and
- o The Golf Course at the northern edge of Kalgoorlie, a location which represents the closest Kalgoorlie residences to the stack.

Ground-level concentrations of sulphur dioxide at these fixed receptors has been analysed throughout the dispersion studies. A third 'variable receptor' which has been analysed is the point of maximum ground-level concentration, which shifts location from 1km to 2km to the north and north-west of the stack, depending on the prevailing wind patterns.

In addition to the fixed and variable receptors used for the stack sensitivity analysis, a full set of isopleths has been produced for each averaging period to give an indication of the spatial distribution of air pollution for the existing and proposed roaster configurations.

The various graphs and isopleths for the plume dispersion simulations are presented on Figures 10 to 13 and are discussed in the following sections.

o Sensitivity of Air Quality to Stack Height

A stack height sensitivity analysis was performed, based on the parameters presented in Table 3, and utilising the simplifying assumption that the proposed satellite roaster would operate in isolation, as the only source of sulphur dioxide emissions in the Kalgoorlie area. The results of the stack height sensitivity runs are summarised on Figure 10, which shows the maximum ground-level concentrations predicted to occur at three receptors: on the northern outskirts of Kalgoorlie; at Kanowna; and at the variable receptor 1km to 2km from the stack. For each receptor, the relationship between stack height and ground-level concentration has been plotted for the 1-hour, 3-hour, 24-hour and 1-year averaging times.

For the North Kalgoorlie residential area (represented by the fixed receptor at the Golf Course), the simulations indicate that any stack height above 80m would ensure that maximum ground-level concentrations remain below both the EPP and NHMRC Guidelines for all averaging periods (Figure 10a). Nevertheless, the slope of the curves (Figure 10a) for 1-hour and 3-hour averaging periods indicate that, for stack heights between 180m and 200m, ground-level concentrations on the northern outskirts of Kalgoorlie would show marked reductions over those which are predicted for a 160m stack. A similar trend is noted for the 3-hour averaging period at the Kanowna receptor (Figure 10b), and for the 1-hour averaging period of the variable receptor near the stack (Figure 10c).

Analysis of meteorological conditions provides an explanation for the apparent advantage of a 180m stack over one of 160m. The highest ground-level concentrations are associated with trapping of the plume beneath an inversion. As the stack height is increased, so the plume can progressively penetrate higher and higher inversions. Also, with the higher stack, the plume dispersion takes place under higher wind speed conditions. As a result, ground-level concentrations are lower.

However, higher stacks would involve significant incremental capital costs, and the additional cost would not be warranted since it has been demonstrated that air quality objectives would be achievable in the north Kalgoorlie area for stacks as low as 80m in height.

For the Kanowna area (Figure 10b), the simulations indicate that the ground-level concentrations would be well within the EPP Guidelines for all averaging period given a stack height of at least 100m, while a stack height of 120m would be more conservative. While the NHMRC guideline is met for the annual averaging period, a stack as high at 200m would not meet the requirements for the 1-hour averaging period.

For the variable receptor near the stack (Figure 10c), the simulations indicate that there is no economically viable stack height which would ensure that the maximum ground-level concentrations at the variable receptor would achieve either the EPP or the NHMRC Guidelines for the 1-hour, 3-hour and 24-hour averaging periods, although the annual guidelines could be achieved with a 160m stack. It should be noted again, that the variable receptor falls within a non-populated area, approximately 1km to 2km north to north-west of the stack, and therefore the health and social impacts of high sulphur dioxide emissions would be insignificant.

In conclusion, ground-level concentrations in the Kalgoorlie-Boulder residential areas would be relatively insensitive to changes in stack heights over the economically feasible ranges (up to 200m high). While a stack height of 80m (assuming a roaster in isolation) would result in acceptable ground-level concentrations in the Kalgoorlie-Boulder urban areas, this minimum height has been increased by 50%, and a 120m high stack has been proposed.

As mentioned previously, the stack sensitivity analysis was performed under the simplifying assumption that the roaster would operate in isolation from other sources.

It should be noted that the proposed roaster plume would only interact with the NKM and KLV roaster plumes under northerly wind conditions and thus, only areas to the south of the NKM and KLV roasters would expect to experience the combined plumes. As can be seen from the following sections and associated isopleth diagrams, the low number of northerly winds, and the conditions with which they are associated, would not give rise to high concentrations in the southern areas of Kalgoorlie or Boulder.

o Existing Air Quality

As mentioned in Section 5.3, the EPA operates three air quality stations, with continuous sulphur dioxide monitoring and data recording equipment, at the Kalgoorlie Regional Hospital, the Kalgoorlie Technical School, and the South Boulder Primary School.

Figure 11 presents the maximum recorded values of sulphur dioxide for all averaging periods for 1984 and 1985 from the three air quality monitors. The data from all three stations have been considered as one data set and represent the highest concentrations that have occurred anywhere in the monitoring network. Figure 11 shows that on past occasions, sulphur dioxide concentrations have exceeded the criteria of the Draft Environmental Protection Policy.

o Comparison of Existing and Predicted Air Quality

Figures 12a, 12b, 12c, and 12d compare the isopleths for the existing roaster configuration (blue contours) with the corresponding isopleths for the proposed configuration (green contours), for all four averaging periods. It is obvious that air quality in the Kalgoorlie-Boulder residential areas would be generally improved by installing the satellite roaster and shutting down the Paringa roaster close to town. The most significant conclusion indicated by these isopleths is that the north-north-westerly direction of the proposed roaster site with respect to Kalgoorlie-Boulder would be very close to the optimum in terms of minimising sulphur dioxide air pollution in those major residential areas. In addition, the isolated location of the proposed site with respect to populated areas would ensure that the health and social impacts would be minimal. The isopleths for the proposed roaster configuration are presented again on smaller scale maps to illustrate the air quality impact on all regions surrounding the proposed roaster. These contours (Figures 13a, 13b, 13c, and

13d) indicate the predicted ground-level concentrations of sulphur dioxide within a 15km radius of the stack. The nearest populated receptors (Kanowna and the Golf Course) are shown on the Figures.

Care should be taken in interpretation of the plume dispersion isopleths on Figures 12 and 13. These contours are constructed from simulated data rather than precise measurements, and should be analysed with respect to overall regional patterns of dispersion as opposed to exact predictions of air quality at specific locations.

- Fumigation

One dispersion scenario, which can not be properly simulated in a Gaussian dispersion model (i.e. the ISC-ST), is the dispersion of pollutants under fumigation conditions. A fumigation episode typically occurs when a plume is emitted under stable conditions such as might apply in the early morning. Because of the stability of the air, the plume experiences slow vertical dispersion. Following sunrise, the ground warms and a convective layer of well-mixed air develops near the ground. This layer deepens with time as the morning progresses and as solar heating continues. When the well-mixed convective layer reaches the slowly dispersing plume, pollutants are rapidly mixed to the ground. This process can result in short-term high concentrations of pollutant at ground-level. These high concentrations occur as the top of the mixed-layer passes through the plume. The temporarily high concentrations eventually decrease once the plume is emitted into the well-mixed layer.

A number of special models have been developed to simulate this dispersion condition. One of the more realistic approaches is that developed by Deardorff and Willis (1982). The Deardorff and Willis model has been used to estimate ground-level concentrations for fumigation of the plume from the proposed roaster. The assumptions made in using the Deardorff and Willis model were such as to represent an unfavourable but nevertheless realistic scenario for fumigation. With these assumptions, the estimated 1-hour average concentration of SO_2 in the fumigation episode would be of the order of 2,800 ug/m^3.

It is interesting to note that this is lower than the highest 1-hour concentrations predicted by the plume dispersion model, which were of the order of 6,400 ug/m^3 for a 120m stack. As discussed previously, these concentrations occurred under limited mixing conditions. It would appear that fumigation would produce high concentrations of sulphur dioxide which would persist for only short periods of time, so that the 1-hour averages would not be particularly high compared with the 1-hour average concentrations which would occur under limited mixing.

Fumigation episodes would likely occur on many days throughout the year. However, the frequency of occurrence over Kalgoorlie is expected to be very low. On an annual basis, less than five percent of winds would actually carry the plume towards Kalgoorlie and very few of these occasions would be associated with conditions conducive to fumigation.

6.1.2 Particulate Matter

The standard guideline for particulate concentration in precipitator outlets is 250 mg/Nm^3 (for Western Australia). The Proponent intends to adhere to these guidelines. In addition, it may be possible to achieve lower particulate emission rates, down to 100 mg/Nm^3.

Particulate matter concentrations contributed from the proposed roaster would be approximately 0.3 percent of the SO_2 concentrations. Thus, the maximum ground-level concentration of particulate matter from a 120m roaster stack is estimated to be 2.0 ug/m^3 and 0.3 ug/m^3 for 24-hour and 1-year averaging periods respectively. These concentrations would be well below the 150 ug/m^3 USEPA secondary standard for 24-hour averaging periods and would also be well below the 90 ug/m^3 NHMRC guidelines for 1-year averaging periods.

6.1.3 Heavy Metals

Certain metals present in the concentrate could be discharged to the atmosphere via the stack. These are arsenic, cadmium, tellurium, antimony and lead. A semi-quantitive analysis was done on calcine and concentrate samples to determine the compositions of numerous elements (Table 4).

TABLE 4

METHODS USED FOR ELEMENTAL ANALYSIS

Method	Elements
Atomic Absorption	Sodium (Na), Potassium (K)
Optical Emission Plasma Spectometry	Magnesium (Mg), Chromium (Cr), Vanadium (V), Nickel (Ni), Arsenic (As), Iron (Fe), Titanium (Ti), Calcium (Ca), Aluminium (Al), Zinc (Zn), Copper, (Cu), Phosphorus (P), Sulphur (S)
Inductively Coupled Plasma Mass Spectrometer	Cadmium (Cd), Lead (Pb), Tellurium (Te), Antimony (Sb) and all other elements

Comparison of calcine and concentrate analysis has indicated that, to a good first approximation, substantial arsenic (As), lead (Pb) and cadmium (Cd) would remain locked in the calcine, and that there would be no significant volatisation of heavy metals, due to the relatively low roasting temperature.

As the roaster would be operating under oxidising conditions, it is likely that the major part of the arsenic in the feed concentrate would remain fixed in the calcine as iron arsenate, and the arsenic trioxide (As_2O_3) would be unlikely to exceed 4 ppm, which is equivalent to less than 13 mg/Nm^3.

6.2 WATER QUALITY

Withdrawal of process water from the Gidji borefield, 8m below the ground surface, would not affect the surrounding vegetation, as the vegetation is more likely to utilise soil-stored water rather than water at depth.

Washdown water would be collected and directed back to the process. All discharges would be piped to the tailings dam and return water would be piped back to process. The concrete slab below the leach/adsorption area would be bunded and provided with a sump so that any potential spillages could be recovered.

Sewage water disposal from the site would be to septic sites.

All process discharges would be directed to the tailings disposal area, where they would be deposited into a conventional tailings dam. Potential impacts due to the operation of the tailings dam could result from leakage of cyanide-bearing effluents from storage. However, the tailings would contain substantial quantities of gold, and the proponent would therefore take every precaution to ensure that gold-bearing effluent would not leak from the dam.

In addition, the scale and potential consequences of leakage would be minimised as a result of:

- o the natural and rapid decomposition of cyanide residues on exposure, due to the action of sunlight, oxygen, carbon dioxide and microbial breakdown.
- o the fine-grained nature of the tailings, which would lead to the deposition of low permeability material on the walls and floor of the dam, and
- o the adsorption of leachate, including heavy metals, onto soil particles.

Leakages from the dam are, therefore, expected to be minimal, and the resultant environmental impact insignificant.

6.3 NOISE

Noise is not expected to be a problem. The major source of noise in the process would be the main exhaust blower.

6.4 AESTHETICS

The roaster site would cover some 2 ha with a further area of 36 ha set aside for the tailings pond. The site is currently an area of mining interest and past activities have degraded the surrounding vegetation. The remote location of the roaster and its distance from any stations, major populations, or public roads would ensure that the aesthetic impact of the project would be slight. Section 7.3 discusses management commitments to minimise aesthetic impact.

6.5 FLORA AND FAUNA

There are no species of rare or restricted flora known from the project area or its vicinity, nor are there any likely habitats for them there. The gold roaster site and surrounding area have been considerably disturbed by previous exploration activities, and woodlands have been cut over for firewood. The total area of disturbance due to the project is planned to be less than 50ha, representing less than 10 percent of the total Gidji leases. Consequently, if disturbance is restricted to the planned infrastructure size and location of the plant, the impacts on the native vegetation and flora would be minimal.

Similarly, no known species of rare or restricted fauna occur within the project area, and the proposed project is not expected to have significant impacts on the fauna of the area, although the tailings dam would have the potential to create an impact as far as wildlife is concerned. In an essentially dry area such as Kalgoorlie, a water hole could become a focal point for wildlife, especially the more mobile species.

Most of the smaller mammals and reptiles do not drink, as water requirements are met by their food. However, kangaroos, domestic stock and birds, especially flocking species such as finches and parrots, present special problems. Experience with other tailings dams indicates that this impact would be minor.

o Effects on vegetation

The impact of sulphur dioxide output on the vegetation around the roaster site may be judged from the effects observed at the Kalgoorlie Nickel Smelter, which operates in a similar meteorological and biological environment to that of the roaster site.*

The smelter is licenced to emit 1,000 tonnes per day of SO_2, but actual emissions in recent years have been in the order of 500 tonnes per day, from a 153m high stack. Since 1983, there has been no visable signs of vegetation damage and previous foliage damage has improved. (WMC pers. comm.). Sulphur dioxide output from the roaster

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* Vegetation damage was recorded from 1km to 3km of the nickel smelter site during a vegetation monitoring programme carried out between 1981 and 1982. However, this damage was attributed to low level discharge from an electric furnace, and foliage has recovered significantly since the furnace was decommissioned in 1983.

would be somewhat less than 400 tonnes per day, from a 120m high stack, and therefore no significant vegetation damage is anticipated. Nevertheless, a vegetation monitoring programme would be implemented by the Proponent.

Mitigative measures for flora and fauna management are discussed in Section 7.2.

6.6 ABORIGINAL SITES

According to the Department of Aboriginal Sites at the Western Australian Museum, there are no registered sites present in the immediate vicinity of the gold roaster. The Proponent intends to comply with the provisions of the Aboriginal Heritage Act 1972–1980.

6.7 TRAFFIC IMPACTS

The small increase in traffic during the construction period of the project is expected to lessen once the plant is operational. There would be some increase in traffic circulation during operation, associated with the trucking of gold-laden carbon from the satellite leach facility to the Fimiston gold plant. Broad Arrow Road, the main access to the site, is the major traffic route between Kalgoorlie and the Leonora/Laverton area and therefore, the impact of increased traffic along the road would be minimal.

6.8 SOCIAL IMPACTS

The down-town centre of Kalgoorlie is 17km south of the project site, while the northern most residential area of Kalgoorlie is 15km to the south. Apart from Kalgoorlie-Boulder, Kanowna Station, 10km north of the proposed satellite roaster site, which has a population of two, is the only permanent population within the area. Golden Kilometre (Broad Arrow Joint Venture) 16km to the north-west has a hotel and 3 or 4 houses and a population of about 10 who remain there on a shift work basis. Many of the mines and pastoral leases in the area are either abandoned or no longer operative. Figure 9 shows the present and abandoned centres of population in the area. Since the permanent population within a 15km radius of the roaster site is only two persons, the expected social impact would be negligible.

6.9 PUBLIC ACCESS

Access to the site from Broad Arrow Road would be via a 2km long unsealed road. Public access would not be permitted to the general site area.

7.0 ENVIRONMENTAL MANAGEMENT AND MONITORING

NKML has a long history of mining and ore processing on the 'Golden Mile'. It is a progressive mining company with considerable operating experience and expertise gained from the development and successful operation of three significant gold mines in the Kalgoorlie area. NKML has a strong commitment to technical excellence with respect to production, safety, and environmental factors, and the company would make a commitment to undertake an appropriate level of environmental monitoring and management associated with the roaster development.

The principal environmental issue for this satellite roaster which requires management commitment to monitoring and control is air quality. Other issues include flora and fauna, rehabilitation and safety procedures. Appropriate commitments are discussed in the remainder of this section.

7.1 AIR QUALITY

NKML is an established gold producer in the Kalgoorlie area, and is consequently involved on a day-to-day basis with environmental monitoring and management of sulphur dioxide for its current operations. The SO_2 monitoring network that currently operates in Kalgoorlie (with assistance from NKML) would be extended by the establishment of an additional SO_2 monitor at the northern outskirts of town. The results of this monitoring programme would be regularly made available to the EPA.

NKML currently undertakes the planning and implementation of contingency procedures (including plant shut-down) in respect of its existing roaster facilities, and expects to incorporate similar contingency procedures in the operation of the new roaster. The NKML current sulphur dioxide monitoring and management programme is summarised in Appendix C.

7.2 FLORA AND FAUNA

o Retention of Trees

The eucalypt woodland communities found in the area are widespread within the Coolgardie Botanical District. Efforts would be made to retain large trees and clumps of trees found on the site. The slurry pipeline, water pipeline, roaster access road and overhead power supply would be aligned so as to minimise the necessity to remove trees.

o Prevent Drinking from Tailings Pond

The area containing the tailings dam would be securely fenced, preventing access by larger fauna, such as stock and kangaroos. As noted in Section 6.5, most small animals do not drink, and the greatest potential impact would be on birds. This impact would be closely monitored, and appropriate management action taken as required. There is a body of useful experience in deterring avifaunal use of tailings ponds in the south-west of Western Australia, although there have been no reports of significant impacts as a result of the many tailings dams developed in the Eastern Goldfields over the last few years.

o Fire Management

Adequate fire breaks would be provided around facilities and nearby susceptible areas and all employees and contractors would be instructed in the need for fire prevention. All mobile equipment would be fitted with extinguishers and the plant would be provided with an adequate fire fighting water supply system.

o Monitoring Effects of SO_2

Emissions of sulphur dioxide and the effects of these emissions on the natural environment should be similar to those of Western Mining Corporation's (WMC) nickel smelter south of Kalgoorlie. Consequently, a programme for monitoring environmental impacts of SO_2 emissions from the gold roaster's tall stack would draw upon the experience of WMC.

The first stage in the WMC programme was to determine which areas received the greatest levels of SO_2 outfall from the WMC smelter tall stack. The procedure used for determining this was to place a total of 60 to 70 posts with SO_2-sensitive lichens in concentric circles around the smelter, spaced between 1km and 10km from the smelter. In the second stage of the programme, three permanent, fenced, monitoring quadrats measuring 100m x 200m were defined between 8km and 11km from the stack. These vegetation quadrats were defined based on two major criteria as follows:

- o the quadrats were located near lichen posts which had shown the greatest pollution impact in Stage 1, and
- o the quadrats were located to include a variety of local species, including higher plants as well as lichens.

A control quadrat was defined in an area without measurable pollution effects, approximately 30km distant, towards Kambala. Transects, including native shrubs and lichens, were laid out in each quadrat for biennial monitoring for effects of SO_2 pollution. No impact of sulphur dioxide pollution on these vegetation transects have been observed to date.

A similar programme for the proposed satellite roaster could be streamlined, based on the pollution pattern observed from the air dispersion modelling studies. For example, lichen posts could be more efficiently located based on prevailing wind patterns than in concentric rings. It is expected that there would be feedback between the environmental officers at both the roaster and the smelter. It is suggested that annual reports on the monitoring programme be submitted to the EPA.

o Firearms Management

Firearms would be prohibited from site to avoid the risk of stock or native species being shot.

7.3 REHABILITATION

Rehabilitation would be undertaken in two areas:

- o rehabilitation of the tailings disposal area, and
- o rehabilitation of the project site after decommissioning.

The proponent intends to rehabilitate the tailings disposal area by revegetation, to produce an artificial landform in keeping with its surroundings, and supporting similar vegetation.

Prior to construction of the first cell in the overall tailings dam, the underlying topsoil would be stripped and stockpiled. This resource would be spread on the slopes of the first cell of the tailings dam, when deposition ceases. This progressive rehabilitation of the tailings dam would allow the success of the programme to be evaluated, and modified as required.

In order to achieve the optimum results with the limited topsoil resources that would be available on site, the outslopes of the tailings area would be graded to a flattened slope that would maximise the potential for revegetation.

Rehabilitation of the project site after decommissioning would be aided by the results of the rehabilitation programme for the tailings dam. At the time of site abandonment, the rehabilitation of the tailings disposal area would have been largely completed, and the experience gained from this programme would then be further applied in the rehabilitation of the other areas, such as roads and tracks, hardstand areas, and other compacted and cleared ground. These areas would generally be ripped or scarified to break up the subsoil, and any remaining topsoil (with its integral seed stock) would then be respread over these areas.

The Proponent actively supports existing rehabilitation initiatives in the Goldfields, such as the Goldfields Dust Abatement Committee, and would utilise the results of any applicable research efforts, including those at the Kalgoorlie nickel smelter, in the roaster rehabilitation programmes.

7.4 SAFETY MEASURES AND CONTROLS

NKML is an experienced mine operator along the Golden Mile, and is fully aware of its obligations towards safety in construction, operation and management.

All plant and equipment would be designed for economic and reliable operation for a life of 15 years. Design, manufacture, construction and testing would be in accordance with the relevant current standards of the Standards Association of Australia. Designs would comply with all relevant Acts, Regulations and associated amendments of the State of Western Australia.

Full compliance with the Construction Safety Act and Mines Regulation Act would be maintained during the appropriate phases. Operator handling and exposure to dangerous goods (especially cyanide) would be minimised and all Mines Department safety regulations would be observed.

Appropriate safety equipment (including safety showers and eye wash equipment) and handling procedures would be employed. Staff would be specially trained in correct handling and emergency procedures. Relevant first aid equipment would be maintained on-site.

7.5 MANAGEMENT OF DANGEROUS GOODS

All government regulations relating to the storage and handling of dangerous goods would be observed.

Vessel entry procedures would be developed for tanks that contain cyanide or other noxious materials.

Sodium cyanide would be transported by truck in drums and/or 920kg bulk bags in wooden boxes. The main cyanide storage of about 150 tonnes would be at the Fimiston plant site. About 15 tonnes would be stored at the roaster site.

Disposal of cyanide drums and similar dangerous packaging would be by burial in a designated area.

8.0 CONCLUSIONS

The long-term viability of gold mining operations at Fimiston and the continued prosperity of the towns of Kalgoorlie and Boulder require the development of additional roasting capacity near Fimiston. The preferred roaster configuration would be to construct a satellite facility 17km to the north-north-west of Kalgoorlie town centre, and to decommission the existing Paringa roaster. The selected site would be close to optimum based on prevailing wind patterns and the isolated nature of the site with respect to populated areas.

The major impacts of the proposed roasting facility would be on air quality, while other environmental and social impacts would be minimal.

The primary issue of concern with respect to air quality would be the impact of sulphur dioxide emissions on human health and vegetation. Analysis has shown that ground-level concentrations of sulphur dioxide in the residential areas of Kalgoorlie and Boulder would generally improve with the proposed roaster configuration. Furthermore, no significant vegetation damage due to sulphur dioxide concentrations is anticipated, based on experience from the nearby nickel smelter. Other emissions from the roaster, such as particulate matter and heavy metals, would be within recommended guidelines.

Environmental management and monitoring commitments for air quality and other issues such as flora and fauna, rehabilitation and safety systems are summarised below:

- Air Quality

  NKML would plan and implement a sulphur dioxide management and control procedure similar to that currently in place with its existing roasting facilities. A new continuous sulphur dioxide monitor would be installed and operated by NKML in the northern outskirts of Kalgoorlie. Regular reports would be provided to the EPA.

- Flora and Fauna

  Efforts would be made to preserve vegetation and stands of trees during project construction. Fire management procedures would be implemented. A programme for monitoring the environmental impacts of sulphur dioxide on vegetation would also be implemented and regular reports would be provided to the EPA. The tailings area would be securely fenced off to prevent access by larger fauna. Avifaunal use of the pond would be monitored and appropriate management action taken as required.

- Rehabilitation

  The Proponent plans to rehabilitate the tailings disposal area by revegetation to produce an artificial landform in keeping with its surroundings, and supporting similar vegetation. Rehabilitation of the project site after decommissioning would include revegetation of roads and tracks, hardstand areas, and other compacted and cleared ground.

- Safety Measures and Controls

  Safety measures and controls would include full compliance with all relevant Acts and Regulations, as well as a comprehensive operator training programme.

- Management of Dangerous Goods

  All government regulations related to the storage and handling of dangerous goods would be observed.

In summary, the satellite gold roaster project would represent an important development in the Kalgoorlie-Boulder area in terms of ensuring future viability of the gold producing region, while achieving air quality objectives for the residential areas.

There are no known environmental or social impacts of the project which would likely be significant or unmanageable. The Proponent would implement various management programmes designed to monitor and mitigate the effects of the operation. Given the nature of the existing environment, the project as described herein, and these management programmes, the project should produce significant benefits to the region and the State without significant adverse environmental impacts.

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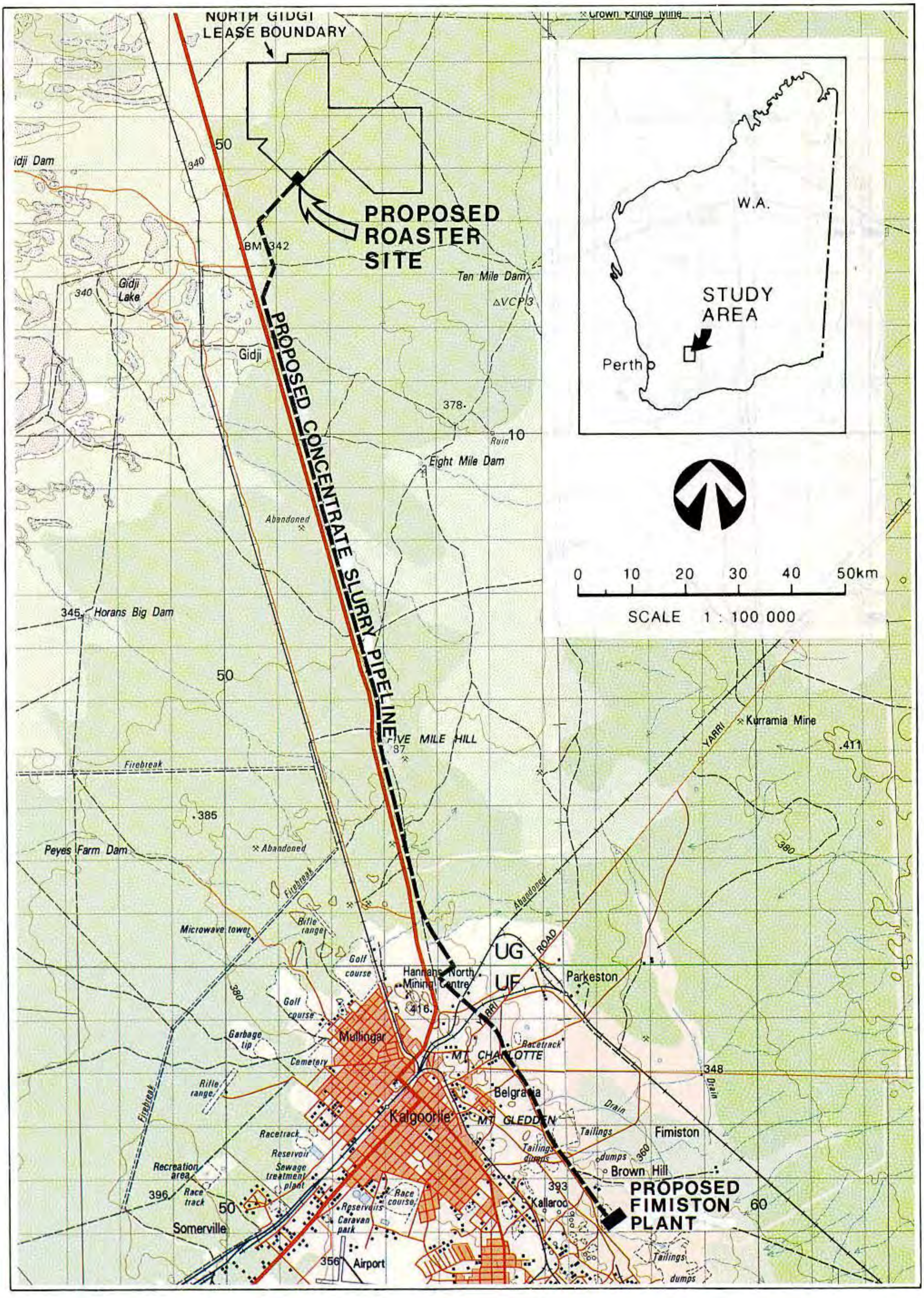
NOMENCLATURE

%	percent
As	Arsenic
As_2O_3	Arsenic Trioxide
BIF	banded ironstone formations
^oC	degrees celsius
C	Fisheries and Wildlife category
Cd	cadmium
CIL	Carbon-in-Leach
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DRM	Dallhold Resources Management Proprietary Limited
E	Fisheries and Wildlife category
EPA	Environmental Protection Authority
EPP	Environmental Protection Policy
G	Fisheries and Wildlife category
GMK	Gold Mines of Kalgoorlie
J	Fisheries and Wildlife category
ha	hectare
hr	hour
HCl	hydrochloric acid
ISC-ST	Short Term Industrial Source Complex model
kg/hr	kilograms per hour
KLV	Kalgoorlie Lake View
km	kilometre
KMA	Kalgoorlie Mining Associates
kV	kilovolt
m	metre
mg	milligram
mm	millimetre
Mpta	million tonnes per annum
NHMRC	National Health and Medical Research Council
NKML	North Kalgurli Mines Ltd
Nm^3	Normal metre cubed
Pb	Lead
PER	Public Environmental Report
pH	a measure of acidity
ppm	parts per million
SECWA	State Energy Commission of Western Australia
Sb	Antimony
SO_2	Sulphur dioxide
SO_3	Sulphur trioxide
T.D.S.	Total Dissolved Solids
Te	Tellurium
tpa	tonnes per annum
VEPA	Victorian Environment Protection Authority
WHO	World Health Organisation
WMC	Western Mining Corporation

FIGURES

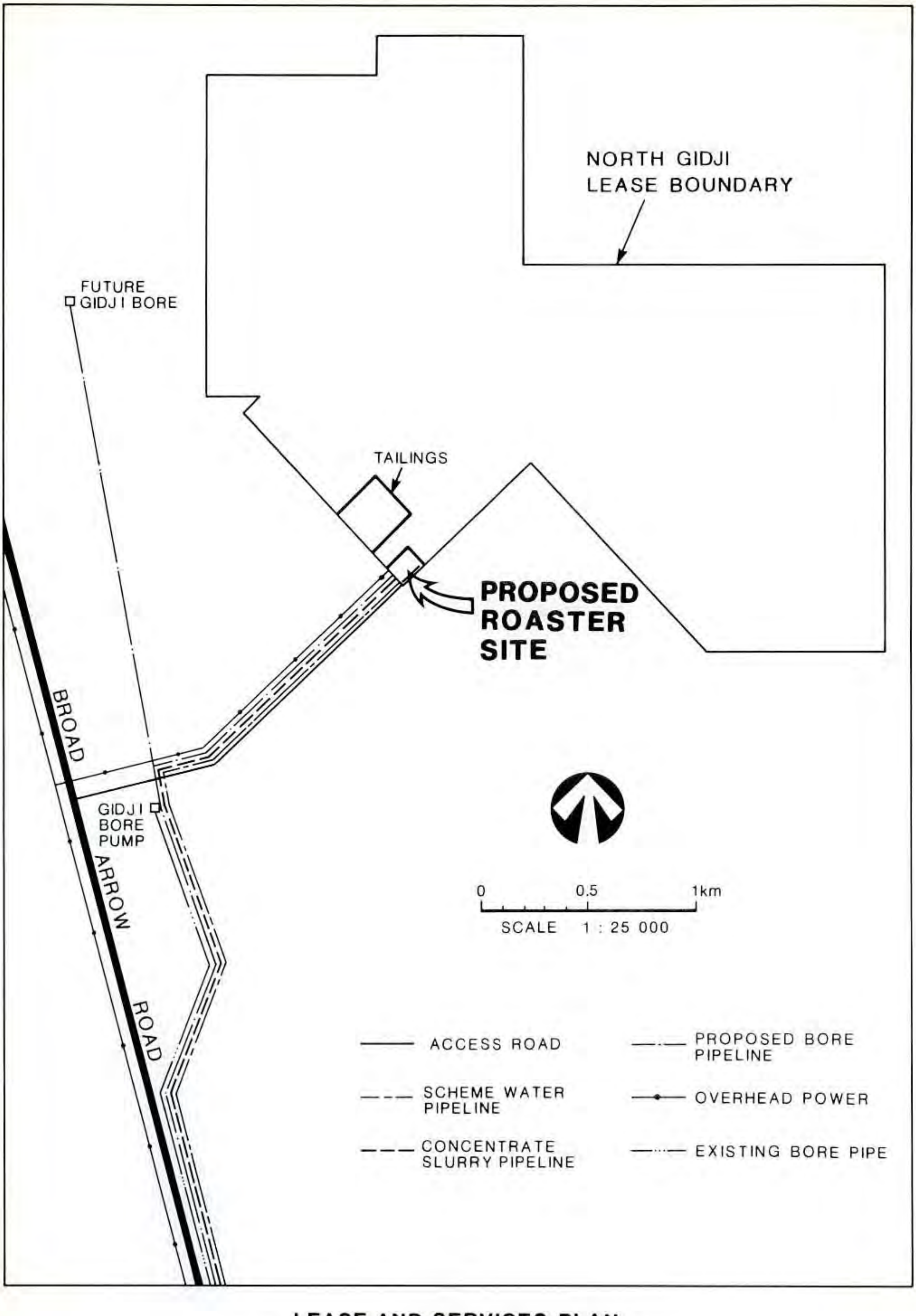


LOCALITY PLAN

NOTE: Base map reproduced by permission of the Surveying and Land Information Group, Department of Administrative Services, Canberra

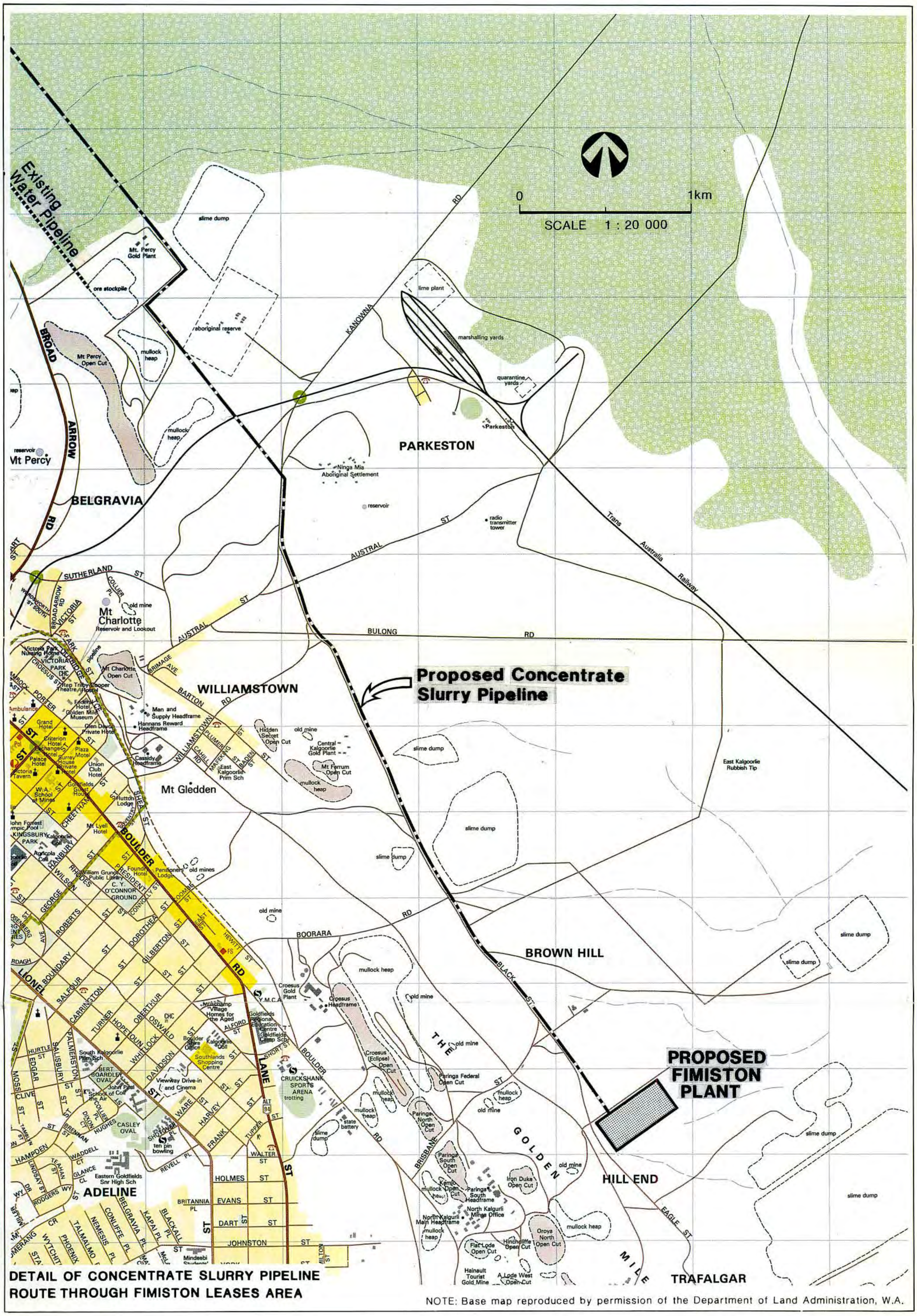
Figure 1

Dames & Moore



LEASE AND SERVICES PLAN

Figure 2
Dames & Moore



DETAIL OF CONCENTRATE SLURRY PIPELINE ROUTE THROUGH FIMISTON LEASES AREA

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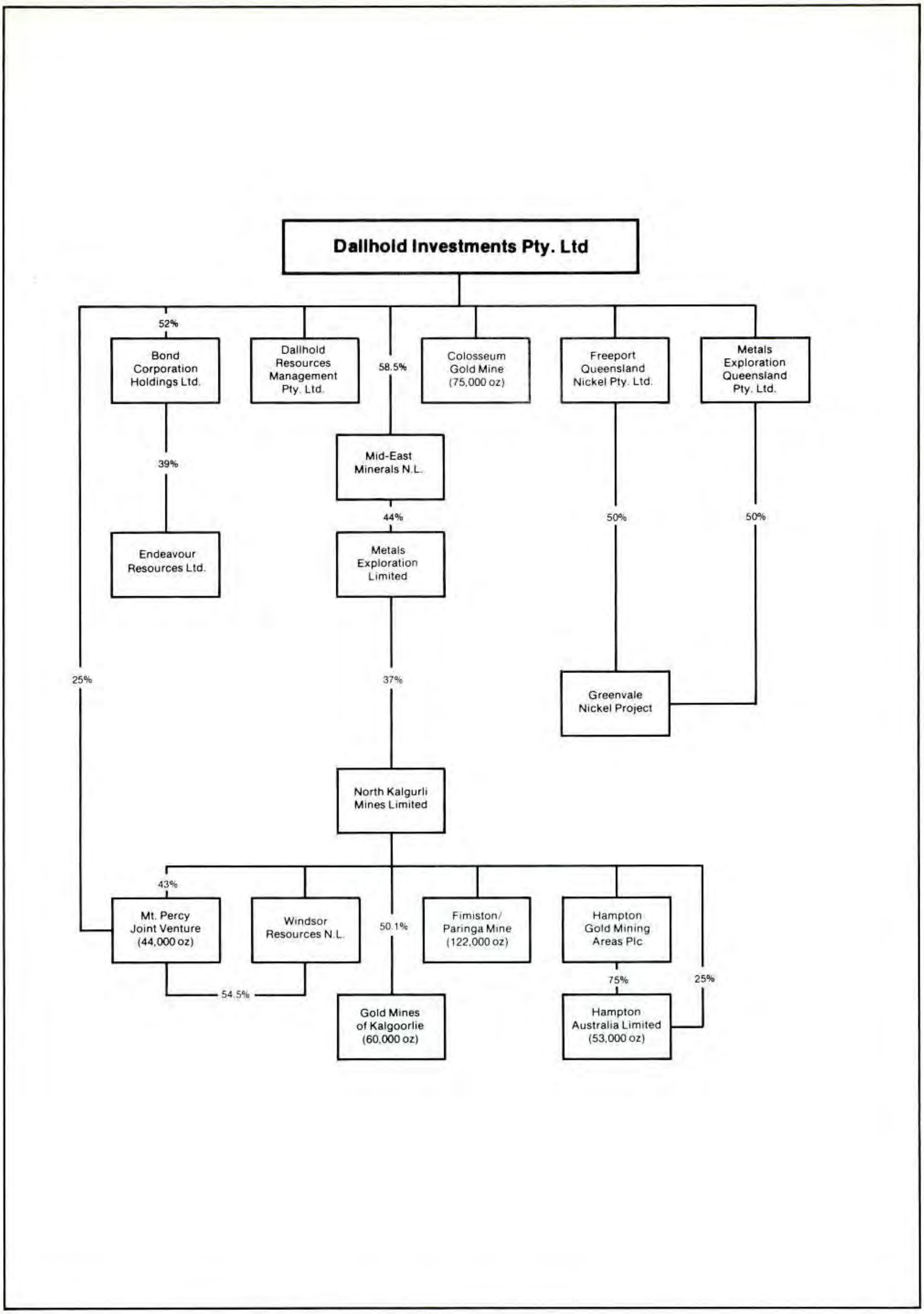
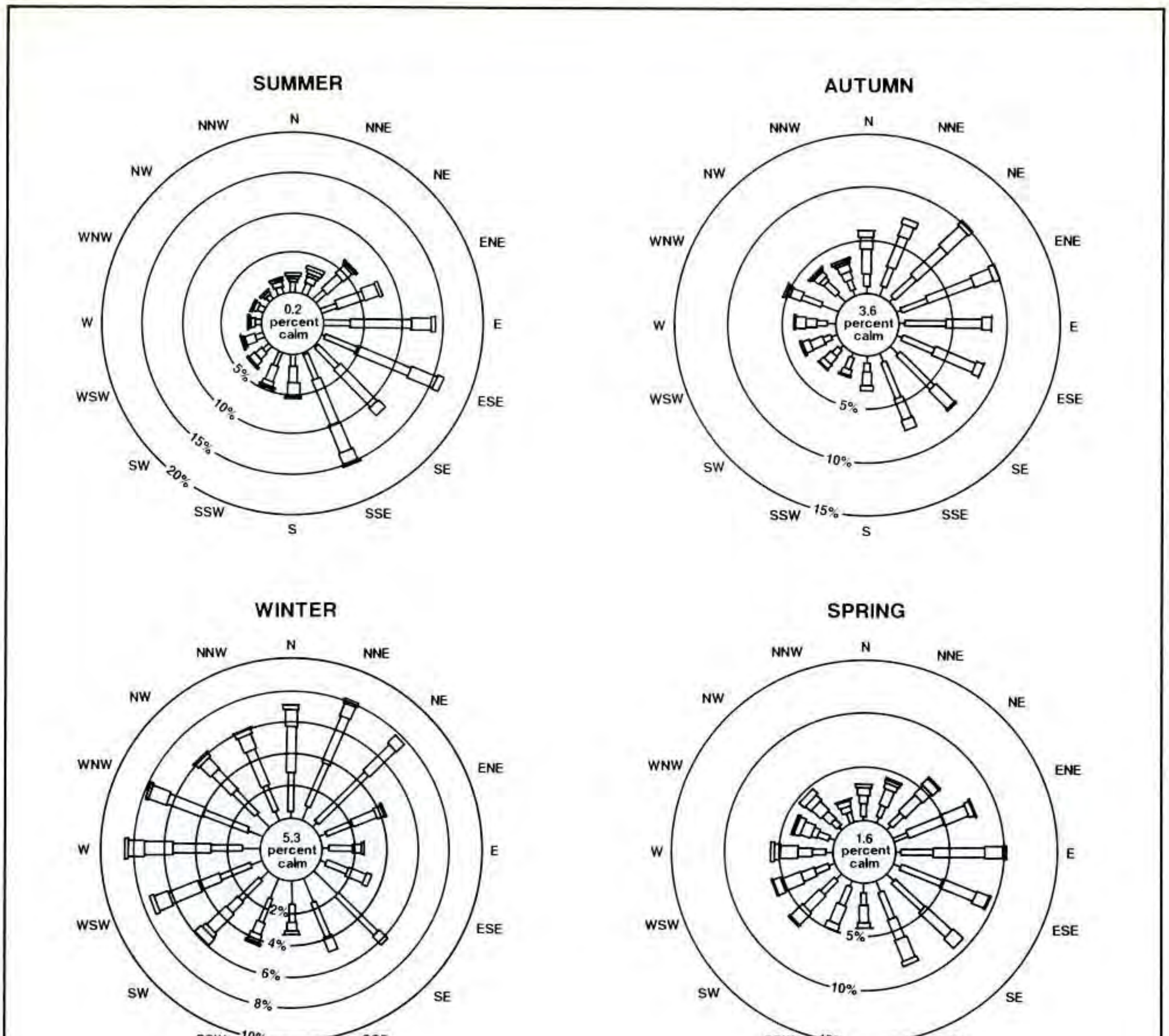
Figure 3
Dames & Moore



CORPORATE STRUCTURE OF DALLHOLD INVESTMENTS PTY. LTD.

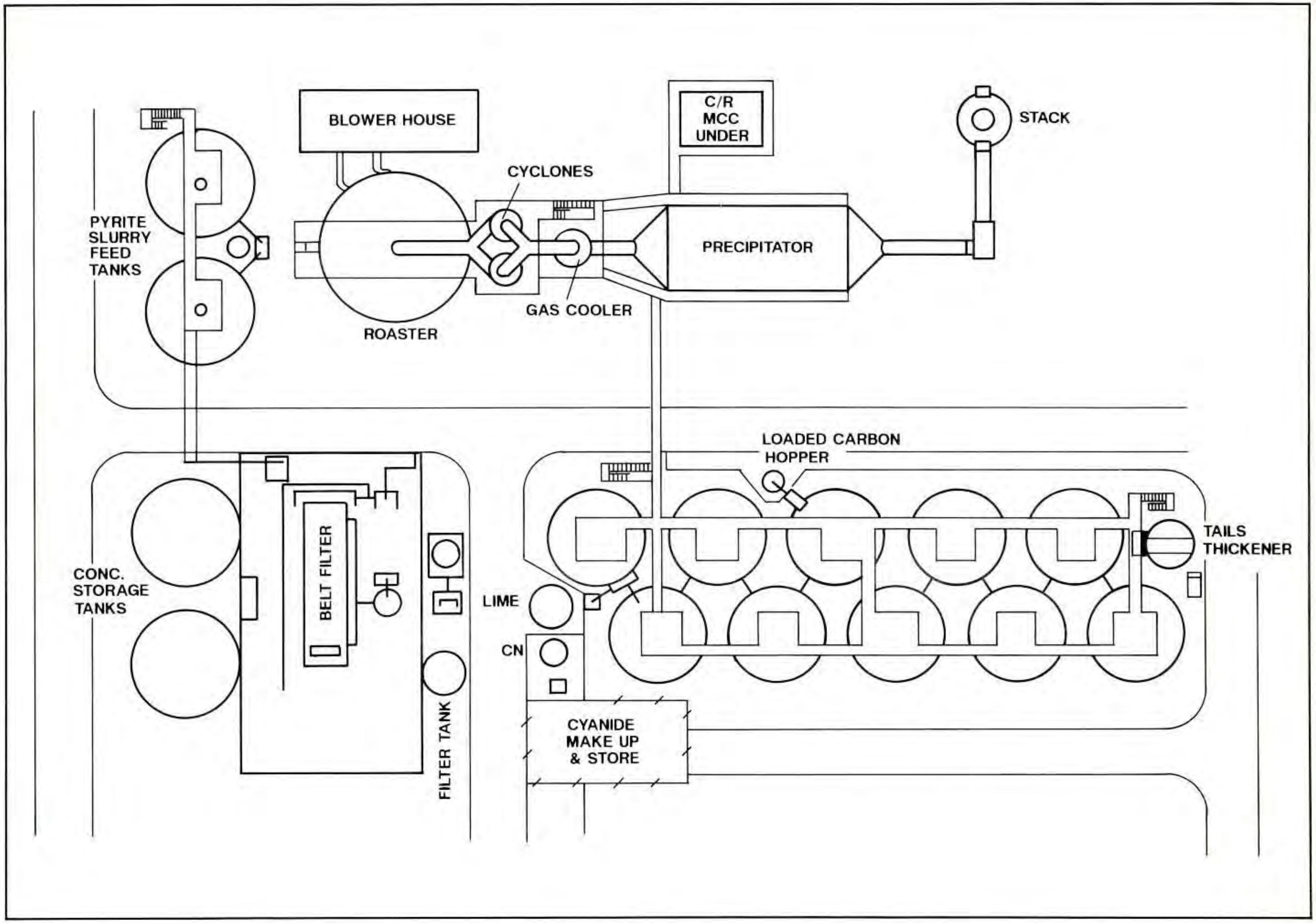
Figure 4
Dames & Moore



SEASONAL AND ANNUAL WINDROSES FROM EPA DATA FOR 1984

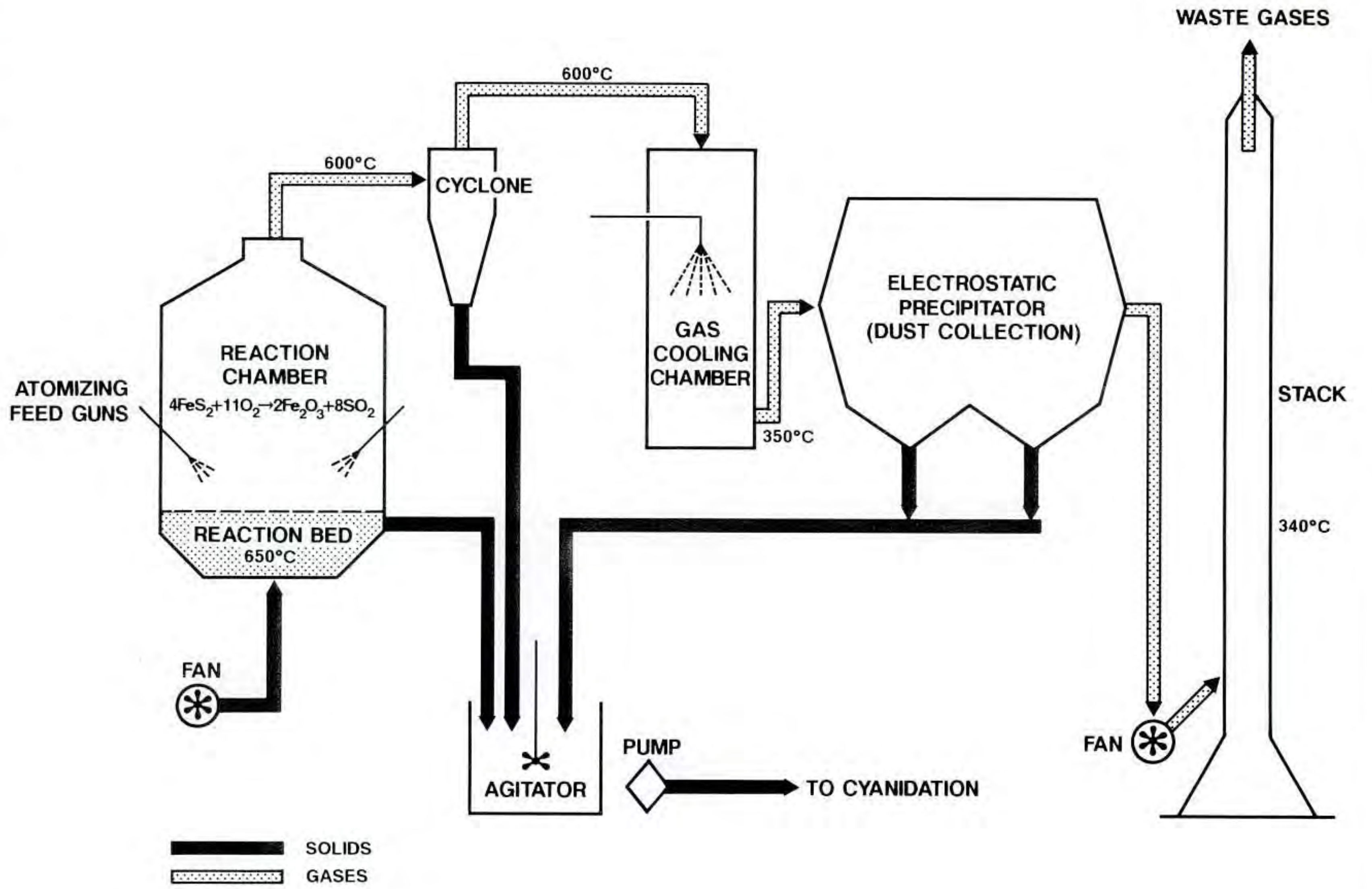
Figure 5

Dames & Moore



PROPOSED PLANT LAYOUT FOR SATELLITE ROASTER AND CARBON-IN-LEACH AREA

Figure 6
Dames & Moore



SOURCE : Department of Resources Development, 1987

CONCEPTUAL FLOW DIAGRAM
FLUID BED AURIFEROUS PYRITE ROASTING PLANT

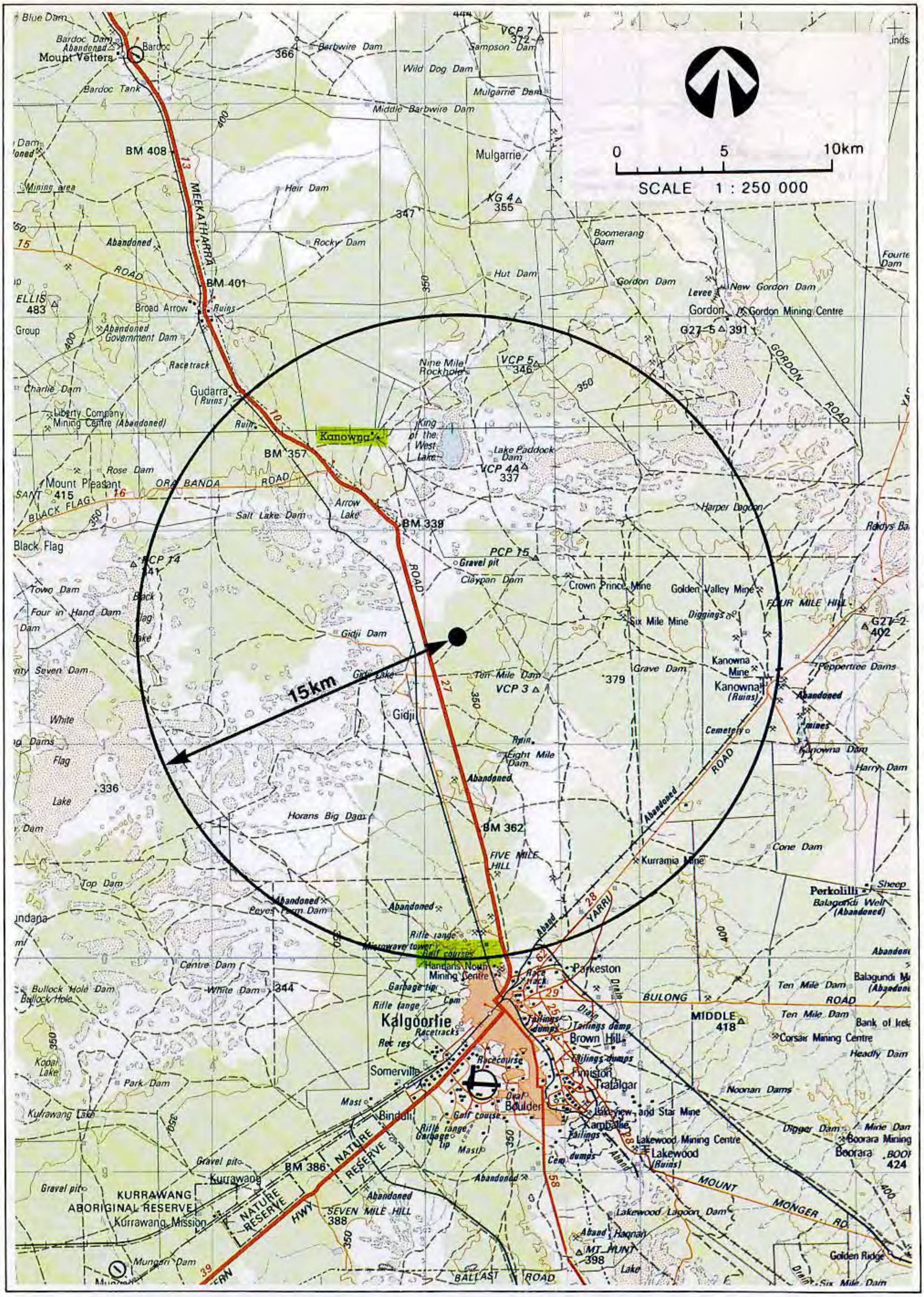
Figure 7
Dames & Moore

A. LOOKING SOUTH-WEST ACROSS PROPOSED ROASTER SITE
(Salmon gum woodland with Eucalyptus gracilis, E. lesouefii, bluebush and Casuarina cristata)

B. PIPELINE ROUTE NEAR BROAD ARROW ROAD, MIDWAY BETWEEN ROASTER SITE AND KALGOORLIE, FACING NORTH

VEGETATION OF THE AREA

Figure 8
Dames & Moore



OUTLYING RECEPTORS WITHIN 15km OF PROPOSED ROASTER STACK

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Figure 9

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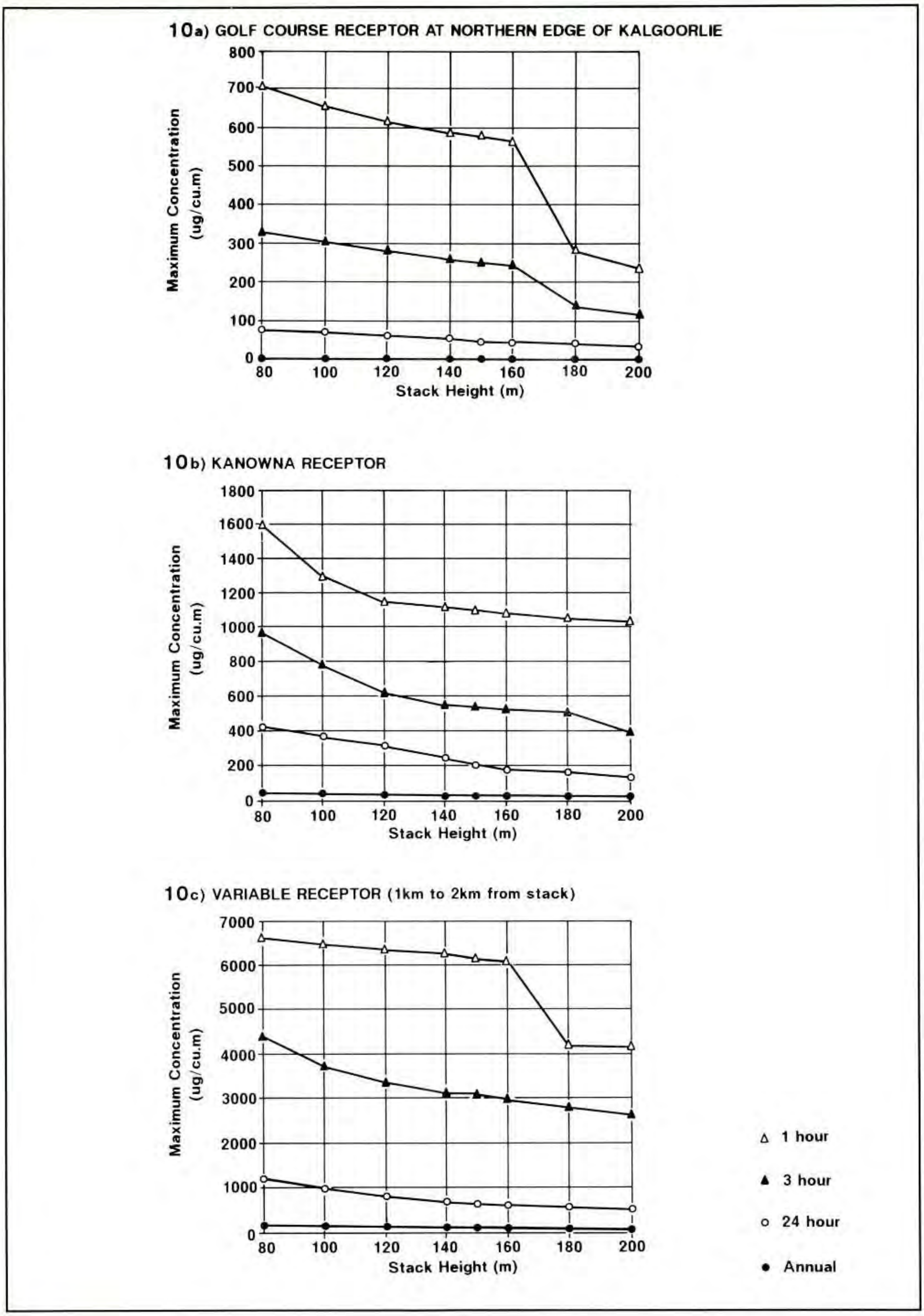
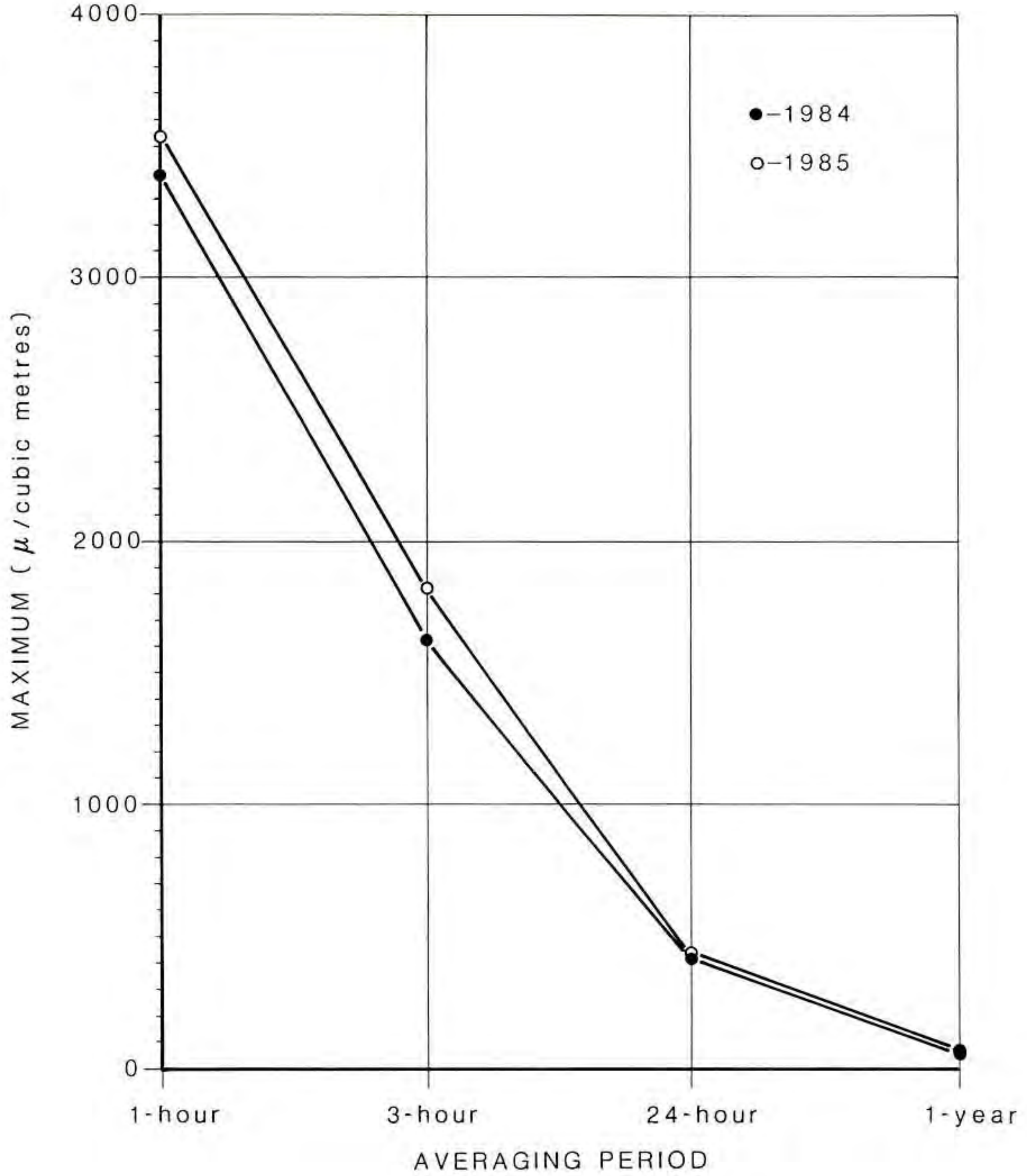


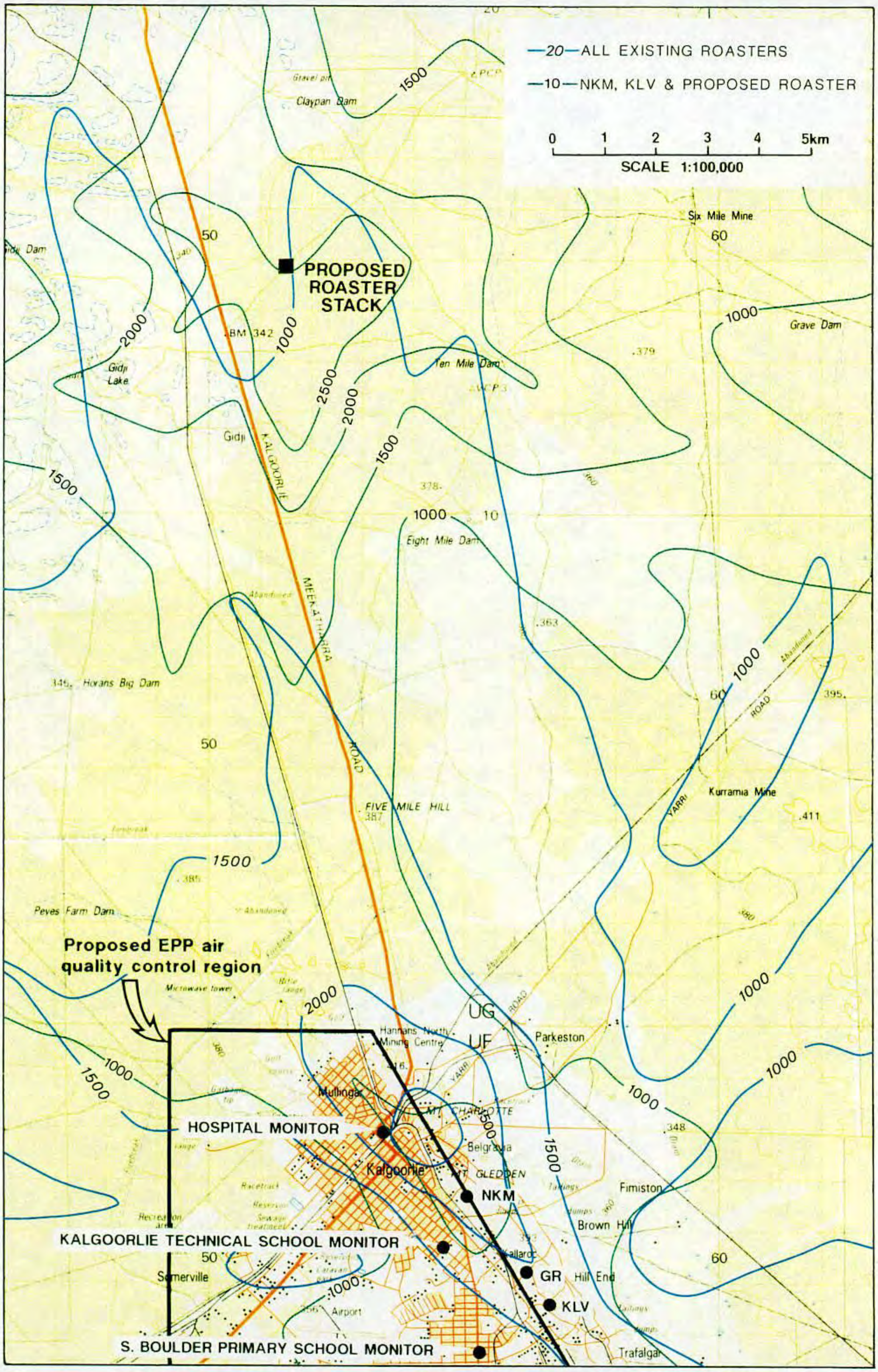
VARIATION OF MAXIMUM GROUND-LEVEL CONCENTRATION WITH STACK HEIGHT

Figure 10
Dames & Moore



EXISTING AIR QUALITY WITH RESPECT TO MAXIMUM SULPHUR DIOXIDE CONCENTRATIONS

Figure 11
Dames & Moore



COMPARISON OF EXISTING AND PREDICTED MAXIMUM SO_2 GROUND-LEVEL CONCENTRATIONS ($\mu g/m^3$) : 1-hour

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Figure 12a

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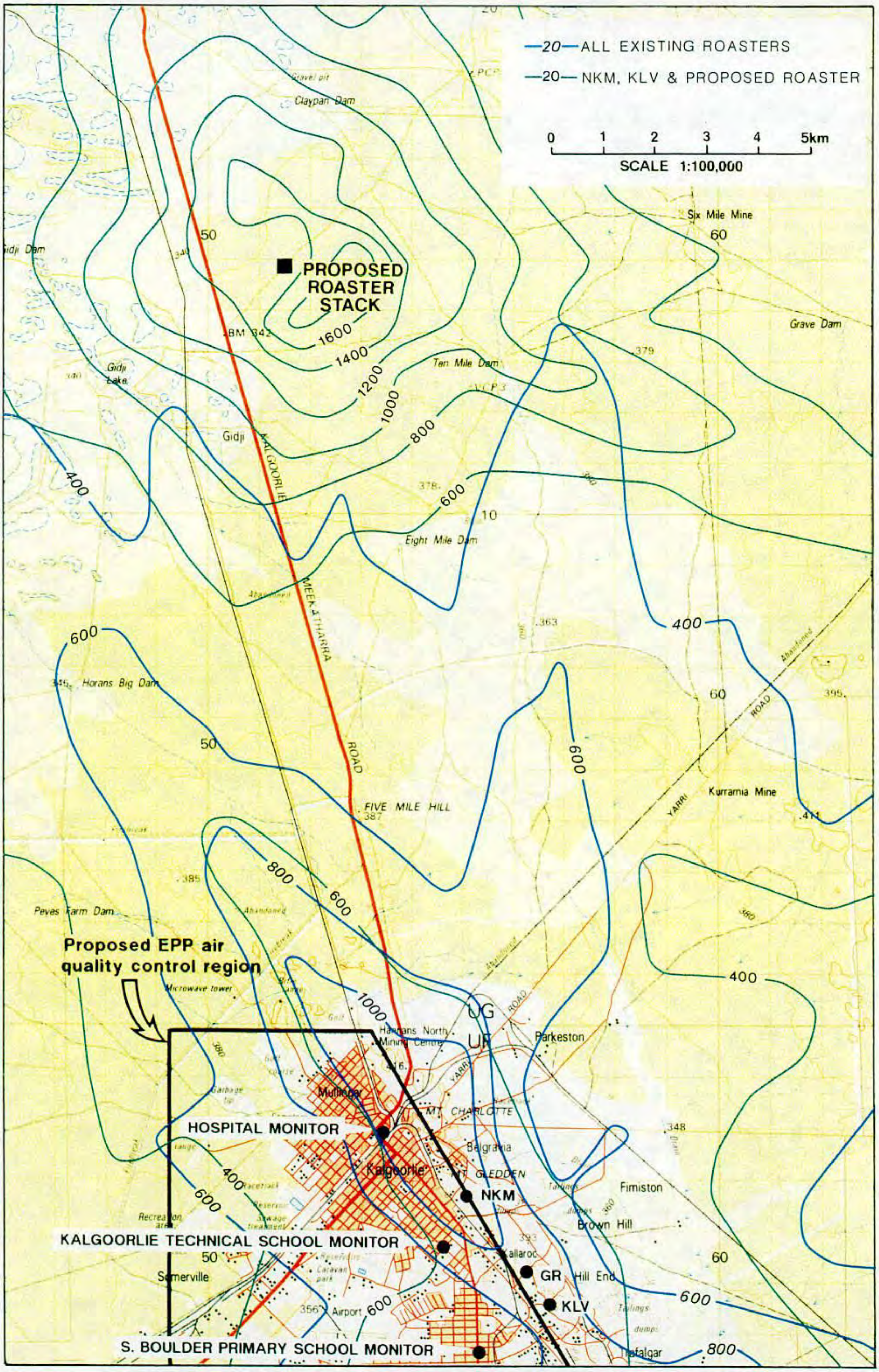

COMPARISON OF EXISTING AND PREDICTED MAXIMUM SO_2 GROUND-LEVEL CONCENTRATIONS ($\mu g/m^3$) : 3-hour

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Figure 12b

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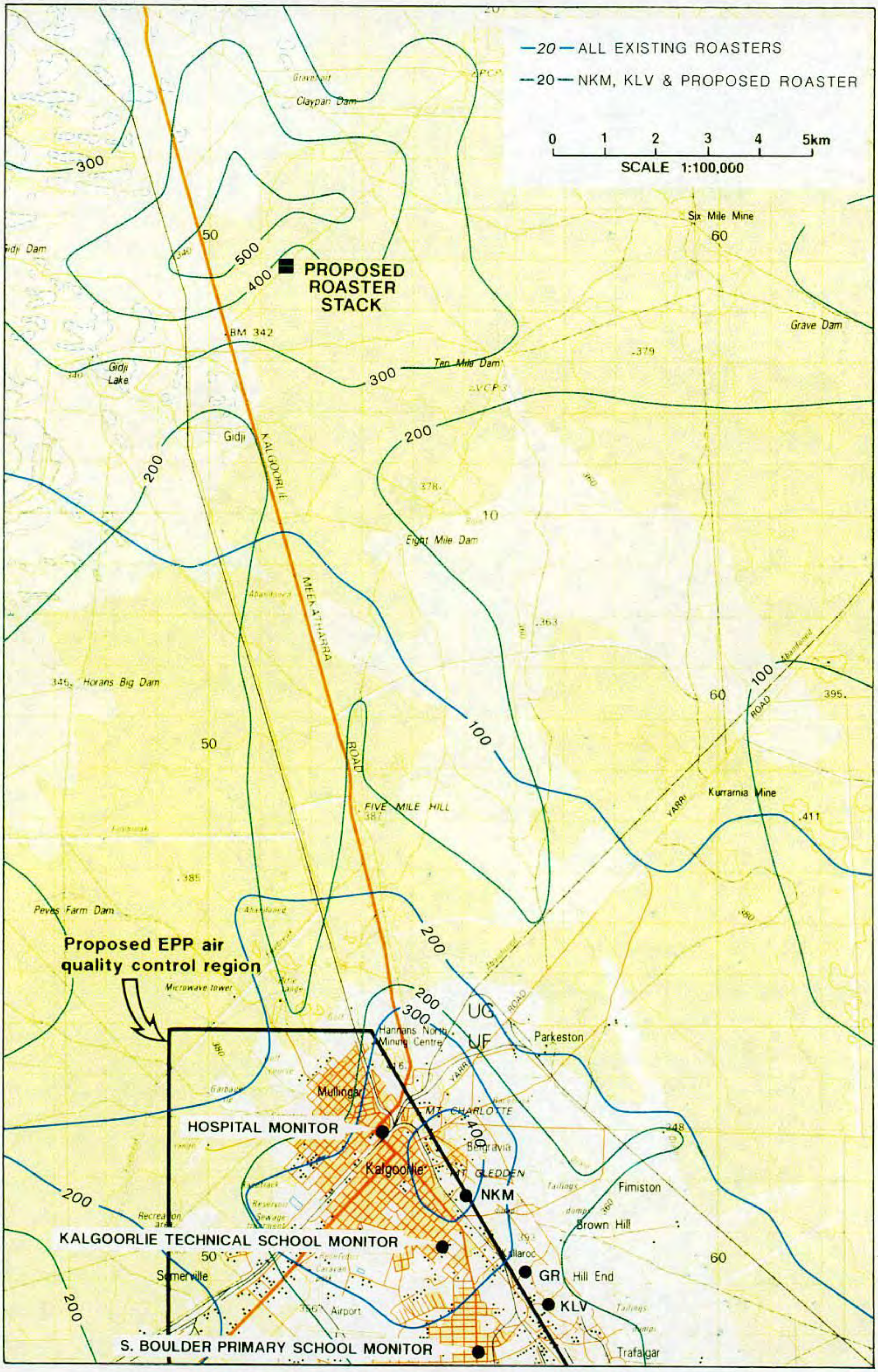

COMPARISON OF EXISTING AND PREDICTED MAXIMUM SO_2 GROUND-LEVEL CONCENTRATIONS ($\mu g/m^3$) : 24-hour

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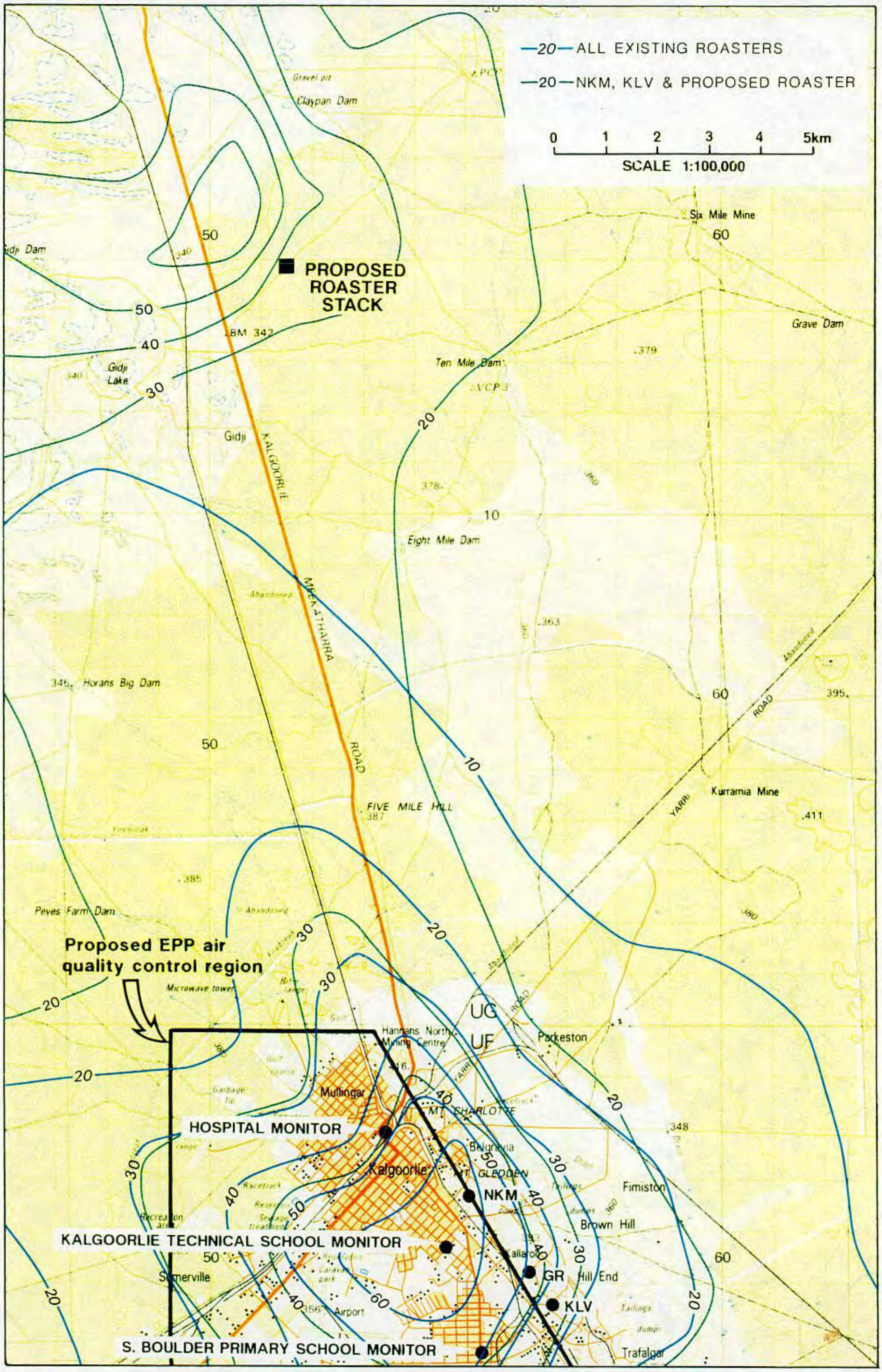
Figure 12c

Dames & Moore



COMPARISON OF EXISTING AND PREDICTED MAXIMUM SO_2 GROUND-LEVEL CONCENTRATIONS ($\mu g/m^3$) : Annual

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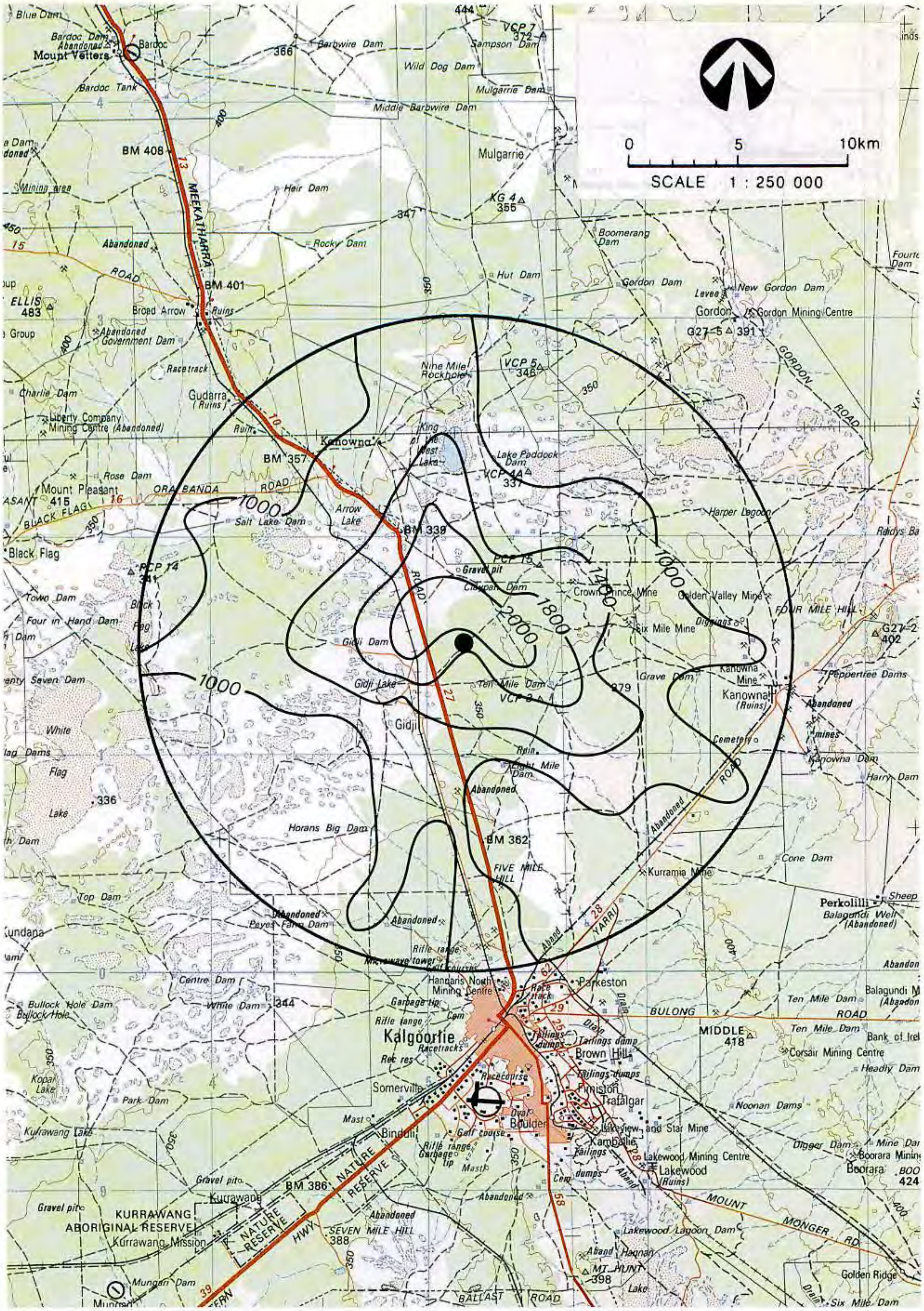
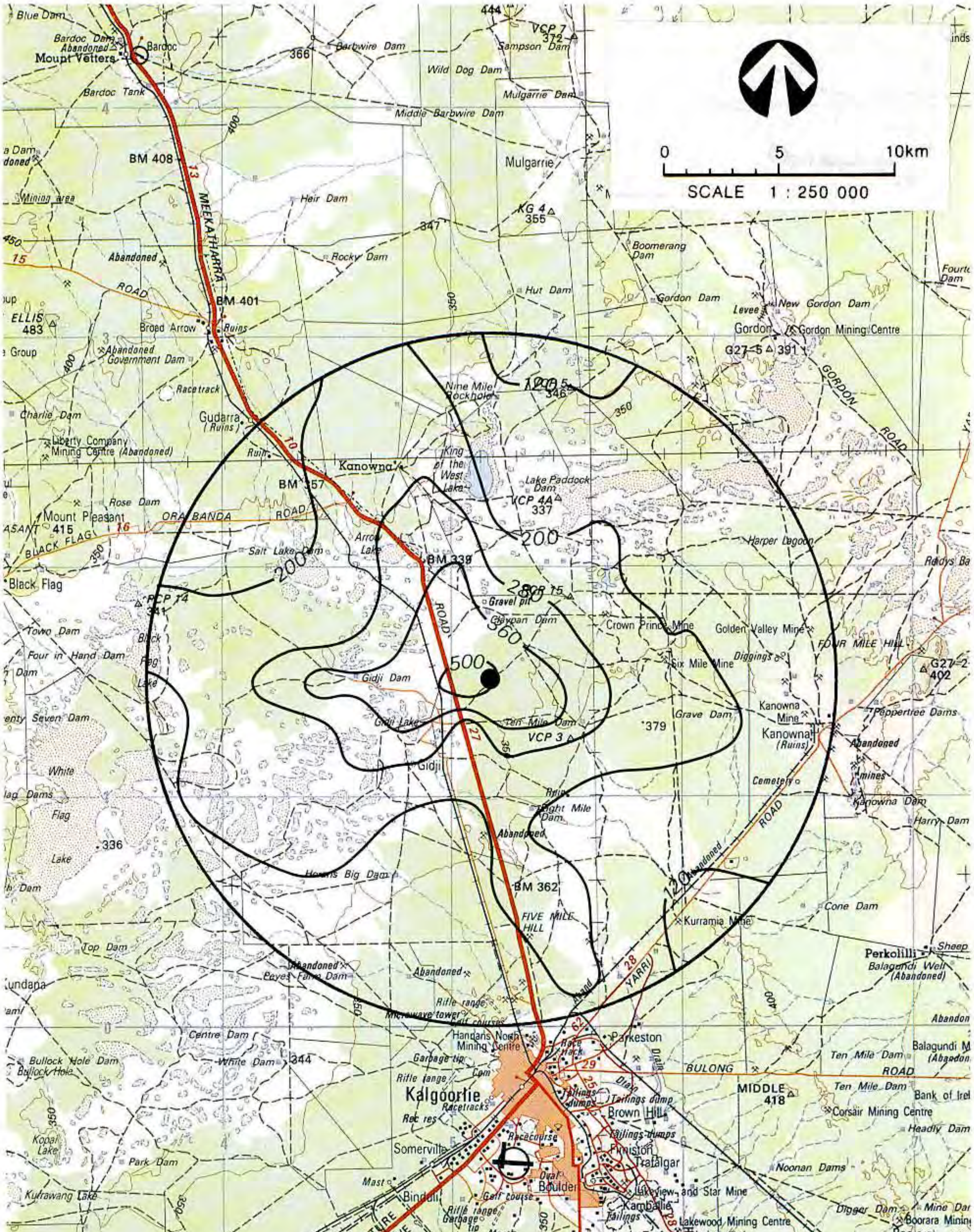
Figure 12d

Dames & Moore



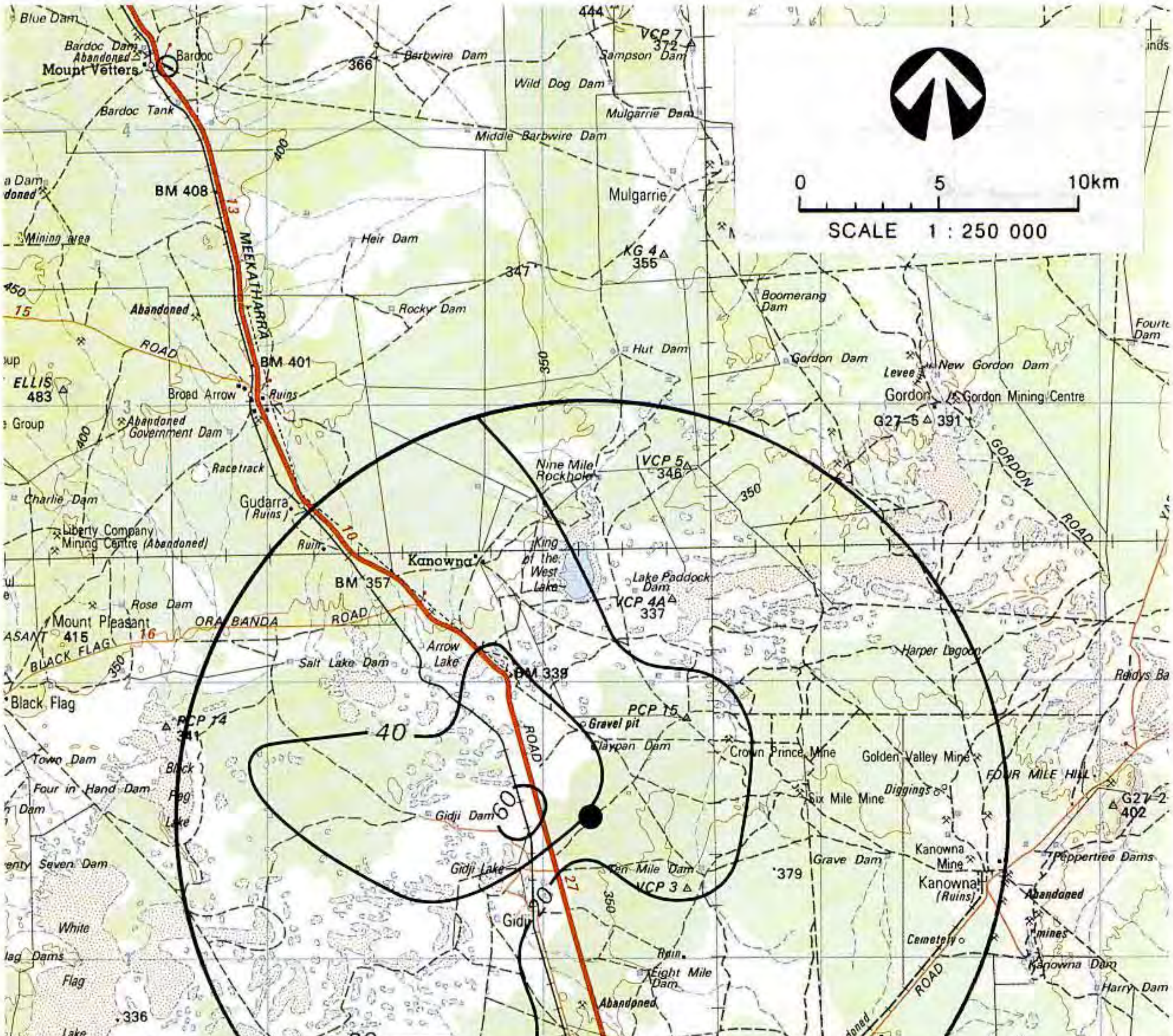
PREDICTED MAXIMUM 1 hour SO_2 CONCENTRATIONS FOR NKM, KLV AND PROPOSED ROASTER WITHIN 15km RADIUS OF STACK (μgm^{-3})

Figure 13a
Dames & Moore



PREDICTED MAXIMUM 24 hour SO_2 CONCENTRATIONS FOR NKM, KLV AND PROPOSED ROASTER WITHIN 15km RADIUS OF STACK (μgm^{-3})

Figure 13c
Dames & Moore



PREDICTED MAXIMUM ANNUAL SO_2 CONCENTRATIONS FOR NKM, KLV AND PROPOSED ROASTER WITHIN 15km RADIUS OF STACK (μgm^{-3})

Figure 13d
Dames & Moore

APPENDIX A

APPENDIX A

EPA Guidelines for the Public Environmental Report

APPENDIX A

ENVIRONMENTAL PROTECTION AUTHORITY'S GUIDELINES FOR THE PUBLIC ENVIRONMENTAL REPORT (PER) PROPOSED SATELLITE GOLD ROASTER for North Kalgurli Mines Ltd.

SUMMARY

This section should contain a clear and concise summary of the salient features of the proposal, site location, alternatives, existing environment, magnitude and extent of potential environmental impacts and environmental safeguards and management.

1.0 INTRODUCTION

This section should include:

- o background, objectives, and scope of proposal,
- o details of proponent,
- o relative legislative requirements and approval processes,
- o explanation of the purpose of PER,
- o environmental interaction with other development present and future.

2.0 NEED FOR PROPOSAL

This section presents an opportunity for the proponent to describe in general the broad costs and benefits of the project to the proponents and the community. These should be described at local and State levels.

3.0 EVALUATION OF ALTERNATIVES

A description should be given on how the proposal has developed and the degree to which development alternatives have been considered. In particular, the possibility of replacing the proponent's roasters should be addressed. Attention should be given to the process and criteria of site selection including provision for a buffer zone around the roaster.

4.0 THE PROPOSAL

The document should provide a description of the important elements of the development including transport of material to site and final disposal of material. It should cover location, layout, anticipated life of the project, timing of the project, possible future expansion and utility services required.

A detailed description of the roaster operations including supplies of raw materials, water and energy should be given. Details of emissions to the environment including SO_2, AS_2O_3, Tellerium, Antimony and other heavy metals and dust levels should be provided. Emission controls and workforce numbers and composition should also be detailed.

5.0 EXISTING ENVIRONMENT

This section should contain a description of the environment and an appraisal of physical and ecological systems likely to be affected by the proposal. A good understanding of the local meteorology and the flora and fauna in the area should be demonstrated so that their interaction with possible pollutants can be addressed.

6.0 ENVIRONMENTAL IMPACTS

This part of the document should describe the overall potential impact of the proposal on the environment. Consideration should be given to both long and short-term effects of the proposal. An indication of the significance of the potential impacts should be given.

The impact of the range of airborne pollutant on:

- o Kalgoorlie/Boulder townships,
- o outlying stations and other residences, and
- o vegetation,

should be fully addressed, taking into account the cumulative impact with other sources of pollution in the region, and possible future expansion. In addition to normal prediction of ground level impacts of pollutants, predictions of the impact and likely frequency of fumigation events should be presented. Stack tip downwash should be considered if appropriate.

7.0 ENVIRONMENTAL MANAGEMENT AND MONITORING

This section should outline the programme of controls and safeguards proposed to minimise adverse environmental impacts. The objectives, scope and details of the programme should be described.

A monitoring programme should be devised to monitor the receiving environment to ensure the environmental management programme is constraining the impacts to an acceptable level. Emphasis should be given as to how the environmental management programme will be adapted to rectify any short comings shown by the monitoring programme. Commitment to environmental management should be given.

The procedures for reporting results of the monitoring programme to the appropriate authorities should be outlined.

The need for monitoring pollutant concentrations at locations of human residence and if necessary implementing a control strategy should be addressed. Management of potential impact on vegetation should be discussed.

8.0 CONCLUSIONS

Conclusions of the overall impact of the proposal (including role of ameliorative measure) should be stated, together with an assessment of the environmental acceptability of the project.

This section should also include a concise summary of all environmental management commitments made in the document.

9.0 REFERENCES (Bibliography/Abbreviation)

- **Glossary**

Provides definition of technical terms used. Also define and explain units of measurements which may not normally be understood by the interested layman.

. **Guidelines**

Guidelines which have been approved by the EPA should be reproduced in the document.

. **Appendices**

APPENDIX B

APPENDIX B

Draft Environmental Protection Policy for
the Control of Sulphur Dioxide in the Air Environment
of the Kalgoorlie-Boulder Area

APPENDIX B

DRAFT ENVIRONMENTAL PROTECTION POLICY FOR THE CONTROL OF SULPHUR DIOXIDE IN THE AIR ENVIRONMENT OF THE KALGOORLIE-BOULDER RESIDENTIAL AREAS

EXPLANATORY NOTES

1. INTRODUCTION

The Environmental Protection Authority proposes to establish an Environmental Protection Policy (EPP) to enable control of sulphur dioxide in the Kalgoorlie-Boulder area. These explanatory notes are provided to assist members of the public in understanding the proposed Policy and making in submissions to the Environmental Protection Authority.

2. WHERE DOES THE SULPHUR DIOXIDE COME FROM

There are several sources of sulphur dioxide in the Kalgoorlie region: three gold roasting operations, east of the town, and a nickel smelter south of the town.

Gold and nickel ores which are processed in these facilities contain sulphur compounds. The gold and nickel cannot be efficiently separated from the ore until most of the sulphur is removed. This is done by burning off the sulphur, which converts it to sulphur dioxide gas which is discharged into the air through chimney stacks.

3. WHAT IS SULPHUR DIOXIDE

Sulphur dioxide is a colourless, pungent, irritating gas. It has an unpleasant taste and odour and causes irritation to the eyes, nose and throat. At a high level it may affect the elderly and those who already suffer from diseases such as asthma and bronchitis. It can also damage vegetation, paints and other materials.

Standards and goals for sulphur dioxide in the air have been set by various authorities around the world, ranging across different levels and different time periods.

The objectives set out in the Environmental Protection Policy have been chosen on the basis of what is considered to be technically achievable, whilst at the same time providing a reasonable level of environmental protection for a town which relies upon the industries for much of its economic stability.

4. WHAT IS AN ENVIRONMENTAL PROTECTION POLICY

Under the Environmental Protection Act 1986, the EPA may recommend to the Minister that an Environmental Protection Policy be established to protect a specific part of the environment of the State. An Environmental Protection Policy provides a means by which environmental quality objectives for a particular region can be tailored to match the environmental sensitivity of the region, community expectations, economic circumstances, or any other considerations. An integral part of development of an Environmental Protection Policy is the involvement of the affected community.

5. WHAT DOES THIS POLICY SAY

The proposed Policy sets 4 objectives for the limits of sulphur dioxide in the air of the Kalgoorlie-Boulder township areas. These goals were initially set in 1983 by a task force established by the then Air Pollution Control Council. The Policy also sets out the controls which will be applied to any sulphur dioxide producing industry.

In summary, these controls will require operators to shut down their plant to avoid the exceedence of 1300 $\mu g/m^3$ in any 3 hour period. It is anticipated that the achievement of this objective will automatically achieve the one hour, one day and annual objectives. If this does not occur in practice, the Environmental Protection Policy provides for a review of the Policy.

6. WHAT IS THE PUBLIC'S ROLE NOW

These explanatory notes coincide with public release of the draft Environmental Protection Policy.

Members of the public are invited to make submissions on the EPP by forwarding written comments to:

Chairman
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

The EPA welcomes any and all public comments on the EPP. These comments will be considered as part of a review of the EPP and a report to the Minister for Environment.

Comments on the EPP should reach the EPA by 18 September, 1987.

7. WHAT IS THE PUBLIC'S ROLE IN THE FUTURE

The Environmental Protection Act (1986) includes provision for Environmental Protection Policies to be reviewed at the direction of the Minister for Environment. Within the Policy being considered here, there is a stated intention to review the Policy after 2 years, and then at intervals not exceeding 5 years. Furthermore, there is an undertaking given to review the Policy within 3 months in the event that the objectives for sulphur dioxide are clearly not being met.

Any review, however initiated, will provide the opportunity for public input to the same extent as the current initial review. Hence, for example, it is in order for the public to assess the adequacy of the Policy with a view to providing relevant comments at the time of a review.

DRAFT ENVIRONMENTAL PROTECTION POLICY
FOR THE CONTROL OF SULPHUR DIOXIDE IN THE AIR
ENVIRONMENT OF THE KALGOORLIE-BOULDER RESIDENTIAL AREAS

Clause 1 This Order is promulgated under Section 31(d) of the Environmental Protection Act 1986.

Clause 2 This Order is divided into parts as follows:

Part I Preliminary
Part II Areas Covered by the Policy
Part III Beneficial Uses to be Proclaimed
Part IV Ambient Air Quality Objectives for Sulphur Dioxide
Part V Means of Achieving Objectives of Policy
Part VI Review of Policy

PART I - PRELIMINARY

Clause 3 In this Order, unless inconsistent with the context or subject matter:

"acceptable level" means that concentration of sulphur dioxide at or below which identified beneficial uses are protected.

"the Act" means the Environmental Protection Act 1986.

"the Authority" means the Environmental Protection Authority as constituted under the Act.

"policy area" means the area in which this policy shall apply, as prescribed in Clause 4.

"source" means a point or an area from which sulphur dioxide is emitted to the air environment.

PART II - AREAS COVERED BY THE POLICY

Clause 4 This Policy applies to that portion of the environment comprising the air at or within five metres of ground level over those areas of the municipal districts of the Town of Kalgoorlie and the Shire of Boulder indicated in Schedule A.

PART III - BENEFICIAL USES TO BE PROCLAIMED

Clause 5 The following beneficial uses shall be protected in the area covered by the Policy:

(a) residential (mining town); and

(b) other human activities involving recreation education and occupational engagement.

PART IV - AMBIENT AIR QUALITY OBJECTIVES FOR SULPHUR DIOXIDE

Clause 6 The purpose of the Policy is to achieve and maintain a level of air quality that will ensure the protection of the identified beneficial uses specified in Clause 5, and to control pollution in the policy area.

Clause 7 The ambient air quality objectives for sulphur dioxide in the policy area shall be those specified in Schedule B.

PART V - MEANS OF ACHIEVING OBJECTIVES OF POLICY

Clause 8 For the purpose of protecting that portion of the environment to which this policy applies, and of controlling pollution therein, the Chief Executive Officer may, in granting a licence under Part V of the Act, require the licensee to comply with, in addition to any other conditions, all or any of the conditions in Schedule C of this Policy in relation to to any source that may cause or contribute to ambient concentrations of sulphur dioxide that exceed Objective 2 set forth in Schedule B of this Policy.

PART VI - REVIEW OF POLICY

Clause 9 In the event that the results of ambient sulphur dioxide monitoring in the policy area reveal that either Objective 1 or Objective 3 in Schedule B have been exceeded more than three times in any period of twelve calendar months, the Authority shall recommend to the Minister that the Minister direct the Authority to review the Policy within three months of that direction.

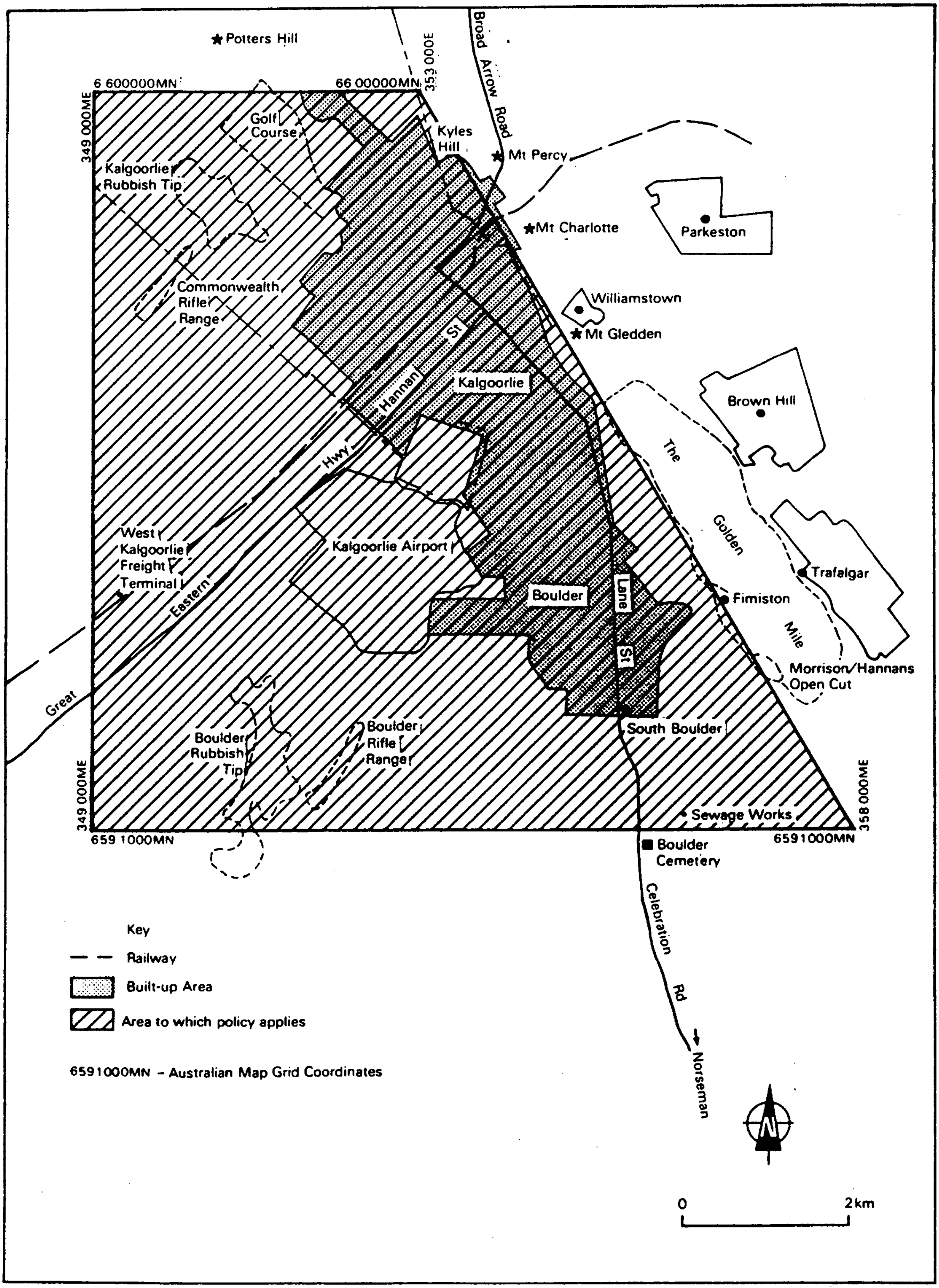
SCHEDULE A

AREA TO WHICH THIS POLICY APPLIES

The area to which this policy applies is that delineated on the map of the Kalgoorlie and Boulder townships appearing in figure 1 hereof, and having the shape of a trapezoid, the boundaries of which are described as follows:

> from a point 6600000 mN and 349000mE, easterly to a point 6600000 mN and 353000 mE, thence generally south easterly to a point 6591000 mN and 358000 mE, thence westerly to a point 6591000 mN and 349000 mE, thence northerly returning to the point 6600000 mN and 349000 mE, where the coordinates of the points are referenced to the Australian Map Grid.

figure 1


Potters Hill
6 600000MN
66 00000MN
353 000E
Broad Arrow Road
349 000ME
Golf Course
Kyles Hill
Mt Percy
Kalgoorlie Rubbish Tip
Mt Charlotte
Parkeston
Commonwealth Rifle Range
Williamstown
Mt Gledden
Hannan St
Kalgoorlie
Brown Hill
The Golden Mile
Hwy
West Kalgoorlie Freight Terminal
Kalgoorlie Airport
Trafalgar
Eastern
Boulder
Lane St
Fimiston
Great
Morrison/Hannans Open Cut
South Boulder
Boulder Rubbish Tip
Boulder Rifle Range
349 000ME
358 000ME
Sewage Works
659 1000MN
6591000MN
Boulder Cemetery
Celebration Rd
Norseman
Key
Railway
Built-up Area
Area to which policy applies
6591000MN - Australian Map Grid Coordinates
0
2km

SCHEDULE B

AMBIENT AIR QUALITY OBJECTIVES FOR SULPHUR DIOXIDE

1. The ambient air quality objectives for sulphur dioxide referred to in Part IV of the Policy shall be as follow:

OBJECTIVE No	UNIT	AVERAGING PERIOD	ACCEPTABLE LEVEL
1	$\mu g/m^3$	1 hour	2 000
2	$\mu g/m^3$	3 hours	1 300
3	$\mu g/m^3$	1 day	365
4	$\mu g/m^3$	1 year	60

where -

(a) $\mu g/m^3$ is the concentration of sulphur dioxide in micrograms per cubic metre of dry air at 0°C and one atmosphere (101.325 kPa);

(b) a 1 hour averaging period is any 60 minute period;

(c) a 3 hour averaging period is any 180 minute period;

(d) a 1 day averaging period is a period of 24 hours beginning at midnight on one day and ending at midnight on the next following day; and

(e) a 1 year averaging period is a calendar year.

2. For the purpose of measuring the concentration of sulphur dioxide in air, one part per million is equivalent to 2860 $\mu g/m^3$.

SCHEDULE C

CONDITIONS

1. The licensee shall conduct its operations so as not to exceed or contribute to the exceedence of, Objective 2 of Schedule B of this Policy.

2. (i) The licensee shall monitor sulphur dioxide at a sufficient number of locations within the Policy area to ensure compliance with Condition 1 above.

   (ii) The licensee shall obtain written approval from the Authority for the sulphur dioxide monitoring and data acquisition equipment used.

   (iii) The licensee shall advise the Authority of the location of each monitoring station.

3. The licensee shall monitor a range of meteorological variables specified by the Authority using equipment approved by the Authority, at a location approved by the Authority.

4. The licensee shall provide to the Authority data from all sulphur dioxide monitors specified by the Authority and from the meteorological station at the intervals of time and in the form specified by the Authority.

5. The licensee shall provide the Authority with a log of plant shutdowns relating to the control of sulphur dioxide emissions, at the intervals of time and in the form specified by the Authority.

6. The licensee shall cease roasting operations immediately when any sulphur dioxide monitor specified by the Authority indicates:

   (i) exceedence of Objective 2 of Schedule B of this Policy; and

   (ii) the meteorological station indicates that the wind is blowing from a direction specified by the Authority, or the meteorological station is inoperative.

7. Where any sulphur dioxide monitoring station specified by the Authority fails to meet performance criteria specified by the Authority, the licensee shall cease roasting operations whenever the meteorological station indicates that the wind is blowing from a direction specified by the Authority or the meteorological station is inoperative.

8. Where the meteorological monitoring equipment of the licensee fails to meet any of the performance criteria specified by the Authority, the licensee shall cease roasting operations.

APPENDIX C

APPENDIX C

Current Sulphur Dioxide
Control Strategy - NKML Practice

APPENDIX C

CURRENT SO_2 CONTROL STRATEGY - NKML PRACTICE

(adapted from Report of the Task Force on Gold Roasting and Ambient Air Quality in Kalgoorlie)

1.1 SHUTDOWN CONDITIONS

The NKML roasters are shutdown immediately when the conditions (i) and (ii) occur:

(i) A Level 1 alarm is raised, indicating that the three hour average of 1,100ug per cubic metre will be exceeded within one hour if the current rate of increase is maintained.

OR

The three hour moving average reaches 750ug per cubic metre.

(ii) The wind direction indicates either the Croesus or Paringa roaster as the source of pollution. A source is deemed responsible if the wind direction falls within either side of a 20^{o} range of true compass. The ranges applicable are as follows:

MONITOR	CROESUS	PARINGA
KRH	117-157	117-157
KTS	50-90	98-138
BPS	348-28	28-68

1.2 START-UP CONDITIONS

The following conditions must be satisfied before start-up:

(i) At least one hour has lapsed since shutdown.
(ii) The three hour moving average is below 700ug per cubic metre.
(iii) The Level 1 alarm condition no longer exists.

1.3 IMPLEMENTATION PRACTICE

Once an alarm condition occurs, roaster feed continues until a bed temperature of 680°C is achieved. This will take between 15 and 20 minutes depending on the bed temperature at the time of the alarm.

After reaching the safe shutdown bed temperature of 680°C, roaster feed is discontinued and the following items are logged:

- Date
- Time
- Source (Croesus and Paringa)
- Monitor in alarm
- Nature of alarm

In addition, the 3 hour moving average graph is printed.

After data logging and printing is completed the KMA roaster control room is notified that either the Croesus or Paringa roaster has been shutdown.

1.4 ROUTINE PRACTICE

(i) Regardless of whether or not an alarm condition occurred, the eight hour plot of five minute readings is printed at the end of each shift.

(ii) A monthly summary sheet is prepared for circulation to the Eastern Goldfields M.A., Boulder Shire, Kalgoorlie Town Council, Environmental Protection Authority and the Department of Mines.

1.5 RESPONSE TO PUBLIC COMPLAINTS

Each complaint is recorded in a "Complaints Book" and is investigated by means of a telephone call or a personal visit by the Metallurgical Superintendent. If the complaint is confirmed as genuine then the roaster concerned is shutdown for at least a one hour period.