KINGSTREAM RESOURCES NL

&

PAVILLY PTY LTD

MID WEST IRON & STEEL PROJECT
GERALDTON STEEL PLANT
PUBLIC ENVIRONMENTAL REVIEW

ALAN TINGAY & ASSOCIATES

and

SIGNET ENGINEERING PTY LTD

JULY 1995

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REPORT NO: 94/65

AN INVITATION TO COMMENT ON THIS PUBLIC ENVIRONMENTAL REVIEW

This Public Environmental Review (PER) describes a proposal to establish a steel mill at the Narngulu Industrial Estate in the Shire of Greenough near Geraldton.

The PER describes the proposal and its likely effect on the environment in accordance with the requirements of the Environmental Protection Act, 1986.

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

The PER is available for public review for eight weeks from 10 July, 1995 to 4 September, 1995.

After receipt of comments from Government agencies and from the public, the EPA will prepare an Assessment Report with recommendations to the Government, taking into account issues raised in 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 by the EPA will be acknowledged. Submissions will be treated as public documents and may be quoted in full or in part in each report unless specifically marked confidential.

Submissions may be fully or partially utilised in compiling a summary of the issues raised or where complex or technical issues are raised, a confidential copy of the submission (or part of it) may be sent to the proponent.

The summary of issues is normally included in the EPA's Assessment Report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining a group or other groups interested in making a submission on similar issues.

Joint submissions may help to reduce the work for an individual or group, while increasing the pool of ideas and information.

If you form a small group (up to ten people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

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

When making comments on specific items in the review document:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- 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, chapter or recommendation in the PER.
- If you discuss different sections of the PER, keep them distinct and separate, so 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.

Remember to include:

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

The closing date for submissions is:

Monday, 4 September 1995.

Submissions should be addressed to:

Environmental Protection Authority
8th Floor, Westralia Square
141 St George's Tce
PERTH WA 6000

Attention: Dr Victor Talbot

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ACKNOWLEDGEMENTS

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SUMMARY

1. Introduction

This Public Environmental Review (PER) describes a proposal by Kingstream Resources NL and Pavilly Pty Ltd to establish a Geraldton Steel Plant (GSP) at the Narngulu Industrial Estate in the Shire of Greenough and close to the city of Geraldton. In particular, the PER provides a description of the GSP and the steel making process and an analysis of the environmental and social implications of the Project. The GSP will be supplied with iron ore from a mine also owned by Kingstream Resources NL and Pavilly Pty Ltd located at Tallering Peak in the Shire of Mullewa. A separate environmental assessment (Notice of Intent) of the mine has been prepared.

The Mid West Iron and Steel Project (which includes both the GSP and the Tallering Peak iron ore mine) will provide major benefits at the National, State and particularly the Local level in terms of revenues, expenditures and employment. Export earnings from the sale of steel will be among the highest for any single industry in Western Australia. The Project will therefore contribute positively to the balance of payments and to reduction of the national debt.

The Federal government will also receive major revenue in terms of company tax, personal income tax from employees, and other taxes and duties. Similarly, the State of Western Australia will receive direct payments from the project in the form of taxes and royalties.

At the Local level, the Project will pay rates to the Shires of Greenough and Mullewa and it is expected that the majority of the workforce will live in Geraldton.

Capital expenditure for construction of the GSP alone will be in the order of $950 million. There will be significant opportunities for individuals and companies in the Mid West Region to be involved in the construction of the GSP and an average of about 750 people will be employed during the 3 year construction period.

In the operational phase, the GSP will employ about 460 people and a further 90 will be employed at the minesite at Tallering Peak and 50 for transport and other support activities. It is estimated that about 450 of the employment positions will not require previous experience in the steel industry and therefore these will be open to residents of the Mid West Region.

The total employment generated by the Mid West Iron and Steel Project including consequential employment is likely to exceed 2000 people.

The Project will also provide improvements to infrastructure and services which will be of benefit to the general community particularly in the Shire of Mullewa where there has been a decline in population in recent years.

2. The Geraldton Steel Plant (GSP)

The GSP will have several main components as follows:

- A Pellet Plant in which the majority of iron ore is converted to pellets suitable for direct reduction.
- A Direct Reduction Plant in which pellets and lump ore are converted to direct reduced iron using natural gas.
- A Melt Shop containing an Electric Arc Furnace (EAF) and a Ladle Furnace (LF) and which produces liquid steel from the DRI plus other additives.
- A Compact Strip Production (CSP) Plant in which the liquid steel is cast into thin slabs then rolled to form coiled steel.
- Handling and storage facilities for incoming materials, for products at various stages of the process, and for outgoing rolled coil and wastes.
- An open cycle gas turbine Power Station.
- Water and wastewater treatment facilities and cooling towers.
- A Cryogenic Oxygen Plant.
- Administration and maintenance facilities.

The GSP will be located in the Narngulu Industrial Estate immediately to the south of the Mineral Sands Separation Plant and Synthetic Rutile Plant operated by RGC Mineral Sands Ltd. The location has been selected because:

- It offers relatively low costs of establishment compared to other locations in the region;
- It is zoned for industrial use and is part of an Industrial Estate where other heavy industries are located;
- Sufficient land is immediately available;
- There are easements to the site for water and gas supply;
- It is close to the City of Geraldton where it is expected that most of the workforce will live; and
- It is close to the Port of Geraldton through which the steel will be exported and various inputs to the GSP will be imported.

The GSP will receive approximately 1.5 million tonnes of iron ore from the Tallering Peak minesite each year comprising 85% fines (less than 10mm size) and 15% lump ore (in the size range 10 - 30mm). It will also receive about 260,000 tonnes of other solid inputs per year including scrap steel, quicklime, limestone, alloys, refractory bricks, electrodes and other materials. The majority of these inputs will be imported through the Port of Geraldton.

The GSP will be designed to produce 1.0 million tonnes of steel each year for export through the Port of Geraldton.

The requirements of the GSP for services and the source of the services will be as follows:

- Water - 4.5Mm^3/yr from the Allenooka Borefield operated by the Water Authority of Western Australia.
- Natural Gas - 74TJ/day supplied through the Dampier - Perth natural gas pipeline located near Mungarra.
- Oxygen, nitrogen and argon - 4,200m^3/hr of oxygen, 2,500m^3/hr of nitrogen and 550m^3/hr of argon will be produced by a Cryogenic Oxygen Plant associated with the GSP.
- Electricity - The average demand for electric power is estimated at 125MW with a maximum demand of 185MW. Electricity will be provided by the Power Station associated with the GSP.

The inputs and outputs of the GSP are summarised in Figure A and a simplified flow chart is provided in Figure B.

3. Environmental Considerations

3.1 Construction

The development of the GSP in the Narngulu Industrial Estate will not incur any significant direct environmental impact as the land involved has been cleared for agricultural purposes and does not support any significant natural vegetation or vertebrate fauna habitat. The physical characteristics of the site are also suitable for industrial development. The soil is not prone to erosion, and is well drained and easy to excavate, and provides good geotechnical conditions for large buildings and heavy equipment. There will be no impact on local groundwater which is generally about 24m below ground level.

Routine environmental procedures will be applied during the construction phase to ensure that dust and noise levels comply with environmental requirements and regulations. A management plan for collection and disposal of waste generated during the construction phase will be developed through consultation with the Shire of Greenough.

3.2 Atmospheric Emissions

The GSP will generate atmospheric emissions mainly in the form of sulphur dioxide, nitrogen dioxide, particulates (dust), carbon dioxide and water vapour. A specialist assessment of the atmospheric emissions has been made as part of this PER. This assessment took account of atmospheric emissions from other existing industries at Narngulu and determined that the ground level concentrations of all emissions will be well below generally accepted regulatory criteria.

The atmospheric emissions from the GSP therefore will not present any environmental or community health issues.

3.3 Noise

A specialist assessment of noise generated by the GSP has been made as part of this PER. This assessment used computer modelling based on data relating to the noise emissions from all major sources within the GSP. The study concluded that the maximum noise levels will be from 40 to 45dB(A) at the Narngulu townsite, houses in the nearby General Farming zone, and most houses in the General Industry zone. At some houses in the General Industry zone the maximum noise level at night may be up to 50dB(A). These maximum noise levels generally comply with existing and proposed environmental regulations. However, further noise attenuation measures will be included in the detailed design of the GSP to ensure that the night time noise level from the GSP in the Narngulu townsite does not exceed 40dB(A).

3.4 Wastewater

There will be no discharge of wastewater from the GSP other than effluent from the sewage treatment plant. The majority of make-up water will be dissipated as water vapour from cooling towers. Blowdown from cooling towers and process water blowdown will be passed through a flash evaporator. The flash evaporator will produce demineralised water which will be recycled and a waste stream containing a high percentage of dissolved salts and additives from the cooling water circuits. The waste stream will be sprayed onto hot slag to evaporate the remaining water leaving a salt residue on the slag.

Effluent from the sewage treatment plant will be sterilised and the water used for trickle irrigation of the shrubs and trees on the boundaries of the lots.

3.5 Solid Waste

Large volumes of wastes produced in the GSP will be recycled in the process. This includes baghouse dust, CSP Plant scale, scrap steel from the Melt Shop and CSP Plant, and sulphur from carbon dioxide removal.

The GSP however, will also produce 130,000 tonnes of solid waste each year which may require disposal. The majority of this waste will be slag totalling about 118,000tpa. Some slag will contain salts from the evaporated wastewater and will be transported back to the mine at Tallering Peak for disposal together with about 9,000tpa of spent refractory bricks. Most of the slag will not be contaminated with salt and may be used as road base or may be disposed of at the mine site if a use cannot be found for it.

CSP Plant sludge and sewage treatment plant sludge will be disposed of in designated landfill areas. Other wastes such as spent desulphurisation catalyst and amine solution residues will be returned to suppliers.

3.6 Visual Impact

The GSP will comprise various large structures and buildings including the Direct Reduction Plant at 92m high, the Melt Shop/CSP Plant buildings at 38m high, and the Pellet Plant at 34m high. In general, the overall appearance of the structures and buildings will be similar to those of the Synthetic Rutile Plant within the Narngulu Industrial Estate.

Although the structures and buildings will be large, they will not be conspicuous from surrounding residential areas because of intervening landscape features or because they will be screened by existing large industrial plants. From Wandina Heights and Ocean Ridge the Narngulu Industrial Estate is largely obscured by an intervening ridge, and at the Narngulu townsite there is intervening vegetation and topography.

The GSP will, however, be visible from the south-west, south and south-east particularly from locations along and to the south of Rudds Gully Road. Very few people live in these sectors and most of these are within the General Industry zone of the Narngulu Industrial Estate. The existing Mineral Sands Separation Plant and Synthetic Rutile Plant are also prominent from these sectors and the view can be classified as industrial within a rural landscape.

3.7 Geraldton Airport

An analysis of the implications of the Direct Reduction Plant for aircraft movement at Geraldton Airport has been made as part of the PER. Part of the Direct Reduction Plant is 92m high and will intrude above the obstacle limitations surface surrounding the airport. It therefore will be classified as an obstacle. However, the Direct Reduction Plant will be a massive structure, equivalent to the size of a multistorey building and will be well lit at night. As such, it is not considered that it will constitute a hazard to aircraft.

The Direct Reduction Plant will not interfere with existing instrument landing procedures.

4. Transport Requirements

The GSP will use approximately 1.5 million tonnes of iron ore each year to produce 1 million tonnes of rolled coiled steel for export. Iron ore will be transported from the mine by road-trains to a Transfer Facility north of Mullewa and from the Transfer Facility to the GSP by train. The transport from Tallering Peak to the Transfer Facility will involve an estimated 120 road-train movements per day (i.e. 60 each way), with trucks operating 24 hours per day and 7 days per week. It will also involve 2 trains per day from the Transfer Facility to the GSP (i.e. four train movements). The trains will comprise twin locomotives pulling 46 bottom dump wagons, with each wagon having a payload of 53 tonnes.

As the transport of iron ore will be on established road and rail routes and the number of vehicles and train movements is not large, it is not expected to cause any significant environmental or social impacts.

Solid waste products from the GSP will be transported to Tallering Peak using the same trains and road vehicles used for transporting iron ore.

Approximately 260,000 tonnes of other solid inputs required for steel production will also be delivered to the GSP each year, mainly by road from the Port of Geraldton. The transport routes from the port will be along Portway, Brand Highway, Rudds Gully Road, and Goulds Road. The number of truck movements involved will be 6 per hour, 12 hours per day, 7 days per week.

The same route will be used by trucks transporting the rolled coiled steel from the GSP to the port. In this case, the number of truck movements is estimated at 12 per hour, 12 hours per day, 7 days per week or 6 per hour, 24 hours per day, 7 days per week.

The combined truck movements to and from the Port of Geraldton will not reduce the level of service of the roads involved although some improvements will be required.

The level of service for Portway, however, is likely to be affected in the relatively near future by a combination of increased general traffic and increased truck traffic associated with the Port of Geraldton, including that related to the GSP. Noise levels from the overall increase in traffic on Portway including truck movements associated with the GSP are also likely to exceed recognised standards at some residences close to the road.

Recent evaluations, including this PER, all indicate a need for road access to be improved from the Rotary to the Port of Geraldton including the provision of noise barriers at strategic locations.

5. Social Implications

A review of population statistics, unemployment levels, and community services for the City of Geraldton, Shire of Greenough and Shire of Mullewa is provided as part of this PER. This review indicates clearly that the infrastructure and services available at Geraldton and within the two shires generally have adequate capacity to accommodate any population increase associated with the establishment of the Mid West Iron and Steel Project.

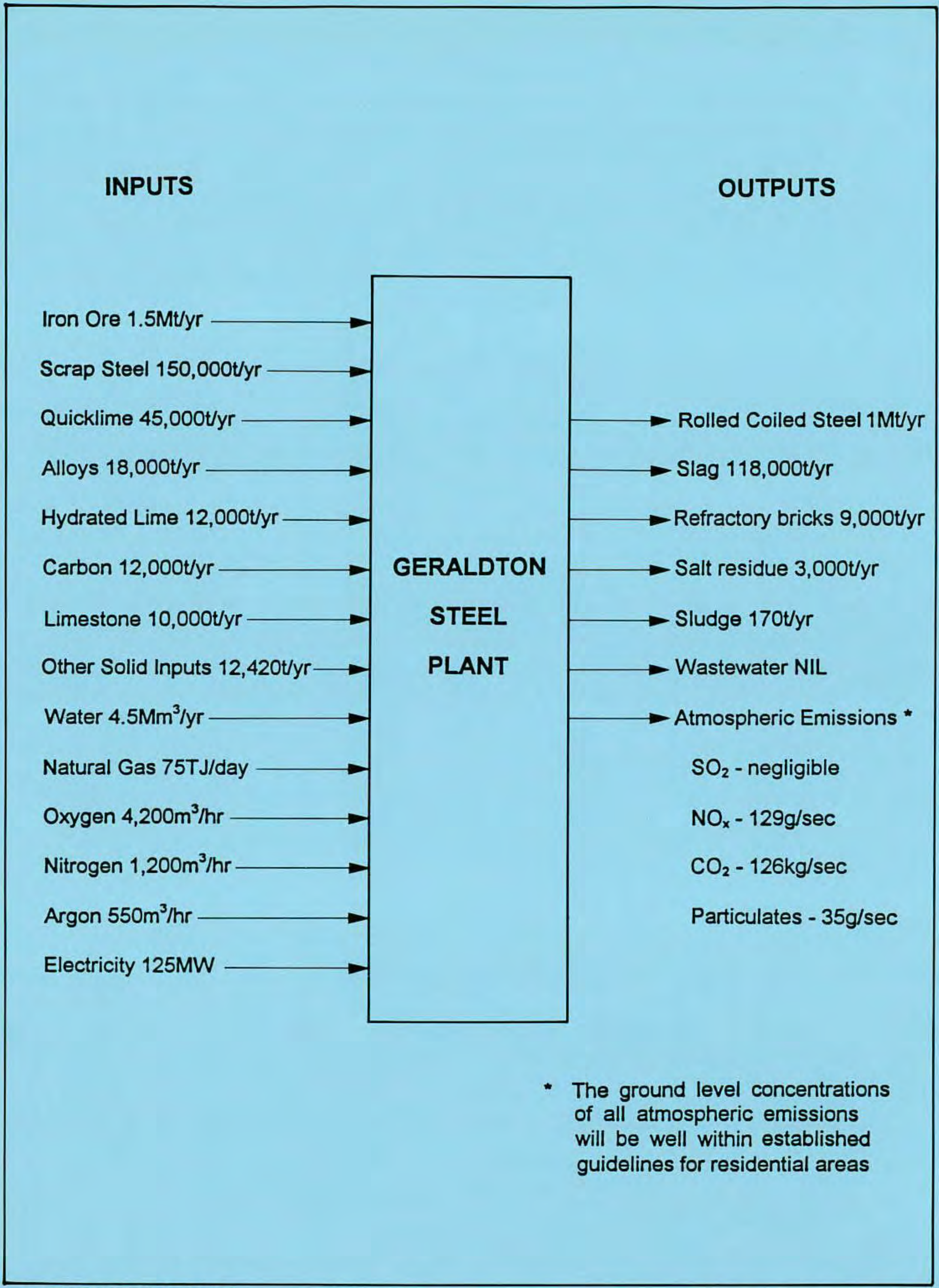
6. Conclusion

The analysis presented in this PER indicates that the proposed GSP at the Narngulu Industrial Estate will provide major economic benefits to the community and will not present any significant environmental or social issues. A summary of the environmental and social implications is presented below.

SUMMARY OF ENVIRONMENTAL AND SOCIAL IMPLICATIONS OF THE GERALDTON STEEL PLANT

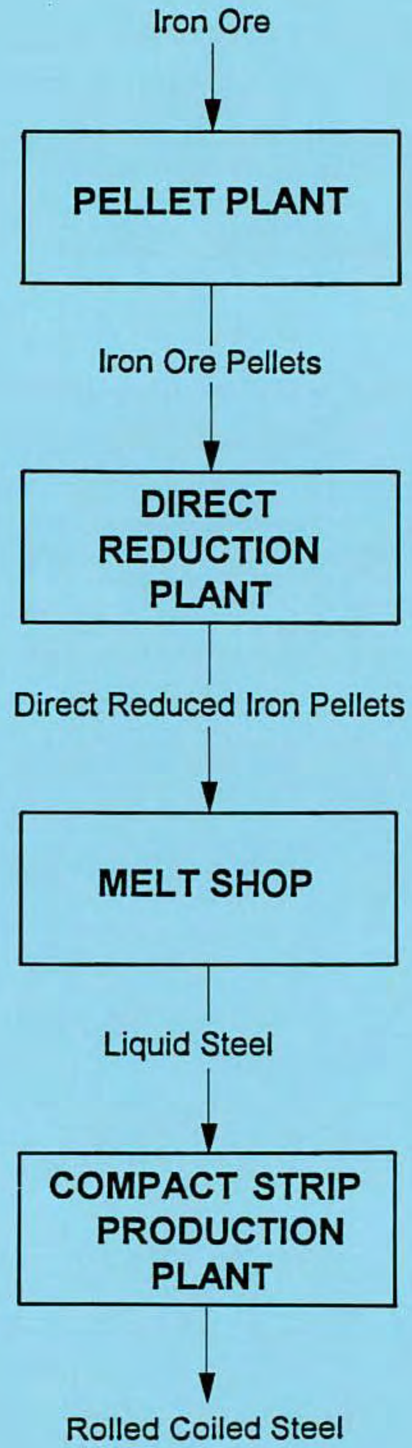
	Comments
Site	Cleared for agriculture, suitable and zoned for industrial development.
Construction	Can be managed by routine procedures.
Supply of Iron Ore	Development of iron ore mine at Tallering Peak has been assessed by Department of Minerals & Energy.
Atmospheric Emissions	All ground level concentrations of atmospheric emissions will be well within recognised criteria for residential areas.
Noise	Can be managed by routine noise attenuation measures. Noise levels at nearby houses will comply with regulations.
Buffer Zone	Not required.
Solid Wastes	Disposed of at Tallering Peak mine site or landfill.
Wastewater	Nil.
Visual Impact	Only from south, south-east and south-west where few people live.
Transport	Iron ore from mine site to Transfer Facility by road train will require upgrade of road, but in remote area with few houses and minor traffic. Transfer Facility to GSP by train, two trains per day each way on existing railway. Increase in train movements negligible. Steel and inputs between GSP and Port of Geraldton, probable significant increase in number of trucks on Rudds

	Gully Road, no implications for Brand Highway or Portway due to existing traffic levels.
Social	Existing community services adequate for population increase. Major employment benefits. Environmental implications at Narngulu will comply with guidelines and regulations.



ALAN TINGAY & ASSOCIATES

GERALDTON STEEL PLANT
SUMMARY OF INPUTS & OUTPUTS
FIGURE A



ALAN TINGAY & ASSOCIATES

GERALDTON STEEL PLANT
SIMPLIFIED PROCESS FLOW CHART
FIGURE B

1. INTRODUCTION

1.1 Structure of the Public Environmental Review

This Public Environmental Review (PER) contains a number of sections which are intended to provide a comprehensive and easy to read description of a proposed Geraldton Steel Plant (GSP) in the Narngulu Industrial Estate near Geraldton, Western Australia. The information contained in the PER has been prepared in accordance with guidelines issued by the Environmental Protection Authority (EPA) of Western Australia and the sections comprise:

- An introduction which provides background information to the proposal, details of the proponent, a description of the purpose of the PER and of the environmental impact assessment process in Western Australia, and details of the consultation program which commenced in 1994 to inform the public of the proposal.
- A brief discussion of the economic and employment benefits of the proposal.
- A description of the analysis which led to the selection of the Narngulu Industrial Estate as the site for the GSP, a description of the Industrial Estate itself, and a description of the specific site of the GSP within the Industrial Estate.
- A description of the GSP and its major components.
- A description of all inputs required for steel production such as iron ore, additives, water, electricity and gas, and of the volumes required and sources and routes of supply.
- An analysis of the environmental considerations and environmental management procedures involved in the establishment and operation of the GSP including such matters as site development impacts, atmospheric emissions, noise, and liquid and solid wastes.
- A description and analysis of the transport of iron ore from the Tallering Peak mine site to the GSP at Narngulu, of steel product from Narngulu to the Port of Geraldton, and of other inputs and waste products.
- A discussion of the social implications of the proposal in terms of population growth, employment opportunities, and the availability of community services.
- A list of commitments by the proponents of the Mid West Iron and Steel (MWIS) Project which relate to the establishment and operation of the GSP.

A guide describing how to make a written submission on the PER to the EPA is also included, together with a summary and a list of relevant references. Technical reports dealing with atmospheric emissions and noise are available separately.

1.2 Background

The MWIS Project involves the establishment of an iron ore mine at Tallering Peak, 63km north north-east of Mullewa; transport of iron ore by road and rail to the Narngulu Industrial Estate near Geraldton; the provision and operation of the GSP at a site within the Narngulu Industrial Estate; and transport of steel product by road from the GSP to the Port of Geraldton for export.

The various locations which are all in the Mid West Region of Western Australia are shown in Figure 1.

The GSP has several major components including a Pellet Plant which converts the majority of the iron ore to pellets suitable for direct reduction; a Direct Reduction Plant using natural gas which converts pellets and lump iron ore to direct reduced iron of suitable quality for steel making; a Melt Shop which produces liquid steel from the direct reduced iron plus other additives; and a Compact Strip Production Plant in which slabs of steel are rolled into the final product. The GSP will produce 1.0 million tonnes of rolled coiled steel each year.

Another major component is a gas fired power station which will supply electricity to all facilities of the GSP.

In addition there are numerous other lesser components of the GSP including an oxygen plant, water and wastewater treatment facilities, cooling towers, materials handling and storage facilities for products, and administration and maintenance facilities.

The MWIS Project was initiated by Kingstream Resources NL and Pavilly Pty Ltd in 1992 when a pre-feasibility study of the project was carried out. In this study the extent and quality of the ore body at Tallering Peak was assessed, various options for iron and steel production were investigated, and the economic viability was evaluated. The pre-feasibility study indicated that a steel making project could be viable in the Mid West Region.

A more detailed full feasibility study was initiated in 1994. The full feasibility study involves the final selection of a site for the GSP; selection of the steel making (i.e. process) technology; completion of assessments of the iron ore resource and preparation of a detailed plan for the iron ore mine; determination of modes of transport for iron ore and other inputs and for the steel product; completion of all necessary arrangements for the supply of utilities; and the formation of a consortium with sufficient technical and other resources to enable the Project to achieve finance and to proceed.

The acquisition of all necessary approvals from the Commonwealth and State Governments is also a key element of the full feasibility study. This includes the acquisition of environmental approvals from the Government of Western Australia and endorsement of that approval by the Commonwealth of Australia. The basis for the application for environmental approval is this PER.

During the last decade, substantial innovations have been made in the processing of iron ore into steel. These innovations have resulted in smaller steel mills becoming economically viable. These mills also have considerably less adverse environmental impact than traditional steel mills. Examples of these innovations are:

- Use of natural gas as a reductant for the conversion of iron ore into iron, eliminating the requirement for coal, coke and sinter plants.
- Development of the Electric Arc Furnace for the conversion of iron into liquid steel.
- Improvements in techniques such as continuous thin slab casting.

The proponent has examined the recent innovations in detail and has incorporated appropriate technically proven improvements in the GSP.

1.3 The Proponent

The proponent for the MWIS Project is Kingstream Resources NL and Pavilly Pty Ltd. Kingstream Resources NL owns 60% of the MWIS Project and is the Project Manager. The registered office of Kingstream Resources NL is at:

Level 40, Exchange Plaza
2 The Esplanade
PERTH WA 6000

The primary activity of the proponents is the establishment of the MWIS Project.

1.4 Purpose of the Public Environmental Review

Kingstream Resources NL and Pavilly Pty Ltd have prepared two documents which describe the environmental implications and proposed environmental management of the MWIS Project. These are:

- A Notice of Intent (NOI) for the Tallering Peak iron ore mine, and
- The present PER which describes the GSP at Narngulu and the transport of inputs to the GSP and steel product to the Port of Geraldton.

The NOI has been submitted to the Western Australian Department of Minerals and Energy for evaluation and is available to the public (Alan Tingay & Associates & Signet Engineering Pty Ltd, 1995). The PER for the GSP has been prepared for assessment by the EPA.

The purpose of the PER is to provide a comprehensive account of the GSP and the transport of materials in sufficient detail to enable all features which may have environmental implications to be identified and described. These features range from such matters as potential emissions in the form of noise, dust and gases; and liquid and solid waste streams; to social considerations arising from the establishment of a new large industry close to the City of Geraldton.

The PER is also required to provide an analysis of the environmental implications in order to determine whether the GSP will meet established environmental standards and requirements, and also an account of management procedures which will be adopted to ensure that environmental performance will be satisfactory throughout the life of the Project.

The full scope of the PER is specified by guidelines issued by the Department of Environmental Protection (DEP). These guidelines are provided in Appendix 1.

The PER also provides the basis for an assessment of the GSP by the DEP and then by the EPA which is required to provide advice on the proposal to the Minister for the Environment. The assessment process is described in the next section.

1.5 PER Assessment Process

The environmental impact assessment process in Western Australia is specified by the Environmental Protection Act, 1986 and is illustrated in the flow chart presented in Figure 2. The Act requires the proponent (in this case, Kingstream Resources NL and Pavilly Pty Ltd) to notify the DEP/EPA of any proposal which may have significant environmental implications. The DEP/EPA then determines whether the proposal should be formally assessed. If a decision is made for a formal assessment, the DEP/EPA requires the proponent to prepare a detailed account of the environmental implications in a report such as the present PER.

After the PER has been prepared, it is reviewed by the DEP to ensure that it provides sufficient detail and a comprehensive coverage of issues. When this has been established, the PER is released for a public review period. In the present case, this public review period extends for eight weeks. During this period any person may make a written submission to the DEP/EPA on any aspect of the proposal. At the end of the public review period, a summary of submissions is supplied to the proponent by the DEP and a response is sought.

The DEP then begins its assessment of the development proposal taking into account the PER, the public submissions, the response by Kingstream Resources NL and Pavilly Pty Ltd to the submissions, and any other relevant information.

The EPA then considers the advice of the DEP and publishes a final analysis of the proposal in the form of an Assessment Report. This Assessment Report includes recommendations to the Minister for the Environment as to whether the proposal is acceptable and what conditions should be imposed in order to ensure satisfactory environmental performance. Ultimately, the Minister for the Environment decides whether the Project should proceed and sets legally binding conditions.

Interested parties can appeal to the Minister about the content of the EPA Assessment Report or any of its recommendations during a specified appeal period.

The environmental assessment process is designed to enable members of the public to obtain details of the proposal and to formally comment on any matters of interest to them. These inputs are required within the specified public review period and are considered by the DEP/EPA together with technical assessments provided by expert staff of the DEP. The public is encouraged to provide written comments to the DEP/EPA as part of the environmental assessment process. Details of the public review period for the GSP proposal and advice on how to make a submission are provided at the beginning of this PER.

The environmental assessment process also enables State Government Agencies to consider in detail the implications of development proposals. These considerations are based on technical assessments of the nature and extent of changes to the existing natural and social environments, on proposed management strategies designed to control or limit adverse changes, and on monitoring programs designed to document and analyse the effectiveness of such strategies.

1.6 Relevant Legislation

The MWIS Project will be subject to the provisions of legislation of the Commonwealth of Australia and of Western Australia. The pertinent legislation is diverse and includes:

- Aboriginal Heritage Act, 1972-1980
- Conservation and Land Management Act, 1984
- Environmental Protection Act, 1986
- Environment Protection (Impact of Proposals) Act, 1974
- Local Government Act, 1960-1973
- Mining Act, 1978-1987 and Regulations
- Mines Regulation Act, 1946 and Regulations
- Occupational Health and Welfare Act, 1984
- Rights in Water and Irrigation Act, 1914
- Soil and Land Conservation Act, 1945-1982
- Town Planning and Development Act, 1928-1972
- Wildlife Conservation Act, 1950-1979

1.7 Public Consultation Program

1.7.1 Objectives

An extensive public consultation program has been undertaken by Kingstream Resources NL and Pavilly Pty Ltd before and during preparation of the PER.

The two main objectives of the public consultation program, are as follows:

- To ensure that the public is informed of all aspects of the GSP proposal, and
- To identify community concerns and social issues surrounding the proposal.

These objectives have been addressed through a series of meetings with Government Agencies, local interest groups and individuals.

1.7.2 Meetings

The public consultation program for the PER has two stages. Stage 1 commenced in August 1994, and continued throughout the preparation of the PER.

Stage 2 is intended to commence during the public review period following the release of the PER.

The following meetings have been held with interested parties and individuals during the course of the public consultation program:

Tuesday 9 August 1994	Landcorp
Wednesday 10 August 1994	Department of Environmental Protection
Thursday 11 August 1994	Shire of Greenough
Monday 15 August 1994	Mr Bob Bloffwitch, Member for Geraldton
Tuesday 16 August 1994	Eradu Progress Association
Wednesday 17 August 1994	Sarah Green, ABC Regional Radio Geraldton Greenough Chamber of Commerce & Industry Port of Geraldton Authority Board Members & Staff Active Community Environmentalists Friends of the Batavia Coast
Thursday 18 August 1994	Shire of Chapman Valley Tarcoola Progress Association Ministry for Planning
Friday 19 August 1994	City of Geraldton Mr Murray Criddle, Member for the Agricultural Region
Friday 26 August 1994	Department of Environmental Protection Department of Resources Development Department of Minerals & Energy
Thursday 8 September 1994	Narngulu landholders
Friday 9 September 1994	Mid West Development Commission
Tuesday 13 September 1994	Shire of Greenough

Wednesday 14 September 1994	Narngulu Neighbours Narngulu Township Residents
Thursday 15 September 1994	Sarah Green, ABC Regional Radio Mayor - City of Geraldton Mid West Development Commission
Monday 10 October 1994	The Hon Colin Barnett - Minister for Resource Development
Thursday 15 December 1994	Department of Main Roads - Geraldton
Monday 19 December 1994	Shire of Greenough General Manager - Geraldton Port Authority Ministry for Planning - Geraldton Mid West Development Commission City of Geraldton
Tuesday 20 December 1994	Westrail - Geraldton RGC Mineral Sands Ltd Marsh Transport Shire of Mullewa
Wednesday 18 January 1995	Department of Environmental Protection
Tuesday 31 January 1995	Water Authority of Western Australia
Friday 3 February 1995	Environmental Protection Authority

1.7.3 Mingenew Expo 1994

The 1994 Mingenew Expo was held on 23 and 24 September 1994 at Mingenew. Kingstream Resources NL and Pavilly Pty Ltd provided part of the display at the Expo co-ordinated by the Mid West Development Commission. Colour photographs of various components of the GSP were on display together with diagrams of the Tallering Peak ore body. Information pamphlets on the proposal were also available.

During the course of the two days, approximately 150 people passed through the display and sought information relating to the proposal.

1.7.4 Geraldton Homes and Living Expo

A display similar to that used at the Mingenew Expo was erected at the Geraldton Homes and Living Expo from 14 to 16 October 1994. Several hundred people viewed the display during this period and indicated overwhelming support for the Project.

1.7.5 Issues Raised During the Public Consultation Program

The main issues raised during the public consultation program are listed below. This list presents a summary of all the issues raised during the program, and the issues are not presented in any order of frequency or perceived importance:

- Impact of the transport of ore to the GSP.
- Noise levels at nearby properties.
- Dust due to uncovered ore stockpiles.
- Proximity of heavy industry to Geraldton.

2. BENEFITS OF THE PROJECT

The major benefits of the MWIS Project will be in terms of revenues, expenditures and employment. These benefits will accrue at the National, State and particularly the Local level of the Mid-West Region.

At the National level, the Project will generate significant export earnings through the sale of 1.0 million tonnes of steel each year. As the steel is a value-added product, these earnings will be substantial and will be among the highest for any single industry in WA. The Project will therefore contribute positively to the balance of payments and to the reduction of the national debt.

The Federal Government will also receive major revenue from the Project in terms of company tax, personal income tax generated by the high level of employment, and other taxes and duties.

Similarly, the State of Western Australia will receive direct payments from the Project, from payroll tax and royalties on raw materials.

At the Local level, the Project will pay rates to the Shire of Greenough (which includes the proposed site of the GSP at Narngulu) and to the Shire of Mullewa (where the workforce for the mine at Tallering Peak will be located).

The scale of this Project is indicated by the estimated capital expenditure, which will be in the order of $950 million. Some $800 million of this represents fixed expenditures associated with the GSP, while the remainder includes development of the mine and the supply of services and infrastructure, such as upgrades of roads and rail, and electricity, gas, and water supplies.

At the Local level, there will be significant opportunity for individuals and companies in the Mid-West Region to be involved in the construction of the GSP, and in providing a very wide range of services during the operational phase. The construction of the GSP will take approximately three years and during this period, an average of about 750 people will be employed. The peak construction workforce during the period will be approximately 1,200 people.

In the operational phase a total of 600 people will be employed by the Project. The GSP will employ about 460 people, with a further 90 employed at the mine site at Tallering Peak, and 50 employed in transport and other activities. It is estimated that about 150 personnel in the operational workforce will need previous experience in the steel industry, but the remainder can be trained "on the job". These positions will therefore be open to people in the Mid-West Region.

A study by Dames and Moore (1990) has estimated the consequential employment (i.e. multiplier effects) which is generated by direct employment in industries such as the MWIS Project in Western Australia. This study suggests the consequential employment could be more than 1,500 people. The total employment generated by the project would therefore be likely to exceed 2,000 people as follows:

Direct employment	600

Direct employment	600
Support and supply industries	455
Induced employment	1160

Total	2215

The Project will also provide improvements to infrastructure and services in the City of Geraldton, and in the Shires of Greenough and Mullewa which will be of benefit to the general community. This is particularly the case in the Shire of Mullewa, where there has been a decline in population in recent years.

3. THE LOCATION OF THE GSP

3.1 Evaluation of Alternatives

3.1.1 Capital and Operating Costs

Seven potential locations for the GSP in the Mid West Region were originally investigated by Signet Engineering Pty Ltd in 1994. The locations are shown in Figure 3 and were:

- Narngulu
- Moonyoonooka
- Oakajee
- Eradu
- Mullewa West
- Mullewa North
- Tallering Peak

These locations were selected on the basis that they were either in the vicinity of Geraldton, or were located on the main transport route between Geraldton and Tallering Peak.

The primary comparisons between the locations were made in terms of the estimated costs, which are:

- The supply and construction of the GSP.
- Infrastructure requirements, including provision of utilities.
- Transport of solid bulk products to and from the GSP during operation.
- Labour and administration costs associated with sourcing and maintaining the operations and maintenance workforce at each location.

Approximately $800 million of the estimated costs associated with the GSP do not vary according to the site location, such as the supply of major process equipment.

The cost comparison of the seven locations is summarised in Table 3.1. The estimated costs were based on a throughput of 700,000tpa of steel product and a 20 year operating life. The estimated capital, operating, and net present cost (NPC) differentials are given relative to the GSP being located at Narngulu, as this is the closest location to Geraldton.

TABLE 3.1

DIFFERENTIAL COSTS OF THE GSP AT SEVEN LOCATIONS IN THE MID WEST REGION

Location	Unit	Narngulu	Moon-yoo-nooka	Oakajee	Eradu	Mullewa West	Mullewa North	Tallering Peak
Capital Cost Differential	$M	Base	-2.7	+15.5	-17.5	+56.7	+80.8	+66.3
Operating Cost Differential	$M/yr	Base	-0.54	+3.45	+2.0	+3.60	+3.83	+2.77
NPC at 5% Discount Differential	$M	Base	-8.0	+49.8	+5.5	+87.8	+111.5	+87.6

The proximity of each location to existing sources of infrastructure influences establishment costs considerably. For example, the capital costs at Eradu are the lowest for all of the locations principally because the main Dampier to Perth gas pipeline is located in this area and only a short lateral gas pipeline is required to service the location. Conversely, Oakajee, and especially the locations at Mullewa and Tallering Peak, are more distant from existing sources of infrastructure and therefore involve relatively high establishment costs.

Operating costs which vary at each location are:

- Transport costs for haulage of solid products.
- Delivery costs for the supply of utilities.
- Labour costs.

Transport costs were derived from rates provided by either road haulage companies or by Westrail. The rates are usually determined on a tonnage per kilometre basis. Transport costs for iron ore are lower than transport costs for steel. Therefore costs will be lower the closer the GSP is located to the port. The exception to this is Oakajee, which is to the north of Geraldton. Iron ore would have to be transported to this location through Geraldton and then steel would be transported back to the port for export.

The costs associated with the delivery of natural gas and electricity were assumed to remain unchanged at each location. However, delivery costs for the supply of water increase as the distance of the location from the water source increases.

Eradu has the lowest water costs as it is the closest location to Casuarina where a new borefield could be developed to supply the water requirements of the GSP. Costs for water at Mullewa West, Mullewa North and Tallering Peak are high due to the distance of these locations from the nearest potential source of water at Casuarina. Hydrogeological investigations available at the time of the investigation indicated that there is little likelihood of obtaining the water requirements closer to these eastern locations. For the locations of Narngulu, Moonyoonooka and Oakajee, water would be obtained from the Allenooka Borefield.

Factors influencing labour costs are:

i) Travelling allowances and increased training due to a higher labour turnover at sites east of Eradu relative to sites closer to Geraldton.

ii) Provision of housing subsidies, relocation expenses and training costs for labour turnover, as well as rates and maintenance on accommodation infrastructure at Mullewa West and Mullewa North.

iii) Provision of catering, janitorial services and personnel transport at Tallering Peak.

A comparison of the estimated operating cost differentials of all locations when compared to Narngulu indicates that Mullewa West and Mullewa North have the highest operating costs followed by Oakajee. The higher cost differential associated with Oakajee is due to this location not being on the direct transport route between the mine and the port and to higher costs associated with the delivery of services.

3.1.2 Net Present Costs

Net Present Cost (NPC) is an indicator which allows an economic comparison of values at a particular discount rate. The NPC differential is a single value which combines the capital costs differentials and the operating cost differentials over the lifespan of the Project at a discount rate deemed appropriate for the evaluation.

Comparing the NPC differentials to Narngulu which is taken as the base case due to its proximity to Geraldton, Moonyoonooka is the least cost option. This is followed by Narngulu and then Eradu. There is a significant increase in the NPC differentials between these three locations and the other locations at Oakajee, Mullewa West, Mullewa North and Tallering Peak.

3.1.3 Discussion and Conclusion

The assessment of potential locations for the GSP demonstrated there is an economic benefit to the Project in locations close to Geraldton and on the transport route between Tallering Peak and the Port of Geraldton.

Following the issue of the assessment, Kingstream Resources NL and Pavilly Pty Ltd arranged for Stage 1 of the public consultation program (described in Section 1.7 of this PER) to commence. This focussed on the advantages and disadvantages of Narngulu, Moonyoonooka and Eradu in land planning, social and environmental management terms and provided an opportunity for community input into the selection of the location of the GSP.

After this process, Kingstream Resources NL and Pavilly Pty Ltd selected the Narngulu Industrial Estate as the location for the GSP.

The decision was based on:

- The relatively low estimated costs at this location,
- The existing zoning of the land for industrial use,
- The immediate availability of the land from LandCorp,
- The existence of easements to the location for water and natural gas supply,
- The proximity of the location to Geraldton, and
- An indication that the majority of people in the Shire of Greenough and the City of Geraldton would accept the GSP being built in the Narngulu Industrial Estate provided that this location was shown to be environmentally acceptable.

Since the completion of the assessment, the throughput of the GSP has increased from 700,000tpa to 1,000,000tpa of steel product. However, the capital and operating cost differentials for the various locations have generally increased proportionally.

With regard to infrastructure and utilities, the only change of substance is that electricity supply has changed from overhead transmission lines from Mungarra Power Station in the original assessment to a power station as an integral part of the GSP and consequently an increase in size of the natural gas supply pipeline to each location. The net effect of these changes is that the significant difference in the NPC differentials between the three locations of Narngulu, Moonyoonooka and Eradu and the remaining four locations increases. Thus the economic benefit in locating the GSP close to Geraldton remains unchanged.

3.2 The Narngulu Industrial Estate

3.2.1 Location of the Estate

The GSP will be located in the Narngulu Industrial Estate. The Estate is in the Shire of Greenough and is situated approximately 5km to the south-east of the boundaries of the City of Geraldton. The regional location is shown in Figure 4.

3.2.2 Area, Zoning and Surrounding Land Use

The Narngulu Industrial Estate has a total area of 670ha of which 470ha is zoned for general industry and 200ha is zoned for noxious industries. The general layout and zoning of the estate and of the surrounding land is shown in Figure 5.

Most of the land surrounding the Industrial Estate is zoned General Farming but there are smaller areas zoned for Public Utility (part of the proposed Meru landfill site) and for Special Rural use.

The Narngulu townsite which is zoned Residential is located adjacent to the eastern boundary of the Industrial Estate. Several private houses are also located within the Industrial Estate itself on land which is zoned General Industry in the area shown in Figure 5.

The Geraldton Airport is located approximately 1.5km to the east of the Industrial Estate and the intervening land largely comprises horticultural properties, some with private houses, and larger agricultural lots.

3.2.3 Existing Industries in the Estate

The Narngulu Industrial Estate currently contains about 50 lots ranging in size from about 0.2ha to about 89.9ha. Fifteen of the blocks are occupied by functioning industries (1993 figure), two are occupied by inoperative industries, and several of the small lots adjacent to Rudds Gully Road have houses on them. The remainder of the lots are vacant, or are reserved for services or other Government requirements.

The existing industries in the Industrial Estate comprise a Mineral Sands Separation Plant and a Synthetic Rutile Plant both of which are operated by RGC Mineral Sands Ltd, an Attapulgite Plant operated by Mallina Holdings Ltd, and a variety of relatively small plants such as sand blasting operations, earthmoving and haulage contractors, and car wreckers.

The locations of the existing large industries adjacent to the site of the GSP are shown in Figure 5.

3.2.4 Existing Infrastructure

The existing infrastructure servicing the Narngulu Industrial Estate has been documented by Alan Tingay & Associates *et al* (1993). This infrastructure is illustrated in Figure 6 and is summarised below.

The existing external road system around the Industrial Estate provides good access from Geraldton via the Geraldton-Walkaway Road (Edwards Road) and good access from the south by Rudds Gully Road which intersects the Brand Highway.

The Industrial Estate itself is serviced internally by Goulds Road. This road has a wider than usual 40m road reserve and therefore has the potential to be upgraded should this be required. In the future, the Industrial Estate may also be served by a new main road network comprising the so-called Geraldton to Mt Magnet Road to the north of the Estate, and the realigned Brand Highway to the west.

Also to the north of the Industrial Estate, Meru Road is identified in the Greenough Shire Town Planning Scheme (TPS) No. 4 as an important future regional road which will provide an east-west link from the future realignment of the Brand Highway to the northern section of Goulds Road.

The major regional railway marshalling yard is also located immediately adjacent to and east of the Narngulu Industrial Estate. Railways connecting into this marshalling yard include the narrow gauge line from Mullewa and the line connecting with the Port of

Geraldton both of which are shown in Figure 6. The railway line from Mullewa is of particular relevance to the MWIS Project as it will be used for transport of iron ore from Mullewa to the GSP.

A railway line also extends from the marshalling yard into the Narngulu Industrial Estate to the Mineral Sands Separation Plant and Synthetic Rutile Plant operated by RGC Mineral Sands Ltd. This line is located in close proximity to the proposed location of the GSP.

The water supply to the Narngulu Industrial Estate is sourced from the Allenooka Borefield which is located approximately 47km to the south-east (Figure 3). This borefield also supplies the City of Geraldton. The main supply pipeline from the borefield follows Edwards Road adjacent to the Industrial Estate and comprises a 600mm diameter steel water main.

The Water Authority of Western Australia (WAWA) has advised that the Allenooka Borefield has a potential yield of about 28 million cubic metres each year (Mm^3/yr) and that the current demand from the City of Geraldton and surrounding region is in the order of 8 to 8.5Mm^3/yr.

The electricity supply to the Narngulu Industrial Estate is provided by two 33kV overhead lines which connect to the Geraldton substation in Eighth Street. The substation is connected to the Mungarra Power Station which is located to the south-east of the Industrial Estate (Figure 3). The Mungarra Power Station is connected to the State electricity grid operated by Western Power.

Natural gas is supplied to the Narngulu Industrial Estate by Alinta Gas through a high pressure pipeline which connects with the Dampier to Perth gas pipeline which is located to the east of the Mungarra Power Station (Figure 3). The gas reticulation within the Industrial Estate is shown in Figure 6 and includes a high pressure pipeline along Goulds Road.

Drainage and sewerage facilities within the Narngulu Industrial Estate are provided by the individual industries operating there.

3.3 The GSP Site

3.3.1 Location and Area

The proposed location for the GSP is on Lot 1277, Part Lot 13 and Lot 6 in the Narngulu Industrial Estate as shown in Figure 5. Lot 1277 has an area of 64ha and is bounded to the west by Goulds Road, to the south by Rudds Gully Road, to the east by small allotments including some private houses which are on land zoned for General Industry, and to the north by the Mineral Sands Separation Plant operated by RGC Mineral Sands.

Part Lot 13 has an area of 26.5ha and is located adjacent to, and to the north-east of, Lot 1277. This lot is bounded to the north by the Attapulgite Plant operated by Mallina Holdings Ltd and by the Mineral Sands Separation Plant, to the east by an undeveloped

Recreation Reserve, and to the south by the small allotments which are zoned for General Industry.

The power station will be located on the other side of Goulds Road on Lot 6. This lot has an area of approximately 40ha, and is bounded to the north by the Synthetic Rutile Plant, to the east by Goulds Road, and to the west and south by allotments zoned for General Farming.

3.3.2 Ownership

Kingstream Resources NL and Pavilly Pty Ltd, the proponent of the MWIS Project, have an option to purchase Lot 1277, Part Lot 13, and Lot 6 within the Narngulu Industrial Estate from their present owner, LandCorp. LandCorp is the operating name of the Western Australian Land Authority (WALA). WALA was established by a specific act of Parliament in 1992 which brought together the land development activities previously carried out by the Industrial Lands Development Authority, the Joondalup Development Corporation, and the original LandCorp (which formerly only dealt with residential land).

The purpose of LandCorp is to provide land, infrastructure, and associated facilities to meet the social and economic development needs of the community. To achieve this purpose LandCorp co-ordinates the development of land in Western Australia in accordance with Government policies and objectives. One of the principal functions of LandCorp is to supply appropriately located, zoned, and serviced sites to industry in order to generate employment opportunities and to assist economic growth.

3.3.3 Environmental Features

The Narngulu Industrial Estate is located on a relatively flat area with an elevation between 20m and 22m AHD. A tributary of the Greenough River is located about 1km to the south of the Estate but there is no surface drainage from the Estate to the river. A monitoring bore constructed by RGC Mineral Sands Ltd in the northern section of the Industrial Estate located brackish groundwater at a depth of approximately 24m. The Geological Survey of Western Australia also located groundwater of between 2,000 and 3,000mg/L total dissolved salts at depths from 15m to 22m under the nearby proposed Meru landfill site (Appleyard, 1990). The direction of groundwater flow is to the west.

The Department of Agriculture has published a Rural/Residential land capability study for the Geraldton region which includes the Narngulu Industrial Estate (Dye *et al*, 1990). According to this assessment, most of the area zoned for General Industry is part of the Bootenal Alluvial Plain which has been formed by deposits from the Greenough River. The plain is described as gently undulating with well developed red duplex soils grading into deep, red uniform sands. There are also some small isolated sandy rises overlying limestone at varying depths. The area zoned for Noxious Industry to the south of Rudds Gully Road mainly comprises a ridge formed of Tamala Limestone overlain by deep yellow-brown siliceous sand. Limestone rock is evident in the eroded stock holding paddocks in this area.

According to the land capability study, the soil types and landform of the Industrial Estate are generally suitable for the development of industry. In particular, the proposed location for the GSP has a moderate potential for wind erosion, low potential for water erosion, high microbial purification ability, moderate to high absorption ability, high ease of excavation, fair to good foundation soundness, no slope instability risk, no flood hazard, moderate suitability for dam construction, and is well drained (i.e. not prone to waterlogging).

Rainfall and temperature data for Geraldton which are representative of conditions at Narngulu are illustrated in Figure 7 while wind patterns for the Narngulu Industrial Estate are shown in Figure 15.

The natural vegetation on Lot 1277, Part Lot 13 and Lot 6, has been removed and the land is now used for sheep grazing and crop production. There are therefore no significant habitats for vertebrate fauna.

4. DESCRIPTION OF THE GSP

4.1 General Description

The major components of the GSP are illustrated in Figure 8 and comprise:

- A Pellet Plant in which the iron ore fines are converted to pellets suitable for direct reduction.
- A Direct Reduction Plant in which the pellets and lump ore are converted to direct reduced iron using natural gas as the reductant.
- A Melt Shop containing an Electric Arc Furnace (EAF) and a Ladle Furnace (LF). The direct reduced iron pellets together with various additives are heated in the EAF to create liquid steel, and further adjustments to the composition of the liquid steel are then made in the LF.
- A Compact Strip Production Plant (CSP) in which the liquid steel is cast in thin slabs then, while still hot, rolled into a coil.
- Handling and storage facilities for incoming materials (iron ore in the form of both lump and fines, scrap steel, various additives including quicklime, ferro-alloys and carbon), for products at various stages of the process (pellets, direct reduced iron), and outgoing rolled coil, slag and miscellaneous wastes.
- An open cycle gas turbine Power Station.
- Water and wastewater treatment facilities and cooling towers.
- A Cryogenic Oxygen Plant.
- Administration and maintenance facilities.

Certain of the major components will be totally enclosed, such as the Melt Shop and CSP Plant while others will be partially enclosed for process or environmental reasons. Components such as the oxygen plant, water treatment facilities and cooling towers are standard industrial structures.

The layout of the GSP and each of its major components are described in more detail below.

4.2 Layout of the GSP

The GSP occupies Lot 1277, Part Lot 13 and Lot 6 within the Narngulu Industrial Estate. The layout is shown in Figure 9. The unloading facility for iron ore delivered from the Tallering Peak mine is on a short spurline from the Westrail marshalling yards and is on the boundary between Lot 1277 and Part Lot 13. Immediately to the east on Part Lot 13 is an enclosed shed for the iron ore stockpiles and adjacent to this is the pellet stockpile. To the north of these stockpiles, also on Part Lot 13, is the Pellet Plant.

The major components of the GSP are located on Lot 1277. These comprise:

- The Direct Reduction Plant in the north-west corner of the lot.
- The Melt Shop immediately to the east of the Direct Reduction Plant.
- The CSP Plant immediately south of, and connected to, the Melt Shop.

Lot 1277 also includes water and wastewater treatment facilities and water cooling towers for the GSP, a large de-dusting plant immediately north of the Melt Shop, the oxygen plant and storage yards for scrap metal and slag waste.

The Power Station and associated switchyard and power compensation equipment is located on Lot 6.

4.3 Iron Ore Receival and Storage

The iron ore delivered from the Tallering Peak mine will comprise 85% fines with a size less than 10mm and 15% lump in the size range 10 to 30mm. These materials will be delivered by train and will enter the GSP site via the Westrail marshalling yards. The unloading facility will be within an enclosed shed. The bottom dumping rail wagons will discharge the iron ore into a below ground receival hopper linked to an enclosed conveyor system which will transfer the ore to covered storage sheds. The fines and lump will be delivered in separate train lots and the unloading and conveying system will be arranged to ensure separation of the iron ore materials.

Recovery equipment and a further enclosed conveyor system will transfer the iron ore fines from the storage shed into the Pellet Plant.

4.4 Pellet Plant

In the Pellet Plant the iron ore fines are converted into spherical pellets. The process is illustrated in Figure 10 and essentially comprises two steps: formation of green pellets, and subsequent hardening of these pellets.

Iron ore fines are conveyed from the stockpile facilities into the Pellet Plant, and are directed into ball mills. Binding materials, such as clay, lime or organic binders are also added. A ball mill is a large cylinder filled with steel balls. As the cylinder rotates, the weight of the moving metal pulverises the iron ore fines and binding materials.

Water is added to the ground materials which are then fed into disc pelletising machines. As the discs rotate, a balling action occurs which causes the ground material to agglomerate into "green" (unfired) pellets.

The green pellets are of low strength and have to be hardened for use in the Direct Reduction Plant. The green pellets are discharged over the lip of the rotating disc and pass through sizing equipment where undersize and oversize pellets are returned to the pelletising machines. Green pellets of the required size (9mm to 15mm diameter) are conveyed onto a travelling grate which carries them at a constant rate through a furnace for hardening. The furnace has four principal zones, in which drying, pre-heating, firing and cooling occur in sequence.

The drying stage has two components: updraft drying, and downdraft drying.

In updraft drying, the pellets are dried using air recycled from the later stages of pellet cooling. Air, at a temperature of approximately 300°C, is diverted from the cooling zone to the updraft drying zone. Here it is passed through the pellet bed in an upward direction, which cools the air to a temperature of approximately 50°C. The air then passes through a dust extraction system before being discharged from the plant.

The pellets are then moved by the travelling grate into the downdraft drying zone. Here, air is recycled from the pre-heating and firing zones, and is passed through the pellets in a downwards direction. The air temperature prior to drying is approximately 350°C, and drops to approximately 120°C as it passes through the pellet bed. The air passes through the dust extraction system before being discharged from the plant.

The next stage of hardening involves the pre-heating and firing of the green pellets. Hot air, at a temperature of approximately 850°C, is redirected from the cooling process into the firing and pre-heating zone by a hood which is located above the cooling zone. The hot air is then mixed with hot combustion gases which raise the temperature to 1100°C in the preheating zone and 1300°C in the firing zone. This gas/air mixture is produced in combustion chambers located on both sides of the furnace and is directed by two fans through the pellets.

The hotter portion of the air leaving these zones, which is at a temperature of approximately 350°C, is then redirected into the downdraft drying zone as described above, while the cooler portion which is at a temperature of approximately 120°C passes through the dust extraction system and is discharged to the atmosphere.

Once the pellets have been hardened by firing, they pass into the cooling zone. Here, air from outside the plant is forced in an upward direction through the pellets, causing the pellets to cool. The air stream is heated during the cooling process, and is split into two streams due to pressure differences caused by the hot pellets. The hotter stream is redirected into the firing and pre-heating process, and the cooler air stream is redirected for updraft drying.

The hardened pellets, on discharge from the furnace, are transferred to a pellet storage stockpile.

4.5 Direct Reduction Plant

In the direct reduction process, oxygen in the pellets and lump iron ore is removed to produce direct reduced iron with an iron content of approximately 90%.

The direct reduction process which will be used in the GSP is known as HYL III. In this particular process, a reducing gas is first produced in a natural gas/steam reformer and then this gas is passed through the pellets and lump iron ore to produce the direct reduced iron. The process is illustrated in Figure 11.

Process Description

In the reformer, natural gas is converted into water vapour, carbon monoxide and hydrogen. The natural gas is pre-heated to approximately 370°C, and mixed with superheated steam. The steam/gas mixture is then pre-heated to a temperature of approximately 620°C, and is fed into the radiation section of the reformer where it is reduced to water vapour, carbon monoxide, and hydrogen in the presence of a nickel based catalyst. This occurs at a temperature of 830°C and a pressure of 7.8 bar.

The reformed gas is transferred to a steam generator, where its temperature drops to about 300°C. The gas is then cooled further in a cooling tower to remove excess water and is then reheated prior to being used in the ore reduction process.

The conversion of iron ore into iron, which involves the removal of oxygen from the iron ore, occurs in a shaft furnace type reactor. Pellets and lump ore in the ratio of 85% pellets and 15% lump ore are transferred by covered conveyor belts from storage sheds and are fed into the top of the reactor. While it would be advantageous to use all lump ore in the reactor, the lump ore is not strong enough and breaks down during the reduction process. This is the reason for using hardened pellets. However, a small percentage of lump ore assists in reducing the tendency of the pellets to stick together during the reduction process.

The reducing gas, which is at a temperature of approximately 930°C, is injected into the reactor at the bottom of the reducing zone and passes up the reactor shaft in counter flow to the descending pellets and lump ore. The hydrogen and carbon monoxide components of the reducing gas react with the oxygen in the pellets and lump ore to form water vapour and carbon dioxide respectively which are discharged through the top of the reactor with residual reducing gas.

The combined gases leave the top of the reactor at a temperature of about 400°C. This top gas is then passed through a scrubber, where it is cooled to a temperature of approximately 40°C. The scrubber also removes any dust and water which has formed as a reduction product. The gas is then diverted through a carbon dioxide removal system, which removes excess carbon dioxide. The cleaned gas is then mixed with new reduction gas and recycled through the reactor shaft. The excess carbon dioxide is used to pneumatically convey the direct reduced iron to the Electric Arc Furnace (EAF), and is then discharged to the atmosphere through the Melt Shop dust collection system.

The reduced pellets and lump ore are continuously discharged from the bottom of the reactor shaft at a temperature of approximately 600°C. From here, the direct reduced iron is pneumatically conveyed (using the excess carbon dioxide) directly to the EAF. When it is not possible to feed the reduced iron to the EAF, such as during maintenance, it is directed to two refractory lined (high temperature) holding bins which have a total storage capacity of approximately 20 hours' production.

4.6 Melt Shop

4.6.1 Electric Arc Furnace (EAF)

In the EAF, direct reduced iron together with scrap steel and other additives is converted into liquid steel. The process is illustrated in Figure 12.

The formation of liquid steel is a batch process in which up to 160 tonnes of liquid steel is formed and discharged from the EAF in an average time (tap to tap time) in the order of 70 minutes for cold direct reduced iron, and 60 minutes for hot direct reduced iron.

The batch process commences with a charging bucket containing weighed amounts of scrap steel, alloys such as ferromanganese and ferrosilicon, and carbon being positioned above the open EAF. The charge is then dropped into the furnace.

The roof and electrodes are then placed on the furnace and the electric power turned on. An electric current is directed down a graphite electrode towards the charge in the base of the furnace. The current then arcs from the electrode to the charge, passes through the charge and then arcs up to another electrode. Heat is generated by the arcs through the resistance to the electric current between the electrodes and the charge.

When the electric power is turned on, direct reduced iron at a temperature of approximately 600°C and lime are fed continuously into the EAF through a feed pipe. The flow of direct reduced iron into the EAF is interrupted only when the furnace is being charged with scrap steel and other additives, or when tapping occurs.

The heat generated from the arcs begins to melt the charge, forming a pool of molten metal in the base of the furnace. The remainder of the charge is melted from the bottom up by heat convection from the pool of molten metal and heat from the arcs. Heating of the charged material is continued until it is completely melted, and then the melt is superheated to a temperature of approximately 1630°C.

Acidic and basic processes can be used in the production of liquid steel. The melt-down of direct reduced iron and scrap steel in the EAF will occur in a basic environment as this process produces a cleaner and more consistent quality steel and assists in the removal of residual sulphur from the melt. During melt-down, impurities in the liquid steel rise to the surface and form a layer on top of the liquid steel. This layer is referred to as the slag, and is basic in composition due to the addition of lime during charging.

Oxygen is introduced through a lance into the EAF during melt-down. The lance is a water-cooled tube and oxygen is blasted at high pressure into the melt. The oxygen reacts with carbon, introduced into the melt in the original charge, to form carbon monoxide gas. The formation of carbon monoxide produces a bubbling effect within the melt. This is referred to as the "carbon boil" and is an essential feature of the steel making process as it promotes stirring within the melt to assist in separating the slag and the steel. It also eliminates temperature and concentration gradients within the liquid steel, as well as some of the hydrogen and nitrogen present in the melt.

The injection of oxygen into the EAF also assists in the melt-down process due to the heat generated as the oxygen burns. Carbon is the principal element removed by the oxygen, but other elements which are present in minor quantities such as silicon, manganese, phosphorus and chromium are also removed.

When the melt has reached the required temperature the power is turned off and the roof removed to enable tapping to be performed. The tapping process involves the separation of the slag from the molten metal. The electrodes are raised from the melt, the furnace is tilted, and the slag poured out into a slag pot which is emptied by a mobile slag transporter into a slag stockpile.

The furnace is then tilted in the opposite direction to that for slag tapping, and the liquid steel is drained from the furnace into a ladle using a slide valve at the bottom of the furnace. This allows the separation of any remaining slag from the pure metal. Tapping takes approximately three minutes.

The process is then repeated.

Gas and dust are extracted from the EAF while it is in operation via an off take in the roof. After extraction, sufficient excess air is drawn into the off take to ensure all combustible elements of the gas are burnt in a combustion chamber. Following burning, the gas passes through a natural draft gas cooler and then is directed to a central dry type bag filter plant where dust is removed before the gas is released to the atmosphere. Other gases emitted from the Melt Shop during the process are collected in a canopy in the roof of the Melt Shop building and are ducted to a central filter plant. The collected dust is stored in a silo from where it is periodically transported to the Pellet Plant for conversion to pellets.

4.6.2 Ladle Furnace (LF)

The LF is essentially a mini-EAF and is used to free the EAF for further melting. Temperature adjustment and trimming occurs in the LF. Trimming refers to the addition of alloys in order to obtain the required steel grade. Argon is also bubbled through the melt to ensure that the liquid steel is homogenous.

Following temperature adjustment and trimming the liquid steel is transferred in the ladle to the CSP Plant.

4.7 Compact Strip Production (CSP) Plant

The CSP process is illustrated in Figure 13. There are three major components of the CSP Plant which are installed in line, namely the Caster, Equalising Furnace and Rolling Mill. These are further described below.

4.7.1 Caster

Liquid steel is transferred to the casting floor in the ladle which is placed by overhead crane in a ladle turret. The ladle turret can carry two full ladles, each ladle having a capacity of up to 160 tonnes. On the casting floor, the liquid steel is poured at a controlled rate from the ladle through a refractory shroud into a tundish. The shroud prevents the metal stream from absorbing oxygen and minimises heat losses.

The tundish is a liquid metal reservoir and distribution system, and is essentially a rectangular box of about 30 tonne capacity with a nozzle located in the bottom. Tundishes are heated prior to use to minimise heat losses from the liquid steel during the start of a casting sequence.

Liquid steel flows from the tundish at a controlled rate into a mould which forms it into a cast slab. The mould is a box type structure made of a copper alloy and with water passages for circulating cooling water to absorb and remove heat from the solidifying steel.

During casting the mould vibrates and casting powder is added. The use of flux powders and vibration of the mould result in the production of thin cast slabs with excellent surface quality. Slab casting speed is between 2.8m and 5.5m per second.

Beneath the mould are rollers which guide the strand of the hot solidifying slab as it emerges.

The slabs are cast in lengths of approximately 48m, about 50mm thick and between 900mm and 1500mm wide.

4.7.2 Equalising Furnace

Temperature gradients that develop in the slab during the casting process are removed in the equalising furnace. As the slab is solidified, the edges cool more rapidly than the middle and this variability in temperature must be eliminated prior to rolling. The equalising furnace is about 185m long and can be used as buffer storage to temporarily hold up to three slabs as well as to equalise the temperature of each slab.

Each slab enters the furnace at a temperature of approximately 1050°C and leaves the furnace at a uniform temperature of approximately 1100°C with a tolerance of 10°C throughout the slab. Scale develops on the surface of the slab while it is in the furnace.

4.7.3 Rolling Mill

After leaving the equalising furnace the slab passes through a rotary shear which removes rough edges and then through a de-scaler where high pressure water dislodges the scale that formed on the slab surface in the equalising furnace.

The slab then moves through an edge reheating system which re-establishes temperature gradients across it. It then enters the Rolling Mill.

The Rolling Mill is made up of a series of six rolling stands with vertical edgers. The vertical edgers have two functions. They prevent the horizontal spread of the slab beyond the desired width, and they can also be used to reduce the width of the slabs without altering the size of the rolling stands. Each stand contains two small diameter work rollers and two large backup rollers which support the work rollers. The Rolling Mill will roll a slab of 50mm thickness and average width of 1250mm to a nominated final thickness between 1.2mm and 12mm. At this stage the steel is referred to as a strip.

As the hot strip leaves the Rolling Mill it passes onto the run-out table where it is cooled to meet the desired metallurgical requirements (known as a laminar cooling). The laminar cooling section has a number of normal and fine water spray sections, both top and bottom, which can be selectively switched on and off to obtain the optimum cooling rate as required.

The cooled strip is then directed into a pinch roll unit which feeds it to the down-coiler. In this, the strip is bent in a downwards direction and rolled to produce a coil.

Each roll is banded to prevent it from uncoiling, and weighed. The rolled coils weigh up to 27 tonnes for a 1500mm wide coil and average 22.5 tonnes. An identification code and information in relation to the characteristics of the strip are placed on the side and the roll is then moved to a storage area where it takes approximately two days to cool to ambient temperature. It is then ready for shipment.

4.8 The Power Station

It is expected that the Power Station will comprise 3 operating 70mW open cycle frame 6FA gas turbines. The basic performance specifications for each of these gas turbines are:

- Continuous Output 70,140kW
- Heat Rate 10,529kJ/kWh
- Gas Consumption 738.5GJ/hr
- Turbine/Generator Speed 5,235/3,000rpm
- Unit Efficiency 34.1%

Each gas turbine unit has basic dimensions of about 36m by 7m by 10m high, with a 30m high exhaust stack.

Power compensation equipment and a switchyard will be located adjacent to the Power Station.

4.9 The Cryogenic Oxygen Plant

The Oxygen Plant will produce high purity oxygen, nitrogen and argon from the atmosphere. Air in the atmosphere comprises approximately 78% nitrogen by volume and 21% oxygen by volume with the remainder made up of argon, water vapour, carbon dioxide and traces of rare gases.

Air is initially filtered, and then passed into an air compressor. Carbon dioxide and water vapour are then removed by passing the compressed air through a bed of activated alumina and a molecular sieve, which absorb the water and carbon dioxide respectively.

The cleaned air is cooled until it liquefies and then moves into an air separation column, where the separation of oxygen, nitrogen and argon is achieved. The column contains a series of perforated trays. The gas stream rises up the column and passes through the perforated trays on which a layer of liquid is maintained. The bubbles of gas passing through the trays are separated into oxygen and the remaining components of air. The oxygen combines with the liquid on the trays, which cascades down towards the bottom of the column. The remaining components continue moving up the column.

The liquid in the bottom of the column has a concentrated liquid oxygen purity in excess of 99.5%. This liquid is then pumped through a liquid oxygen pump, which raises its pressure. It is then directed back through the heat exchanger, where it is converted to a gas for use in the GSP.

The nitrogen which has risen to the top of the air separation column has a concentration purity of approximately 99.99%. The nitrogen is heated to ambient temperature in a heat exchanger prior to being directed for use in the GSP.

Argon is removed from the middle section of the air separation column and is then directed for use in the Melt Shop.

5. INPUTS TO THE GSP

5.1 Iron Ore

About 1.5M tonnes of high grade iron ore will be delivered each year from the Tallering Peak mine site to the GSP. This ore will comprise 85% fines of less than 10mm size and 15% lump in the size range 10 to 30mm. The crushing and screening of the iron ore to these specifications will occur at the mine site.

A typical assay of the high grade ore as mined is as follows:

- Fe 64% (65% after crushing and desliming)
- SiO_2 3%
- Al_2O_3 2%
- LOI 1 to 1.5%
- TiO_2 0.2%
- P 0.02%
- S 0.01%
- CaO 0.01%

5.2 Other Solid Inputs

Other solid inputs to the GSP are as follows:

• Scrap steel	150,000t/yr
• Quicklime	45,000t/yr
• Alloys	18,000t/yr
• Hydrated Lime	12,000t/yr
• Carbon	12,000t/yr
• Limestone	10,000t/yr
• Refractory bricks	9,000t/yr
• Electrodes	2,800t/yr
• Casting Powder	500t/yr
• Hydraulic Fluid, Oil and Grease	120t/yr

TOTAL	259,420t/yr

The uses of the major commodities listed above are described in Section 4.

5.3 Storage Requirements

The methods of storage of the solid inputs to the GSP and the capacity of each storage facility are listed in Table 5.1.

The storage capacities are based on all solid inputs, other than iron ore, being delivered through the Port of Geraldton. It is possible once more detailed technical requirements are available and subject to suitable commercial arrangements, that some of the solid inputs may be obtained from within Western Australia and delivered to the GSP by road and rail. This applies particularly to scrap steel, limestone and lime products, and possibly refractories and some alloys. If these inputs are sourced in Western Australia, the storage capacities may be reduced.

TABLE 5.1

GERALDTON STEEL PLANT STORAGE DETAILS

Material	Storage Description	Storage Capacity (tonnes)
Pellet Plant		
Fines Ore	Covered stockpile	8,000
Limestone	Covered bin	2,000
Hydrated Lime	Covered bin	2,400
DRI Plant		
Lump Ore	Covered stockpile	2,500
Pellets	Open stockpile	8,000
Melt Shop & CSP Plant		
Reduced Iron	Refractory lined bins	2 at 1,300
Scrap	Open scrap yard	30,000
Quicklime	Covered bin	9,000
Alloys	Bins	3,600
Carbon	Covered bins	2,400
Refractory Bricks	Covered warehouse	2,000
Slag	Open stock pile	3,500
Finished Coils	Covered warehouse	40,000

5.4 Water

5.4.1 Water Requirements of the GSP

The GSP will require a water supply of approximately 13,600m^3/day or 4.5 million cubic metres per year (Mm^3/yr). The water is required for cooling purposes and for various process needs such as de-scaling of the steel in the Rolling Mill. The water requirement of each major component of the GSP is as follows:

•	Pellet Plant	0.49
•	DRI Plant	1.77
•	Melt Shop	0.43
•	CSP Plant	1.36
•	Oxygen Plant	0.05
•	Other	0.04
	Sub Total	4.14
	10% Contingency	0.41
	TOTAL	4.55Mm^3/yr

The use of water in the GSP is shown in Figure 14.

5.4.2 Water Supply Alternatives

Three options have been considered for the supply of water to the GSP. These are:

- Exclusive use of fresh (potable) water,
- Use of brackish (non-potable) groundwater for cooling purposes with potable water used for all other requirements, and
- Use of seawater for cooling purposes with potable water used for all other requirements.

For the purposes of the feasibility study for the MWIS Project, it has been decided that all of the water supply to the GSP will be of potable quality. While it is known that extensive aquifers containing brackish groundwater occur in the Geraldton region, proving that there is an adequate resource within a short distance of the Narngulu Industrial Estate would require a potentially time consuming exploration and test pumping program. Similarly, the use of seawater for cooling purposes would require the definition of a pipeline route for seawater uptake and discharge and consideration of the additional environmental factors which are involved.

The Water Authority of Western Australia (WAWA) has advised that potable water can be supplied to the GSP at the standard rates that major consumers are charged. Currently WAWA obtains potable water for the Geraldton area from the Allenooka Borefield approximately 47km to the south-east of the Narngulu Industrial Estate and it is delivered to Geraldton via a 600mm diameter pipeline passing immediately to the east of the Estate. A recent draft Groundwater Management Plan prepared by WAWA indicated that the sustainable yield of the groundwater resources at Allenooka is 28.7Mm^3/yr of which 8.5Mm^3/yr is currently used for public water supply. The GSP requirement is estimated at 4.5Mm^3/yr as described in Section 5.4.1.

As WAWA will be supplying water to the GSP, it will be responsible for the expansion of the Allenooka Borefield and for increasing the capacity of the existing pipeline or for installing a new pipeline to the Narngulu Industrial Estate should this be necessary.

5.5 Natural Gas

5.5.1 Natural Gas Requirements of the GSP

The natural gas requirement for the GSP is estimated to be approximately 74 terajoules (TJ) per day. The use of gas in the GSP is as follows:

• Pellet Plant	3.8
• DRI Plant	31.3
• Melt Shop	0.6
• CSP Plant	4.0
• Power Station	34.3
TOTAL	74.0TJ/day

The main uses of natural gas in the GSP are the direct reduction process and as fuel in the Power Station.

5.5.2 Supply of Natural Gas

Natural gas will be supplied to the GSP at Narngulu from the main Dampier-Perth Natural Gas Pipeline. The location of the main pipeline is shown in Figure 3. There is an existing gas lateral pipeline from this main pipeline to the Narngulu Industrial Estate. The route is also shown in Figure 3. An additional gas pipeline will be installed.

5.6 Other Gas Requirements of the GSP

Oxygen, nitrogen and argon are also required as inputs to the GSP. Oxygen is used in the EAF to produce the 'carbon boil' (Section 4.6.1), nitrogen is used for purging systems, and argon is used in the Ladle Furnace to equalise the temperature of the melt. The volumes of gas required are listed in Table 5.2

TABLE 5.2

GERALDTON STEEL PLANT GAS REQUIREMENTS OTHER THAN NATURAL GAS

	Oxygen	Nitrogen	Argon
Direct Reduction Plant	NR	1200m^3/hr	NR
Melt Shop:			
Electric Arc Furnace	4200m^3/hr	{1200m^3/hr	NR
Ladle Furnace	NR	{	300m^3/hr
Caster	NR	100m^3/hr	250m^3/hr

NR = not required

These gases will be produced on site in the Cryogenic Oxygen Plant described in Section 4.9. The location of this plant is shown in Figure 9.

5.7 Electricity

5.7.1 Electricity Requirements of the GSP

The average demand for electric power for the GSP is estimated at 125 megawatts (MW) and the estimated peak load is 185MW. The use of electric power in the complex will be as follows:

• Pellet Plant	5
• Direct Reduction Plant	5
• Melt Shop	87
• CSP Plant	18
• Oxygen Plant	3
• Auxiliaries	7
TOTAL	125MW

The main users of electricity are the EAF and the LF in the Melt Shop and the roll drives in the CSP Plant. The Melt Shop and CSP Plant are described in Sections 4.6 and 4.7 of the PER.

5.7.2 Electricity Supply

Electricity will be supplied to the GSP by a Power Station with an installed generating capacity of 200MW. The Power Station is described in Section 4.8.

6. ENVIRONMENTAL CONSIDERATIONS

6.1 Development of the Site

6.1.1 Site Values

The development of the GSP in the Narngulu Industrial Estate will not incur any significant direct environmental impacts as the land involved has been cleared for agricultural purposes and does not support any natural vegetation or vertebrate fauna habitat.

The physical characteristics of the site are also suitable for industrial development (see Section 3.3.3). The soil is not prone to erosion, and is well drained and easy to excavate, and provides good geotechnical conditions for large buildings and heavy equipment. This is demonstrated by the existing Mineral Sands Plant and Synthetic Rutile Plant within the Industrial Estate which are located immediately north of the site of the proposed GSP.

6.1.2 Dust

There is the potential for dust to be generated during earthworks associated with construction of the GSP particularly during dry summer conditions. There will therefore be a requirement for all contractors responsible for earthworks to manage and suppress dust using water trucks or other forms of water spray. There will be no unstable areas within the complex following construction as the ground surface will be either paved or landscaped.

6.1.3 Noise

Noise will be generated during the construction period particularly by earthmoving and other machinery. All construction contractors will therefore be required to manage noise levels within acceptable limits. The management measures will include restriction of activities with high noise levels to daylight hours (7.00am to 7.00pm Monday to Friday, and 8.00am to 7.00pm on weekends) and a requirement that noise from stationary equipment does not exceed 85dB(A) at a distance of 1 metre.

6.1.4 Waste Disposal

A management plan for the collection and disposal of waste generated during the construction phase will be developed through consultation with the Shire of Greenough. This plan will seek to direct waste to recycling wherever possible (e.g. scrap metal, and waste oil from machinery) but when this is not practical, the waste will be directed to approved landfills.

6.1.5 Environmental Management During Construction

The management and supervision of construction activities with respect to dust, noise and waste collection and disposal, will be the responsibility of a specific site Environmental Manager. The Shire of Greenough and residents of Narngulu will be provided with a contact phone number for the site Environmental Manager and a specific duty of the

Manager will be to respond to, and resolve, any complaints regarding dust, noise or other issues associated with construction of the GSP.

6.1.6 Landscaping

A landscape plan for the Narngulu Industrial Estate has been prepared by the Narngulu Industrial Committee (Alan Tingay & Associates, *et al.*, 1993). This plan includes the planting of trees and shrubs along the southern and western boundaries of Lot 1277 on which most of the GSP will be located. These plantings commenced in 1994. Kingstream Resources NL and Pavilly Pty Ltd will take over responsibility for the maintenance of these landscape belts when it acquires the Lot. It will also extend the plantings along the eastern margin of Lot 1277 and the southern margins of Part Lot 13 and Lot 6. The basic aim will be to achieve a 10m wide belt of dense and relatively tall vegetation on the perimeters of the Lots and especially adjacent to public roads and the smaller landholdings with houses.

6.1.7 Groundwater

The GSP will have no impact on groundwater at Narngulu either during construction or operation. Groundwater in the area is known to be about 24m below ground level which is considerably lower than the deepest foundations for any part of the Plant.

The GSP also will not store any wastewater or other effluent in ponds from which infiltration to groundwater could occur nor will there be any discharge of wastewater to ground.

Finally, all tanks used for the storage of fuels or other liquids will be fully bunded so that there is no possibility of groundwater contamination in the event of any tank failure.

6.2 Atmospheric Emissions

6.2.1 Introduction

Virtually all industrial plants produce atmospheric emissions in the form of gases and particulates. These emissions may be innocuous both to the environment and to human health, or they may have the potential to be harmful to both.

The significance of atmospheric emissions from industrial plants is assessed in terms of the concentrations of the emissions at their point of release to the atmosphere and by estimates of the ground level concentrations of those emissions in the air at increasing distances from the industrial plant. The ground level concentrations are most relevant for determining the implications in terms of the environment and public health.

Computer modelling is used to estimate the ground level concentrations on the basis of the emission levels, local meteorological (weather) conditions, surrounding landforms and other factors which may affect atmospheric dispersion. The modelling also has to include emissions from other nearby industries which may increase the ground level concentrations.

In summary, therefore, in order to determine the potential environmental and health implications of atmospheric emissions it is necessary to:

- Determine local meteorological conditions,
- Identify the types of emissions which will be produced,
- Determine and describe the sources of emissions,
- Determine the levels of emissions at the points of release to the atmosphere,
- Estimate the ground level concentrations of the emissions around the industrial plant, and
- Interpret the emission levels and ground level concentrations in terms of statutory requirements and guidelines.

Information on the local meteorological conditions and atmospheric emissions from the GSP is provided in the following sections.

6.2.2 Meteorological Conditions (Air Quality Data)

Meteorological data suitable for air quality modelling have been specifically collected at the Narngulu Industrial Estate by RGC Mineral Sands Ltd from March 1994 and at Oakajee by the Geraldton Mid West Development Commission from 8 June 1990 to 14 March 1994.

These data consist of wind speed, direction, specific wind conditions, air temperature, relative humidity, differential temperatures between 10m and 1.5m above ground level, short wave and nett radiation, and rainfall. For all instruments, the sensors were chosen to meet the relevant Australian Standards, such as AS2923 for Air Quality Wind Sensors.

Other available meteorological data within the region consist of:

- Wind speed and direction measurements collected by the Western Power at Geraldton Airport and various other locations for periods of one to three years,
- Surface and upper air measurements collected by the Commonwealth Bureau of Meteorology at Geraldton Airport, and
- Wind speed, gust, direction, air temperature, relative humidity, barometric pressure and rainfall collected by the Port of Geraldton Authority since November 1991.

The primary source of data used for the air quality modelling for the GSP was those collected at the Narngulu Industrial Estate. At present, only 10.5 months of data have been collected and there is a two month gap from May to July 1994. For this period of missing data, information from the air quality database collected at Oakajee was used (Steedman Science & Engineering, 1993). It is acknowledged that this may introduce a slight error as the winds at Oakajee are stronger in seabreezes and onshore flows.

However, from May to July seabreezes are weak and the winds are generally controlled by synoptic forces which usually vary little over the Geraldton region.

Monthly annual wind roses for the Narngulu Industrial Estate are presented in Figure 15. These show that the predominant winds at the site of the proposed GSP are southerlies which occur mostly in summer.

6.2.3 Atmospheric Emissions Models

A specialist assessment of atmospheric emissions from the GSP has been prepared as part of this PER (WNI Science & Engineering, 1995). This specialist assessment involved the use of the DISPMOD computer model developed by the Western Australian Department of Environmental Protection (Environmental Protection Authority, 1992) and AUSTOX, an emergency response and preparedness model developed by the Centre for Applied Mathematical Modelling (1994).

DISPMOD was used to simulate all the positively buoyant plumes from the GSP (i.e. all atmospheric emissions apart from carbon dioxide). These emissions have the potential to interact with the thermal internal boundary layer which develops downwind of the west coast for onshore winds. This layer is a region of convective turbulence which grows with distance downwind from the coast and is capped by an inversion or stable layer of air.

Atmospheric emissions on the west coast from tall stacks or very buoyant sources can be emitted into the stable onshore flow and then be brought rapidly to the ground at some down wind distance by the growing thermal internal boundary layer. This process is particularly important in the dispersion of emissions from tall stacks at or near the coast and can lead to high ground level concentrations at a particular down wind point for several hours.

For short stacks and less buoyant plumes, the plume will be trapped beneath the boundary layer. This again can lead to higher ground level concentrations than otherwise would occur due to the vertical restrictions on dispersion. The DISPMOD model, which was developed for the Kwinana Air Modelling Study, accurately predicts the dispersion of these types of buoyant plumes.

In running DISPMOD, there are various optional formulations for plume penetration and dispersion, etc. The options chosen for the present modelling exercise and the treatment of air quality parameters are described in the specialist report (WNI Science & Engineering, 1995).

The major carbon dioxide emissions from the GSP will form negatively buoyant plumes which will sink instead of rise. The DISPMOD computer program cannot model these plumes and therefore the AUSTOX model has been used. For negatively buoyant plumes, the thermal internal boundary layer described above has minimal effect especially within 1km of the source as the plumes remain effectively at surface level below the layer.

To determine the maximum concentration of carbon dioxide emissions from the GSP, a worst case modelling procedure was used as described by the EPA of Victoria (1985). This technique uses artificial meteorological data to determine the highest concentration of carbon dioxide at the "worst affected receptor". The assumptions used in modelling are described in the specialist report.

6.2.4 Atmospheric Emissions from the GSP

Atmospheric emissions will occur from the Pellet Plant, Direct Reduction Plant, Melt Shop and Power Station. The locations of these components are shown in the site plan (Figure 9) while details of the sources, nature, and volume of the emissions are summarised in Table 6.1.

The principal atmospheric emissions from the GSP will be sulphur dioxide, oxides of nitrogen, carbon dioxide, and particulates. Each of these is discussed below in terms of criteria for acceptable levels of emissions, the sources and concentrations of emissions from the GSP, results of computer modelling of the dispersion of the emissions, management measures, and environmental and public health implications. The discussion is based on the specialist assessment prepared by WNI Science & Engineering (1995).

The GSP will also emit volatile organic compounds (VOCs) and water vapour (steam). The VOCs will be emitted from the Melt Shop stack at 0.08g/sec. These emissions are negligible and are not considered to be significant. Water vapour will be emitted continuously from cooling towers at a total volume of $312m^3/hr$. The water vapour plumes will be visible but have no environmental or public health implications.

TABLE 6.1

GERALDTON STEEL PLANT
SUMMARY OF ATMOSPHERIC EMISSIONS DATA

					MASS FLUX			
Source	**Stack Height (m)**	**Emission Volume (m^3/sec)**	**Emission Temp. (°C)**	**Stack Diameter (m)**	**SO_2 (g/sec)**	**NO_2 (g/sec)**	**Particu-lates (g/sec)**	**CO_2 (kg/sec)**
Pellet Plant								
Waste Gas	29	222	160	3.76	negl	25.0	7.0	13.74
Waste Gas	25	142	80	3.00	negl	19.6	5.5	11.63
Feed end de-dust	25	4.44	30	0.53	negl	negl	0.2	negl
Feed end de-dust	25	390.4	50	4.98	negl	negl	16.5	negl
DRI Plant								
CO_2 removal	75	3.77	45	0.49	negl	negl	negl	5.70
Reformer flue	40	71.9	180	2.14	0.064	6.2	negl	6.97
Heater flue	75	39.9	180	1.59	0.39	3.42	negl	42.28
De-dusting System	20	6.17	30	0.63	negl	negl	0.28	negl
Meltshop/CSP Plant Meltshop	30	500	130	5.64	negl	4.93	4.1	19.95
Power Station F6FA Gas Turbine (each)	25	475	600	4.0	negl	23.3	0.62	8.75
TOTAL					0.45	129.1	35.4	126.52

6.2.5 Sulphur Dioxide

Background Information

General information on sulphur dioxide is provided in Bulletin 644 of the Western Australian Environmental Protection Authority (1992) and the EPA Air Quality Guidelines (1993). It is a colourless gas which has a pungent odour and can irritate and be absorbed in the respiratory tract. The sensitivity of humans to sulphur dioxide varies considerably and asthmatics may suffer adverse reactions at quite low levels.

The gas also dissolves in moisture forming dilute sulphuric acid and sulphates which can be readily absorbed onto small airborne particles. This increases the potential for adverse effects on humans and for environmental impacts such as leaf damage to plants and reduced water quality in wetlands.

Sulphur Dioxide Emissions from the GSP

Sulphur dioxide emissions from the proposed GSP will be low and will comprise a total of 0.45g/sec from two flues at the Direct Reduction Plant (Table 6.1).

Existing Sulphur Dioxide Emissions at Narngulu

Existing industries within the Narngulu Industrial Estate consist of the Synthetic Rutile Plant, Mineral Sands Separation Plant and Attapulgite Plant. Of these, only the Synthetic

Rutile Plant currently emits airborne pollutants through stacks and vents. Stack and emission data for the Narngulu Synthetic Rutile Plant have been obtained from an earlier environmental impact study (AMC Mineral Sands Ltd, 1989), EPA License Conditions (License No. 4393) and from the current operators of the plant, RGC Mineral Sands Ltd. These data are summarised in Table 6.2.

Emissions of sulphur dioxide from the Synthetic Rutile Plant occur from two rotary kilns. The emission levels typically are about 25% of the maximum EPA Licence value. However, for short periods of about 15 minutes, 3 times each year the emission levels from each kiln approach the maximum licence value of 55mg/sec.

For the purposes of the present study, it was assumed that one of the kilns at the Synthetic Rutile Plant operates continuously with maximum sulphur dioxide emissions. That is, the level of emissions was deliberately set at a much higher level than is actually the case.

TABLE 6.2

SYNTHETIC RUTILE PLANT NARNGULU INDUSTRIAL ESTATE ATMOSPHERIC EMISSIONS DATA

Parameter	Units	Kiln C	Kiln D
Stack Height	(m)	49	57
Exit Density	(kg/m^3)	1.044	0.996
Exit Temperature	(°C)	65	8.1
Exit Volume	(m^3/sec)	37.1	53.4
Stack Diameter	(m)	1.5	1.8
Source Strength SO_2	(g/sec)	55[1]	55[1]
Particulates	(g/sec)	6.1[2]	8.1[2]

Notes: 1. Licensed maximum. On average the SO_2 mass flux is typically 25% of this value.
2. Based on maximum measured dust concentration in exhaust. Average mass flux is expected to be lower.

Results of Modelling

The results of the modelling for sulphur dioxide for the combined GSP and the Synthetic Rutile Plant and for different averaging time periods are shown in Figure 16 and are summarised in Table 6.3. The results are virtually identical to those predicted from the Synthetic Rutile Plant operating alone as the level of sulphur dioxide emissions from the GSP are very low.

These results indicate that the predicted maximum one hour ground level concentration of sulphur dioxide is 501μg/m³ within the Narngulu Industrial Estate, with a slightly lower secondary maximum occurring just to the west of the Estate. For the ninth highest hourly, maximum 24 hour and annual average concentrations the highest values all occur to the north-east of the Synthetic Rutile Plant within the Industrial Estate. For the longer averaging periods such as the annual average, the concentrations are strongly skewed towards the north due to the persistent southerly winds.

TABLE 6.3

PREDICTED MAXIMUM GROUND LEVEL CONCENTRATIONS OF ATMOSPHERIC EMISSIONS FROM INDUSTRIES AT NARNGULU

Pollutant	Air Quality Objective	Maximum Predicted At Any Location		Maximum Predicted Within Industrial Estate	
		Existing Sources ($\mu g/m^3$)	Existing Sources & GSP ($\mu g/m^3$)	Existing Sources ($\mu g/m^3$)	Existing Sources & GSP ($\mu g/m^3$)
SO_2	Maximum 1 hourly	501	501	480	480
	9th Highest 1 hourly	291	291	220	220
	Maximum 24 hour	91.1	91.1	50	50
	Annual Average	11.0	11.0	7	7
NO_2	Maximum 1 hourly	negl	228	negl	228
	9th Highest 1 hourly	negl	154	negl	154
	Maximum 24 hour	negl	49	negl	49
	Annual Average	negl	7.1	negl	7
Particulates	Maximum 24 hour	18.5	23.9	9	23.9
	Annual Average	2.4	5.0	2.0	5.0

Note: SO_2 concentrations have been predicted conservatively assuming that one kiln at the Synthetic Rutile Plant is continuously in an upset condition.

Guidelines and Criteria

The Environmental Protection Act, 1986 does not specify maximum air quality objectives throughout Western Australia. However, the EPA has promulgated two Environmental Protection Policies (EPPs) for atmospheric pollutants for the Kwinana and Kalgoorlie areas. The EPA uses the Kwinana EPP standards and limits as guidelines for the assessment of new industrial projects (where there are no existing sources) and for existing industrial plants which are seeking approval for modifications (Environmental Protection Authority, 1992). These standards and limits, which are for sulphur dioxide and particulates only, were used previously by the EPA in its assessment of the acceptability of the expansion of the Synthetic Rutile Plant at Narngulu (Environmental Protection Authority, 1989).

In the Kwinana EPP, a limit is defined as "a concentration not to be exceeded" and a standard is defined as "a concentration which it is desirable not to exceed". The standard is interpreted as the value which the ground level concentration must be below for 99.9% of the time. For one hourly averages this equates to the 9th highest hourly value predicted during a year being less than the standard.

The standards and limits for sulphur dioxide used in the EPP for the Kwinana policy area are summarised in Table 6.4

TABLE 6.4

PROPOSED AIR QUALITY GUIDELINES FOR THE NARNGULU INDUSTRIAL ESTATE

Species	Area	Averaging Period	Standard ($\mu g/m^3$)	Limit ($\mu g/m^3$)
Sulphur Dioxide	Industrial Estate	1 hour 24 hour Annual	700 200 60	1400 365 80
	Residential	1 hour 24 hour Annual	350 125 50	700 200 60
Particulates PM_{10}	Residential	24 hour Annual	- -	120 40
Nitrogen Dioxide	Residential	1 hour 24 hour Annual	320 - -	- 150 100

Discussion of Results

Comparison of the atmospheric modelling results for sulphur dioxide with the standards and limits described above clearly demonstrates that concentrations within and outside the Narngulu Industrial Estate will be below the guidelines for residential areas. Outside the Estate, the maximum one hourly, ninth highest one hourly, maximum 24 hour and annual averages are approximately 480, 220, 50 and 7$\mu g/m^3$ respectively which are well below the corresponding residential guidelines of 700, 350, 125 and 50$\mu g/m^3$ respectively.

Therefore, the predicted sulphur dioxide emissions from industries at Narngulu including the GSP do no present any environmental or community health issues.

6.2.6 Nitrogen Dioxide

Background Information

Nitrogen dioxide is a reddish brown gas which is soluble in water and is a strong oxidant. The major sources of man-made emissions to the atmosphere derive from the combustion of fossil fuels. In most situations, nitric oxide is emitted and is then transformed into nitrogen dioxide in the atmosphere. At low concentrations, nitrogen dioxide can cause irritation of the mucous membranes and may cause or exacerbate respiratory problems such as asthma and bronchitis.

Levels of Nitrogen from the GSP

Nitrogen dioxide emissions from the GSP are associated mainly with the Pellet Plant and the Power Station. The details of these emissions are provided in Table 6.1.

Existing Nitrogen Dioxide Emissions at Narngulu

The existing emissions of nitrogen dioxide at the Narngulu Industrial Estate are minor. Therefore the predicted emissions from the GSP can be taken as the total emissions.

Results of Modelling

The predicted one hourly average, ninth highest one hourly average, maximum 24 hour and annual average nitrogen dioxide concentration from the GSP are illustrated in Figure 17 and are 228, 154, 49 and 7.1μg/m^3 respectively (Table 6.3). The modelling data indicate that the highest concentrations for all but the maximum one hourly averaging period occur approximately 500m to the north-east of the Narngulu Industrial Estate with a secondary lower maximum at Mount Fairfax.

Guidelines

The EPA has not yet set any limits and standards for nitrogen dioxide emissions under an EPP. Therefore, the guideline of the National Health and Medical Research Council for the one hour averaging period has been adopted for the purposes of the present proposal. This guideline states that the 320μg/m^3 level is not to be exceeded more than once a month. For the longer averaging periods, the World Health Organisation (1987) and USEPA (1977) limits have been adopted. These are 150μg/m^3 for the 24 hour average and 100μg/m^3 for the annual average respectively. The proposed air quality guidelines for nitrogen dioxide at the Narngulu Industrial Estate are summarised in Table 6.4.

Discussion of Results

Comparison of the results of the computer modelling of nitrogen dioxide emissions from the GSP with the air quality guidelines described above indicates that the predicted ground level concentrations are a factor of two to eight times lower than the recommended guidelines for residential areas.

Therefore the predicted nitrogen dioxide emissions from the GSP do not pose any environmental or community health issues.

6.2.7 Suspended Particulates

Background Information

Suspended particulates include a wide range of substances such as combustion particles, metal vapours, and dust. The inhalation of fine particles (less than 10μm in diameter) with air over a long period of time has the potential to affect human health. Coarse (i.e. larger) particles may not present a major health hazard but may cause irritation such as to the eyes. They may also create a dust nuisance.

Particulate Emissions from the Proposed GSP

The sources and levels of particulates emitted to the atmosphere from the proposed GSP are summarised in Table 6.1. The emissions are mostly associated with the Pellet Plant and will be below 10μm in diameter.

Management of Particulate Emissions

Equipment for the control and extraction of particulates (dust) will be a major feature of the GSP. The management measures will include:

- Enclosure of the iron ore unloading facilities at the rail head.
- Enclosed storage for stockpiles of iron ore.
- Enclosure of all conveyor systems.
- Dust extraction at the feed and discharge ends of the Pellet Plant by electrostatic precipitation or scrubbers.
- Fully enclosed handling of the direct reduced iron pellets.
- Dust extraction by baghouse from the Melt Shop.

The effectiveness of the control systems is illustrated by the performance of dust extraction systems in the Melt Shop. The dust emissions rate from the final extraction system (i.e. the baghouse) is estimated at 1.2kg of particulates every hour. In contrast, inputs from the Melt Shop to the baghouse may be at a maximum of 2,800kg/hr.

The baghouse attached to the Melt Shop will collect about 20kg of dust for every tonne of steel produced. This means approximately 20,000 tonnes of dust each year for 1 million tonnes of steel product. The composition of this dust is given in Table 6.5.

Similarly, in the Pellet Plant all dust creating areas will be covered with hoods or casings and connected to dust extraction systems. These will maintain low ambient dust levels and provide clean working conditions.

The dust collected from the baghouse at the Melt Shop and from waste gas and de-dusting systems in the Pellet Plant will be recycled to produce pellets.

TABLE 6.5

COMPOSITION (%) OF DUST FROM BAGHOUSE ATTACHED TO THE MELT SHOP [1]

	DUST COMPOSITION	
COMPONENTS	RANGE	TYPICAL
ZnO	2-4	2
PbO	<1	0.5
Fe_2O_3	30-80	68
Cr_2O_3	<1	0.5
NiO	<1	0.2
MnO	<7	3.0
MoO_3	0.5	-
CoO	2-30	8
SiO_2	2-10	10
MgO	<8	1.0
Al_2O_3	2	1.0
Na_2O	<7	2.0
K_2O	<2	1.0
Ce	<4	1.5
F	<2	0.5

1 - Based on 80% direct reduced iron/20% scrap steel inputs.

Existing Particulate Emissions at Narngulu

The Synthetic Rutile Plant is believed to be the only existing industry within the Narngulu Industrial Estate which emits particulates which are less than 10µm in diameter. The levels of these emissions are listed in Table 6.2.

Results of Modelling

The predicted maximum 24 hour and annual average concentration of particulates due to emissions from both the Synthetic Rutile Plant and the GSP are shown in Figure 18 and Table 6.3. These are 23.9 and 5.0µg/m^3 respectively.

Guidelines

All particulate emissions from the GSP will involve particles of less than 10µm diameter.

The Clean Air Society of Australia and New Zealand (1994) has proposed ambient air quality standards of 120 and 40µg/m^3 for 24 hour and annual averages respectively for particulates in this category and these have been used in the interpretation of the modelling results.

Discussion of Results

The computer modelling of particulate emissions indicates that the peak level concentrations will be between four to eight times lower than the CASANZ standards.

The predicted level of particulate emissions from the GSP therefore do not present environmental or community health issues.

6.2.8 Carbon Dioxide

Background Information

Carbon dioxide is a greenhouse gas and worldwide industrial emissions are considered to be a major contributor to global warming. The Federal Government, in accordance with international agreements, has announced an intention to stabilise carbon dioxide emissions in Australia by the year 2005. In line with this policy, it has recently indicated (1995) the possible introduction of a carbon tax or environmental levy on industry. Such a tax would be based on the number of tonnes of carbon dioxide emitted each year by each industry.

Therefore, it can be expected that in the near future there will be both environmental and financial reasons for industry to seek to minimise its levels of carbon dioxide emissions.

Levels of Carbon Dioxide Emissions from the GSP

Carbon dioxide will be emitted from most processes within the GSP but the largest source will be the Direction Reduction Plant. The levels of carbon dioxide from the GSP are listed Table 6.1. For two of the sources, the carbon dioxide concentration will be such that the plume density will be equal to or greater than the air density. These plumes, from the heater flue and carbon dioxide removal stack, will consist of 54% and 90% carbon dioxide by volume and will be neutrally buoyant and heavier than air.

Existing Carbon Dioxide Emissions at Narngulu

There are no known significant emissions of carbon dioxide from existing industries within the Narngulu Industrial Estate.

Results of Modelling

The modelling of the heavier-than-air carbon dioxide plume from the carbon dioxide removal stack was performed using AUSTOX and for a range of artificial meteorological conditions.

The results of this modelling indicate that the highest ground level concentrations occur under light winds and within several hundred metres of the stack. The predicted highest three minute concentration of 0.3% by volume occurred at a distance of 160m. This is one-tenth of the occupational health exposure standard (STEL). However, the specialist assessment has indicated that there may be a potential for the plume to cause localised high concentrations of carbon dioxide at the Direct Reduction Plant. This potential will therefore be further investigated in order to ensure that there will be no occupational health concerns.

6.2.9 Stack Emission Concentrations

Guidelines for maximum concentrations of emissions from stacks and vents may also apply to industrial plants in addition to guidelines for ground level concentrations of emissions.

The relevant guidelines for emission concentrations proposed for the GSP are those defined by the Australian Environment Council and the National Health and Medical Research Council (1986).

The emissions from all stacks and vents in the GSP have been designed to be below these guidelines except those from the gas turbines in the power station.

The oxides of nitrogen (NO_x) emissions from the gas turbine exhaust stacks are up to three times higher than the relevant guideline of 0.07g/m^3 for turbines greater than 10MW. The guideline could be achieved by specific emission control systems but it has been estimated that these would add about $3.2 million to production costs each year. This is substantial and the proponents consider that they should not be required to incur these additional costs given that the ground level concentrations of nitrogen dioxide from the GSP will be well within the recommended criteria for residential areas. Furthermore, in Western Australia emission control systems for NO_x have only been fitted to some gas turbines in the Perth area where there is a potential for photochemical smog. At Narngulu there is very little potential for such smog due to the local meteorological conditions.

6.2.10 Emissions During Maintenance

During routine shutdown of the Direct Reduction Plant for maintenance, the gases in the reduction shaft will be vented via a blowdown stack. The volume of gas during each venting will be about 1,000m^3 and the mixture will consist of hydrogen, carbon monoxide, carbon dioxide, water vapour, methane and nitrogen. The venting will be rapid as the temperature of the gas at the start of venting will be about 900°C. Three shutdowns and ventings are anticipated each year.

The volume of gas involved and the rate of venting ensure that no significant ground level concentrations of gas will occur.

6.2.11 Monitoring of Atmospheric Emissions

Kingstream Resources NL and Pavilly Pty Ltd will implement a monitoring program designed to provide regular data on atmospheric emissions from the GSP. The nature of this monitoring program will be determined in consultation with the DEP.

6.3 Odour

The GSP will not generate any odorous gases. Some direct reduction processes involve the injection of hydrogen sulphide (H_2S) into the reactor to prevent corrosion, and therefore generate H_2S emissions. However, the HYL III direct reduction process which will be used in the GSP does not require the addition of H_2S.

The evaporation of wastewater on hot slag also will not generate odour.

6.4 Noise

6.4.1 Acceptable Noise Criteria and Ambient Noise Levels

A specialist assessment of predicted noise emissions from the GSP has been made by Herring Storer Acoustics (1995). The study was commissioned to determine whether noise levels at residences close to the GSP will comply with requirements of the Environmental Protection Act, 1986 Regulations.

Under the current regulations, the acceptable levels of noise at residences in the vicinity of the proposed GSP are as follows:

- Narngulu Townsite - Residential zone - 40dB(A) at night, 50dB(A) during the day.
- Residences on land zoned General Farming - 45dB(A) at night, 55dB(A) during the day.
- Residences on land zoned General Industry - 50dB(A) at night, 60dB(A) during the day.

6.4.2 Existing Noise Levels

The existing or ambient noise levels at Narngulu were measured over a one week period as part of the specialist assessment of noise emissions made by Herring Storer Acoustics (1995). The minimum noise level during the recording period ranged from less than 30 to over 40dB(A) while the average noise level was around 45dB(A) and rarely was less than 40dB(A) at night.

Noise levels from 30dB(A) to over 50dB(A) were exceeded for 10% of each hourly time interval. This is known as the L_{10} level and this level is generally used to determine whether noise is intrusive by comparison with regulatory guidelines.

6.4.3 Sound Power Levels

The sound power levels predicted from various components of the GSP with standard industrial noise attenuation measures are listed in Table 6.6.

These sound power levels will be used as the basis for design of the GSP with respect to noise emissions. As a general design principle, no source within the GSP will exceed a sound pressure level of 85dB(A) at 1m. This will ensure compliance with the Western Australian Occupational Health Safety and Welfare Regulations.

6.4.4 Noise Modelling

The specialist assessment of noise emissions considered the GSP both with and without noise attenuation measures. In the discussion below, the GSP with noise attenuation measures only is discussed, as noise control will be a specific feature of the plant design. In effect, the noise modelling was used to indicate types of standard noise control measures which will need to be incorporated into the design of the GSP in order to ensure compliance with noise regulations.

The noise attenuation measures incorporated in the noise study were as follows:

- Discharge silencers on the waste gas fans, feed end and discharge end de-dust fans of the pellet plant; the heater combustion air fan and reformer fan of the Direct Reduction Plant; and the de-dust fan of the Melt Shop.
- A 4m high solid wall around the outside of the scrap handling facility with unloading and handling of scrap only to occur during the day.
- Construction of earth bunds along the southern and eastern side of the Pellet Plant and the eastern side of the CSP Plant.
- General building attenuation including internal absorptive lining particularly for the Melt Shop.
- Standard proprietary acoustic package installed by the manufacturer for the gas turbines in the Power Station.

Other noise attenuation measures could be used in place of the above to achieve the same level of noise attenuation. The final measures actually used in the GSP will be determined at the detailed design stage.

TABLE 6.6

GERALDTON STEEL PLANT
SOUND POWER LEVELS dB(A) WITH ATTENUATION

No	FREQUENCY (HERTZ)	31.5	63	125	250	500	1K	2K	4K	8K
1	Waste Gas Fan Discharge	116	111	100	91	86	85	83	81	88
3	Feed end discharge	108	105	104	95	90	89	87	84	85
4	Discharge end de-dust	112	109	99	90	85	84	82	80	84
6	Mill	115	119	15	90	85	84	82	80	84
7	Heater flue discharge	108	108	107	108	103	98	93	88	88
8	Heater combustion air fan	114	110	104	98	92	87	86	86	88
12	Reformer	111	111	105	103	97	91	86	83	86
13	Cooling tower	96	96	95	94	91	87	86	79	79
14	De-dust stack	123	121	110	101	96	95	93	91	98
15	De-dust fan	103	103	102	103	98	93	88	83	83
17	Furnace & refractory demolition	106	103	98	97	95	91	83	68	56
18	De-scaling	117	115	110	104	98	92	86	80	78
19	Cooling tower	99	99	98	97	94	90	89	82	82
20	Scrap stockpile	111	111	111	111	111	111	111	111	111
21	Turbine intake	116	109	102	96	93	90	87	89	87
22	Turbine enclosure	120	115	112	105	104	99	99	97	92
23	Turbine exhaust	132	129	125	115	111	105	98	91	82
24	Turbine fin fan	116	113	108	103	102	99	96	94	91

The propagation of noise from the GSP was modelled using the computer program E.N.M. (Environmental Noise Model). This program was developed for the New South Wales State Pollution Control Commission, and is endorsed by the Australian Environmental Council and the Department of Environmental Protection in Western Australia.

The topography around the GSP site at Narngulu was digitised for incorporation in the computer model. A number of scenarios were then modelled including calm conditions and a gentle wind of 2m/sec from the west. These are ideal conditions for noise propagation. In reality, light winds are not common at Narngulu and strong sea breezes and easterlies are more usual. During stronger wind conditions the ambient noise levels increase and this will influence noise levels at nearby residences more than noise from the GSP.

The modelling also included separate consideration of daytime and night-time operation of the GSP as some noise generating activities such as the handling of scrap will only occur during the day.

Noise level contours for the GSP in calm conditions and during winds of 2m/sec during the day and at night are shown in Figure 19. The modelling indicates that the maximum noise levels during the 'worst-case' wind conditions of 2m/sec, at residences relatively close to the GSP, will be as follows:

- The Narngulu township, houses in the General Farming zone close to the plant on the south side of Rudds Gully Road, and at houses very close to the plant in the General Industry zone on the north side of Rudds Gully Road: 40-45dB(A) during both day and night time conditions.
- At properties adjacent to the township, but within the General Industry zone: 40 to 45dB(A) at night and 45-50dB(A) during the day.
- At some properties in the General Industry zone south of the Pellet Plant and north of Rudds Gully Road: 45-50dB(A) at all times.

6.4.5 Discussion of Results

The results of the specialist noise study indicate that noise emissions from the GSP (with standard noise attenuation measures in place) will generally comply with the regulations.

At the Narngulu Townsite however, the night-time noise levels during 'worst-case' wind conditions are predicted to be about 43dB(A) whereas the regulation level is 40dB(A). These worst-case conditions will occur about 5% of the time each year.

Therefore, additional noise attenuation measures, such as the full enclosure of the ball mills associated with the Pellet Plant, will be incorporated in the detailed design of the GSP to ensure total compliance with the noise regulations.

6.4.6 Monitoring of Noise Emissions

Kingstream Resources NL and Pavilly Pty Ltd will implement a monitoring program designed to provide regular data on noise emissions from the GSP. The nature of this monitoring program will be determined in consultation with the DEP.

6.5 Buffer Zone

Industrial plants may require buffer zones between them and the nearest houses in order to effectively manage atmospheric and noise emissions. The analyses of atmospheric and noise emission from the GSP, however, indicate that no provision for a buffer zone needs to be made in this case. This is because the predicted ground level concentrations of atmospheric emissions and the noise levels at nearby houses will be within the recognised criteria and statutory requirements.

6.6 Wastewater

The majority of wastewater produced in the GSP will be blowdown from cooling water circuits, although some wastewater will be blowdown from process water circuits. The circulating water in the cooling and process water circuits is treated as required by coarse particle precipitation, clarification and filtration to enable it to be recirculated. Virtually all the make up water to the GSP is discharged as water vapour from the cooling towers in the cooling water circuits. The blowdown has an increased concentration of dissolved salts from the make up water plus corrosion and algae inhibitors introduced into the circulating water.

The blowdown water is passed through an evaporator to produce an enriched saline solution and demineralised water. The demineralised water is used as make up to the indirect cooling water circuit.

The enriched saline solution will be disposed of by spraying it onto hot slag deposited in the slag pit. The slag pit will have a sealed base to collect and recirculate any saline solution not evaporated when sprayed on the hot slag.

6.7 Solid Wastes

6.7.1 Types of Solid Wastes

The solid wastes produced by the GSP will comprise the following:

• Slag from the EAF and CSP Plant	118,000t/yr
• Used refractory bricks from the EAF, LF and CSP Plant	9,000t/yr
• CSP Plant scale	20,000t/yr
• CSP Plant sludge	170t/yr
• Salts from evaporation of wastewater	3,500t/yr
• Sulphur on activated carbon from CO_2 removal	55t/yr on 200t carbon
• Desulphurisation catalyst	21t/yr
• Decomposition product of amine solution	26t/yr

6.7.2 Composition

Slag

The composition of the slag will vary depending on the composition of scrap metal used for steel making but is expected to be approximately as follows:

• CaO	36.70%
• FeO	25.28%
• SiO_2	21.00%
• MgO	07.99%
• Al_2O_3	04.35%
• MnO	00.10%

- P_2O_5 00.10%
- Others 02.30%

Refractories

The majority of the refractories will be high alumina bricks or conventional fire clay bricks. Typical compositions are:

- Heavy duty fire clay bricks
  SiO_2 54%
  Al_2O_3 40%

- High alumina bricks
  Al_2O_3 50-85%
  Balance SiO_2

CSP Plant Scale

The scale from the CSP Plant has a high iron content generally of more than 70% and less than 4% silica, alumina, lime and magnesia.

CSP Plant Sludge

The smaller particles of mill scale are generally referred to as mill sludge. The sludge contains 30 to 40% iron and has an oil content from two to 25%. The oil derives from equipment used in the steel plant.

Salts from evaporation of wastewater

The evaporation of wastewater on the hot slag will leave a residue of salts. As the wastewater is bore water from the Allenooka Borefield, the residue will be a concentration of typical salts in drinking water and especially sodium chloride.

Sulphur from CO_2 Removal

The desulphuriser associated with carbon dioxide removal in the Direct Reduction Plant will generate 55t of sulphur on 200t of carbon each year.

Spent Desulphurisation Catalyst

The spent catalyst comprises about 20% zinc sulphide (ZnS) and 80% zinc oxide (ZnO).

Amine Solution

This comprises the amine solution with activated carbon and impurities.

6.7.3 Solid Waste Disposal

The solid waste from the GSP will be disposed of in various ways as follows:

- Slag. The use of slag as a road base is being investigated. If this proves possible then it is probable that the slag will be used for this purpose. If it is not possible to use the slag, it will be transported to the mine site at Tallering Peak and disposed of into the mine waste dump. Some of the slag will be contaminated with salts from the evaporation of wastewater at a ratio of approximately 3% and this may limit its use. The process of disposal at the mine site, dust management, and rehabilitation of the waste dump are described in the NOI for the Tallering Peak iron ore mine (Alan Tingay & Associates and Signet Engineering Pty Ltd, 1995).

- Refractory Bricks. Disposed of in the mine waste dump at Tallering Peak.

- CSP Plant Scale. Recycled to steel making process.

- CSP Plant Sludge. Disposed of into an approved landfill or at the Tallering Peak minesite. The potential for processing and recycling of the sludge will be investigated.

- Salts from Wastewater. See Slag above.

- Sulphur. Recycled.

- Spent Catalyst. Returned to catalyst supplier.

- Amine Solution Residues. Returned to supplier.

6.8 Visual Analysis

The GSP includes various large buildings and associated stacks. Some indicative heights are as follows:

- Pellet Plant
  - Furnace Building 34m

- Direct Reduction Plant
  - Reactor Tower 92m
  - CO_2 Removal Tower 75m
  - Heater Stack Structure 75m
  - Reformer Stack 40m

- Melt Shop/CSP Plant
  - EAF Building 38m
  - Casting Building 32m
  - Equalising Furnace Building 26m
  - Rolling Mill 30m

- Power Station
  - Turbine Exhaust Stacks 30m

In general, the overall appearance of the buildings and structures in the GSP will be similar to those of the Mineral Sands Separation Plant and Synthetic Rutile Plants operated by RGC Minerals Ltd in the Narngulu Industrial Estate. All of the structures will feature lighting at night. A pictorial representation of the GSP is shown in Figure 20.

An assessment of the visibility of the GSP from surrounding areas was made for this PER by determining the visibility of the existing Synthetic Rutile Plant from a number of localities to the north, east, south and west of the Narngulu Industrial Estate as shown in Figure 21. The Synthetic Rutile Plant is immediately adjacent to the site of the GSP and is similar in overall height except that the tallest structure in the GSP is the reactor tower in the Direct Reduction Plant which will be 92m high, whereas the tallest structure in the Synthetic Rutile Plant is 76m high. Photographs from each viewpoint were also taken with the camera lens setting at normal vision scale. Some of the photographs are shown in Figure 22A to 22C for illustration purposes.

The general visibility of the GSP from various locations nearby will be as follows:

- West

  Location 1: Wandina Heights - only the top of the Direct Reduction Plant will be visible in the distance from this location as the remainder of the GSP will be obscured by an intervening ridge. The visual intrusion is rated as very low

  Location 2: Ocean Ridge - only the top of the Direct Reduction Plant will be visible in the middle distance as the remainder of the GSP will be obscured by an intervening ridge. The visual intrusion is rated as very low.

  Location 3: Rudds Gully Road - the Direct Reduction Plant, Melt Shop and CSP Plant will all be visible and prominent from the west on this road. The visual intrusion is rated as high.

- South

  Location 4: Rudds Gully Road - the entire GSP will be visible and prominent from this road immediately to the south of the Plant site. The visual intrusion is rated as high.

- South-East

  Location 5: Rudds Gully Road - a large section of the GSP will be visible from some elevated parts of Rudds Gully Road to the south-east and from properties within the General Industry zone of the Narngulu Industrial Estate. The visual intrusion from these locations is rated as high.

- East

  Location 6: Narngulu Residential Area - the GSP will generally not be visible from the residential area due to intervening vegetation and topography in the recreation reserve. The top of the Direct Reduction Plant structure, however, is likely to be visible. The visual intrusion is rated as low.

- North

  Location 7: Walkaway Road - the top of the Direct Reduction Plant structures and part of the Pellet Plant will be visible from some sections of Walkaway Road to the north but most of the GSP will be obscured by the Mineral Sands Separation Plant. The visual intrusion is rated as low.

- Location 8: Goulds Road - the top of the Direct Reduction Plant structures will be visible but most of the GSP will be obscured by the Mineral Sands Separation Plant. The visual intrusion is rated as low.

In summary, the GSP will be most visible from the south-west, south and south-east. Very few people live in these sectors and most of these are within the General Industry zone of the Narngulu Industrial Estate. The existing Mineral Sands Separation Plant and Synthetic Rutile Plant are also prominent from these sectors and the view can be classified as industrial within a rural landscape.

The views of the GSP from these locations will also be moderated by landscape planting and vegetation around the boundaries of the GSP but the scale of the GSP will mean that it is unavoidably prominent.

From the Narngulu residential area the complex will mostly not be visible. Similarly, from the west (Ocean Ridge and Wandina Heights) the complex will be mostly obscured and in the distance. If houses are built on the ridge overlooking the Narngulu Industrial Estate however, the GSP will be very visible and prominent as will all of the existing industrial plants in the Industrial Estate.

From the north the GSP mostly will be obscured by the existing industrial plants.

6.9 The Geraldton Airport

The proposed GSP may have implications for aircraft operations at Geraldton Airport which is located about 1.5km to the east of the Narngulu Industrial Estate (Figure 5). This potential relates to the height and location of the Direct Reduction Plant relative to the airport and to the approach to Runway 03 from the south-west.

The Civil Aviation Authority of Australia (CAA) has defined an Obstacle Limitation Surface (OLS) around the Geraldton Airport. The OLS is a height above ground level above which any protruding structures may interfere with aircraft approaches. The Narngulu Industrial Estate is within the OLS surrounding the Geraldton Airport. From the OLS Plan, shown in Figure 23, the allowable inner horizontal height for this area is 77.7m

AHD. The highest structure in the GSP will be the reactor tower of the Direct Reduction Plant, which has a height of 92m above ground level. The ground level of the GSP site is approximately 20m AHD, therefore the top of the reactor tower will be 112m AHD. This means that the reactor tower structure will protrude 34.3m above the OLS.

The tallest structure in the Synthetic Rutile Plant and a radio mast near the airport also extend above the OLS.

When considering the implications of the GSP for Geraldton Airport, two factors must be taken into consideration: the potential hazard of the Direct Reduction Plant structures to aircraft and whether the structures may affect instrument approach landings.

The hazard of a structure to aircraft is assessed by the CAA. The CAA has been informed of the GSP proposal but has stated that it will only formally assess the Direct Reduction Plant structures after they have been constructed. In the interim, the CAA has advised that with regards to the visual and circling operations at Geraldton Airport, the proposed Direct Reduction Plant structures would be considered an obstacle in International Civil Aviation Organisation (ICAO) terminology. The ICAO regulations state that:

> "New objects or extensions of existing objects should not be permitted above the conical surface or inner horizontal surface except when, in the opinion of the appropriate authority, the object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes."

In the case of Geraldton Airport, the appropriate authority is the Shire of Greenough.

In its initial advice, the CAA considered that the Direct Reduction Plant structures would be an obstruction to aircraft turning and descending on left base (i.e. left hand turn) to Runway 03, and therefore may have the potential to affect the existing safety level of the airport. However, it notes that the structures would be easier to avoid if they are conspicuous by day and night.

In fact, the Direct Reduction Plant structures are equivalent in size to a substantial, multi-storeyed building, and will be well lit at night.

An instrument landing height limitation also applies to Runway 03 at Geraldton from the south-west. This height limit applies in a triangular area extending back from the Runway. The triangle is divided into primary and secondary sectors according to their distance from a centre line extending from the Runway as shown in Figure 23. In the primary sector, aircraft must have a minimum clearance of 300ft (91.4m) above all obstacles, i.e. the height of any obstacle will define the approach altitude of the aircraft.

In the secondary sector, the minimal obstacle clearance reduces progressively from 300ft (91.4m) at the boundary with the primary sector to 0ft (0m) at the outer edge of the secondary sector.

The Direct Reduction Plant is located in the secondary zone as shown in Figure 23. At this location, the minimum approach altitude has been calculated at 512ft (156m) plus 100ft (30.5m) (forecast altimeter supplement) which equals 612ft (186.5m) AHD. As this is less than the existing minimum approach altitude of 700ft (213.3m) for aircraft on instrument landings, the Direct Reduction Plant in this location will not affect instrument approach landings at the airport.

7. TRANSPORT OF IRON ORE, STEEL AND OTHER INPUTS

7.1 Introduction

The transport requirements for the GSP have been assessed in detail by Halpern Glick Maunsell Pty Ltd (1995). The requirements can be considered in two sections:

- Transport of materials between the Tallering Peak mine site and the GSP at Narngulu, and

- Transport of materials between the GSP and the Port of Geraldton.

Approximately 1.5M tonnes of iron ore will be transported from the Tallering Peak mine to the GSP each year. The majority (85%) of the ore will be fines (less than 10mm particle size), and the remainder (15%) lump ore (between 10mm to 30mm particle size). Waste products produced at the GSP will also be backhauled to the mine site for disposal, and in particular slag and refractory bricks. The quantities involved are in the order of 118,000t/yr of slag and 9,000t/yr of bricks. Further details are provided in Section 6.7.1.

One million tonnes of rolled coiled steel will be produced at the GSP each year. This will be transported to the Port of Geraldton for export. Approximately 260,000t/yr of solid inputs, other than iron ore, are required for the iron and steel making process as listed in Section 5.2. The PER is based on all solid inputs being delivered through the Port of Geraldton although in reality some may be sourced from within Western Australia.

7.2 Transport of Iron Ore

7.2.1 Methods of Transport and Handling

Iron ore will be transported from the mine site to the GSP in two stages:

i) By road between the mine site to a Transfer Facility north of Mullewa, and
ii) By rail from the Transfer Facility to the GSP.

At the mine site, the ore will be loaded into triple road trains, which consist of a prime mover and three articulated trailers, with a carrying capacity of approximately 80 tonnes. The trucks will be loaded by driving under an overhead bin, which will open at the bottom, discharging ore into the trailers.

The trucks will then travel to a Transfer Facility located approximately 2km to 3km north-west of the town of Mullewa. The precise location will be determined in consultation with the Mullewa Shire Council and local land owners but it is assumed that it will be in the vicinity of the refuse tip.

The trucks will discharge their loads to form piles adjacent to a rail siding and will pick up waste which has been railed from the GSP for transport back to the mine site. The railway will be extended from near Mullewa to the siding.

It is estimated that the road haulage will involve up to 120 truck movements per day (i.e. 60 each way), with trucks operating 24 hours per day and 7 days per week (i.e. 5 truck movements every hour).

Two trains per day will be used to transport the iron ore from the Transfer Facility at Mullewa to the GSP at Narngulu (i.e. 4 train movements). Each train will comprise 2 locomotives with 46 bottom dump wagons, with each wagon having a capacity of 53 tonnes (i.e. a maximum of about 2400t of ore will be transported by each train). The wagons will be loaded from the stockpiles using a front-end loader.

The trains will unload at the GSP into a bottom reclaim hopper, enclosed in a shed. Iron ore will be transferred from the hopper to enclosed stockpiles using covered conveyors. The location of the unloading facility at the GSP is shown in Figure 9.

7.2.2 The Transfer Facility

The Transfer Facility north-west of Mullewa will comprise a stockpile served by a straight rail siding with enough double track for the locomotives to disconnect and re-position at the front end of the train. The siding will incorporate a viaduct which will enable the waste material returned from the GSP to be dumped from the rail wagons while the loading of iron ore is taking place.

The surface of the facility will be sealed with the railway down one side. One area of the facility will be allocated for the storage of lump ore, another for storage of fines ore, and one for waste material. Each of these areas will be alongside the railway line.

Trucks arriving from the mine site will approach the lump or fines storage area and then tip their loads as close as possible to the railway track. The trucks will then pull away and return to the mine unless they are designated to backhaul waste.

A front-end-loader will be used to load the trains, to move ore closer to the train loading zone, and to manipulate the stockpiles.

The waste materials backhauled from the GSP will be bottom dumped from the railwagons at the viaduct into a below ground hopper. A belt feeder will then convey the waste onto a conveyer belt which will transport it above ground to a conical stockpile.

The Transfer Facility will incorporate a drainage system including silt traps. The prevailing winds at Mullewa are mostly from the south-west, south and the south-east and therefore there is little potential for dust to blow towards the town of Mullewa which is to the south-east.

The facility would operate 24 hours a day and will require lighting.

7.2.3 Transport Route

Traffic between the Tallering Peak mine site and Mullewa will use the existing Carnarvon-Mullewa Road. Traffic accessing the Transfer Facility will use an access road from the Carnarvon-Mullewa Road. Access between Tallering Peak and the Carnarvon-Mullewa

Road is currently provided by dirt tracks, and the Carnarvon-Mullewa Road itself is sealed for the first 16km north of Mullewa and thereafter is gravel surfaced.

In order to accommodate transport between Mullewa and the mine site, it will be necessary to upgrade the existing Carnarvon-Mullewa Road to a sealed all weather road with heavier pavement. It is anticipated that the road will be 10m wide with a sealed width of approximately 8m with some passing lanes provided. It will also be necessary to construct a crossing (bridge or culverts) across the Greenough River and to upgrade culverts as required at creek crossings.

New sealed access roads will also be established between the Carnarvon-Mullewa Road and the Tallering Peak mine site and to the Transfer Facility.

The main land use along the Carnarvon-Mullewa Road is pastoral or general farming. However, the "A" Class Urawa Nature Reserve and a 'C' Class Reserve for the purpose of conservation of flora and fauna, are located adjacent to the western boundary of the road.

It will also be necessary to construct a rail spur line about 4km long between the existing rail line and the proposed Transfer Facility. This spur line will pass through general farming land to the west of Mullewa.

The existing railway line between Narngulu and Mullewa passes near the small town of Moonyoonooka and through the small town of Eradu (Figure 24). Land on either side of the railway is either used for general farming, or is uncleared native bush.

The track is maintained at a standard to support 16 tonne axle loads and would require upgrading to permit 19 tonne axle loads. It is envisaged that the upgrading will occur progressively over a number of years.

The trains will enter Narngulu on the existing railway line, and discharge of the ore will occur on a new spur line. This will be constructed on land owned by Kingstream Resources NL and Pavilly Pty Ltd that is currently zoned for industrial purposes. The existing rail currently passes through general farming land and next to the Narngulu townsite before entering the Narngulu Marshalling Yards.

7.2.4 Environmental and Social Implications

It is not anticipated that there will be any issues associated with the transport of iron ore from the minesite to the Transfer Facility given the absence of houses along the transport route. The trucks will not impact on Mullewa residents as they will not enter the town. The Carnarvon-Mullewa Road will readily accommodate the increased number of trucks as it is not subject to large traffic volumes at present (average 54 vehicles per day, peak 70 vehicles per day). Upgrading of the existing road to a sealed road will provide benefits in terms of safety and will have no significant impacts on the existing environment.

Iron ore will be stockpiled at the Transfer Facility in open stockpiles and dust may be generated from these and during unloading of trucks, and loading of trains. It may therefore be necessary to implement dust suppression strategies, such as watering the stockpiles during strong winds.

Lights at the Transfer Facility may also need to be shrouded to reduce its visibility at night.

All transport of iron ore from the minesite to the GSP will be in covered road trailers or rail wagons, which will prevent dust emissions.

The number of trains along the line between Mullewa and Narngulu is currently a maximum of four per day, all of which are associated with grain transport. The addition of four extra train movements per day (one every six hours) is not expected to cause a significant impact on residents at Mullewa, Eradu, Moonyoonooka or Narngulu.

Herring Storer Acoustics (1995) estimates that the noise levels associated with existing and predicted train movements on the Mullewa to Narngulu railway at a distance of 15m are:

- Existing four train movements LA_{eq} 24 hour 49dB(A); LA_{max} 88dB(A).
- Predicted eight train movements LA_{eq} 24 hour 52dB(A); LA_{max} 88dB(A).

The recognised criteria for train noise at residences are:

- LA_{eq} 24 hour 55dB(A).
- LA_{max} 80dB(A).

These criteria are based on the State Pollution Control Council of NSW Environmental Noise Control Manual (1988), Part J "Rail Traffic Noise" Guidelines for Planning Levels. The maximum acceptable levels are set down as 5dB(A) above the criteria values.

Although the LA_{max} noise level predicted for trains on the Mullewa to Narngulu railway exceeds the recognised criteria, the predicted levels are based on a distance between the railway line and the nearest house of 15m. Houses are only close to the railway line at Eradu and at Narngulu but the majority are likely to be more than 15m away and the noise level will therefore be less. At both locations the existing maximum noise level associated with train movements is estimated to be 88dB(A) and this will not change as a result of the additional train movements associated with the GSP. At Eradu, the average noise level associated with trains during each 24 hour period may increase by up to 3dB(A) at the closest houses to the railway line. At Narngulu, the increase in the average noise level associated with trains will be less as there are considerably more train movements at this location.

The unloading of iron ore at the GSP will occur within covered areas to prevent dust. Additional dust suppression measures, such as the use of water sprays, will also be implemented if necessary.

7.3 Transport To and From the Port of Geraldton

7.3.1 Truck Movements

Steel will be transported to the Port of Geraldton by trucks with a total capacity of up to 55 tonnes, although the average load will be 46 tonnes. The heaviest and average loads are based on two coils with maximum and average strip widths of 1500mm and 1250mm respectively. The coils will be loaded at the GSP onto trucks using a forklift and also will be removed by forklift at the Port of Geraldton. Each truck will probably be a double road-train with special trailers suitable for transporting the coils. The coiled steel will be stockpiled on reclaimed land behind Berth No. 6 until it is shipped.

It is estimated that the transport of 1,000,000t/yr of steel to the Port will involve 6 truck movements each hour over a 24 hour period or 12 truck movements each hour over a 12 hour period.

Other inputs to the GSP, which are described in Section 5.2, will be imported through the Port of Geraldton. From here the inputs will be transported to the GSP on trucks. The method of loading the inputs onto the trucks will be determined by the nature of the product. For the delivery of 260,000t/yr of materials from the Port of Geraldton, the number of truck movements (assuming that conventional semi-trailers are used) is estimated to be on average in the order of 6 per hour, 12 hours per day, 7 days per week.

However, as deliveries will be made to the Port in ships involving substantial tonnages, it is probable that campaign haulage will be undertaken involving an increased number of truck movements over short periods.

7.3.2 Transport Route

The preferred route for the transport of the steel product to the Port of Geraldton is via Rudds Gully Road, Brand Highway, Portway and Marine Terrace. Solid inputs to the GSP from the Port will also use this route in reverse. The route is shown in Figure 24.

Rudds Gully Road is a two lane, single carriageway road bounded on both sides by general farming areas. Brand Highway is a single carriageway rural highway between the intersection of Rudds Gully Road and Ackland Street, which is within the City of Geraldton limits. Between Ackland Street and the Rotary, Brand Highway is a four lane divided road.

The Highway is bounded by general farming land to the east and coastal dunes to the west until it enters the City of Geraldton, where it is bounded on both sides by residential and commercial areas.

Portway is a two lane, single carriageway that carries mainly Port related traffic between Marine Terrace and Fitzgerald Street. Between Fitzgerald Street and the Rotary the traffic also includes a large proportion of cars and light vehicles which access residential and commercial areas mainly to the north but also to the south of Portway.

From Portway vehicles access Berth No. 6 via Marine Terrace. Marine Terrace is a two lane, single carriageway which carries predominantly Port related traffic, but also a limited amount of local traffic to the residential areas, caravan parks and beaches at the west end of Point Moore.

7.3.3 Environmental and Social Implications

The transport of steel product to the Port and solid inputs from the Port to the GSP will involve increased traffic along the transport route. The increase in traffic, however, is not substantial in terms of predicted traffic levels on the Brand Highway and Portway without the GSP traffic. Uloth & Associates (1988), in an independent study of traffic in Geraldton, predicted that the number of vehicle movements (i.e. two-way traffic) during peak hour on these two roads in the year 2011 would be:

- Brand Highway 1,600 including 160 heavy vehicle movements.
- Portway 1,000 including 400 heavy vehicle movements.

The number of heavy vehicle movements associated with the GSP on these two roads in peak hour is estimated at 18. This represents a 9% increase of the predicted number of heavy vehicle movements on Brand Highway and a 4% increase of the predicted number of heavy vehicle movements on Portway.

The implications of traffic levels on driving conditions given the type of road involved, is assessed in terms of levels of service. For the Brand Highway, both of the projected traffic levels (without and with GSP traffic) fall within level of service A. This level of service is defined as:

> "A condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. The freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent."

For Portway both of the traffic levels fall within a level of service C but are approaching a level of service D. Level of service C is defined as:

> "In the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level."

Level of Service D is defined as:

> "Close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems."

This means that the predicted level of traffic on Portway in the year 2011 even without any trucks associated with the GSP will generate poor driving conditions. It is likely therefore that improvements in the design of the road such as additional lanes will be required to provide for the predicted increase in traffic. The traffic associated with the GSP will add to this potential problem but in itself will not reduce the predicted poor level of service without improvements to Portway.

An estimate of the increased noise levels due to truck movements associated with the GSP has been made by Herring Storer Acoustics (1995).

This assessment concluded that the noise emission from the future traffic level on Portway in the year 2011, without GSP traffic, will exceed acceptable levels. The Department of Main Roads in Western Australia has a design guideline of 63dB(A) for traffic noise in "quiet areas". The DEP, however, has indicated that it considers that traffic noise should not exceed 58dB(A) during any hour between 11pm and 6am. The predicted noise levels in 2011 from general traffic is 70dB(A) during the daytime and 63dB(A) during the night.

When GSP traffic is added to the general predicted traffic level there is very little change in the noise level as the number of additional truck movements each hour is relatively few.

The implication of truck movements associated with the GSP on Rudds Gully Road is not known as there are no data on existing traffic levels. It is assumed however, that at present relatively few trucks use this road and that therefore 18 truck movements an hour will be a substantial increase. These truck movements will be between Goulds Road and the Brand Highway and there are a few houses along this route. Kingstream Resource NL and Pavilly Pty Ltd therefore will liaise with the Shire of Greenough to determine whether any specific road improvements may be considered necessary or desirable on this road.

7.4 Transport of Waste Products

7.4.1 Methods of Transport

The main waste products to be disposed of from the GSP will be slag and used refractory bricks, totalling about 126,000t/yr.

The slag and used bricks will be loaded onto the trains by front-end loader for transport to the Transfer Facility near Mullewa. The handling of slag and bricks at the Transfer Facility is described in Section 7.2.2. From the Transfer Facility the slag and bricks will be transported to the mine site at Tallering Peak in the road-trains used to transport iron ore.

Other solid waste products from the GSP, other than waste products returned to suppliers, will be about 180t/yr of CSP Plant sludge and sewage sludge from the sewage treatment plant. This will be transported by truck to a landfill area operated by a statutory authority.

7.4.2 Transport Route

Slag and used refractory bricks will be transported along the railway from the GSP to the Transfer Facility north of Mullewa and then along the road from the transfer station to the Tallering Peak mine. This route is described in Section 7.2.3.

7.4.3 Environmental and Social Implications

The transport of slag and used refractory bricks from the GSP to the Tallering Peak mine site will not impact on residents either at Narngulu or Mullewa. The transport of slag and used bricks will not increase traffic volumes, as the waste materials will be hauled in trains that are returning to the Transfer Facility at Mullewa, or in trucks returning from the Transfer Facility back to the mine site. Slag and used refractory bricks are consolidated materials, therefore the loading and unloading of these wastes will not generate dust.

The transport of CSP Plant sludge and sewage sludge will require one truck every six weeks. The number of truck movements therefore is not significant.

8. SOCIAL IMPLICATIONS

8.1 Introduction

The establishment of a large industry such as the MWIS Project naturally is likely to have a number of social effects, including growth in population, increased demand for community services and housing, and increased availability of employment. To ensure that adequate resources are available, and that provision is made to take best advantage of the benefits which could flow from the project, Kingstream Resources NL and Pavilly Pty Ltd intend to carry out extensive consultations with local authorities (City of Geraldton, Shire of Greenough and Shire of Mullewa), with relevant Federal and State government agencies, and with community groups following completion of the feasibility study.

As part of this PER, an assessment of local population trends, unemployment levels and community services has been made. This is presented below, together with a general discussion of the implications of the Project on existing social conditions.

Sources used to develop the profile of existing social conditions include the Australian Bureau of Statistics (ABS) census data, Local and State Government Agencies, and a review of unemployment data in the Geraldton area prepared by LandCorp (1994) as part of the PER on the proposed Oakajee Industrial Park.

8.2 Overview of the Region

The MWIS Project is located in the Mid West Region of Western Australia. The proposed GSP is adjacent to the small town of Narngulu within the Shire of Greenough and is close to the City of Geraldton. The Tallering Peak iron ore mine is within the Shire of Mullewa. A general description of these localities is provided below followed by more detailed information on population, employment and facilities.

The Mid West Region consists of 20 Local Government Authorities which include the City of Geraldton, the region's commercial and service centre. The region extends along the west coast from Greenhead to Kalbarri and more than 1000km inland to the Northern Territory border, covering more than 616,000km^2, almost a quarter of the total land area of Western Australia.

The economy of the Mid West Region is based predominantly on mining, agriculture, and tourism and is an important contributor to the Western Australian economy. A breakdown of annual turnover of the major industries in the Region is given in Table 8.1.

TABLE 8.1

ANNUAL TURNOVER OF MAJOR INDUSTRIES IN THE MID WEST REGION

INDUSTRY	ANNUAL TURNOVER
Mining (gold, mineral sands, zinc, petroleum products, natural gas)	~$1000M
Agriculture	
- Wheat	$ 160 M
- Lupins and other crops	$ 60 M
- Wool	$ 100 M
Fishing (including Rock Lobster)	$ 80 M
Manufacturing	$ 300 M
Retail/Service	$ 300 M
Tourism	$ 190 M

The City of Geraldton is the commercial service centre of the Mid West Region, with a population of about 20,500 people. Geraldton expanded rapidly in the 1890s in response to the gold boom of that era, and has continued in its role as a major service centre for the mining industries which have established in the Mid West Region, and for the wool, grain and fishing industries.

The City has excellent services and facilities with adequate capacity for continuing growth of the population.

The Shire of Greenough is the second fastest growing Shire in Western Australia, with an estimated population of 10,200. The Shire covers an area of approximately 1,748km^2, and the primary land use is agriculture but also includes major industries at the Narngulu Industrial Estate. The Estate is the proposed site for the GSP.

Infrastructure servicing the Shire of Greenough is the same as that for the City of Geraldton.

The Narngulu townsite lies on the eastern boundary (Geraldton-Walkaway Road) of the Narngulu Industrial Estate and is made up of approximately 26 single residences. A small undeveloped Recreation Reserve separates the town and the Estate.

General farming land borders the southern and eastern margins of the Narngulu Industrial Estate and also east of the Geraldton-Walkaway Road. Part of the general farming zone along the north-eastern margin of the Estate comprises small scale market gardens some of which also include the owners' homes. The Geraldton Aerodrome is located about 1.5km north-east of the Estate. Close to the north-west boundary of the Estate, there is an area zoned Public Utility, which is part of the proposed Meru landfill facility.

The Tallering Park Iron Ore mine which will supply ore to the GSP is located within the Shire of Mullewa.

The administration of the Shire of Mullewa is centred in the town of Mullewa, located 96km east of Geraldton and 464km north of Perth. Mullewa is the commercial centre for a large rural area and income in the Shire is mainly derived from agriculture.

The Australian Bureau of Statistics estimated the residential population of the Shire of Mullewa at 1349 in June 1993, 60% of whom or about 800 people were resident in the town of Mullewa.

The main agricultural activities within the Shire of Mullewa include grain crop production, with an annual harvest of wheat, oats, barley and lupins in excess of 250,000 tonnes. Wool production from the Shire exceeds 1.4 million kilograms. The value of the agricultural production is in the vicinity of $63 million each year.

The Shire Council considers that infrastructure in Mullewa substantially exceeds current population demands, and can be readily expanded to service a much larger population.

The town of Mullewa is predominantly serviced by septic tanks for effluent disposal, however, there is also a small reticulated sewerage system. Water is supplied by the Water Authority of Western Australia (WAWA) through a pipeline from the Wicherina Dam, west of the town, and from the Allenooka Borefield south of Geraldton. About 280 connections are currently consuming 210,000kL/yr, however supply capability is 450 connections with potential expansion to 620 with augmentation from the Allenooka Borefield and a pump upgrade.

Electricity is supplied to Mullewa by Western Power via a 33kV aerial powerline from Geraldton. The town demand is presently 700kW, with a capacity of 900kW. Potential expansion of this capacity to 1800kW can be achieved by installation of a voltage regulator.

Mullewa's transport needs are well catered for by both road and rail. The town is also serviced by a licensed aerodrome with commercial night operation capacity.

8.3 Social Profile of Greenough/Geraldton/Narngulu Area

8.3.1 Population

Population data for the City of Geraldton and Shire of Greenough since 1971 are shown in Table 8.2.

TABLE 8.2

POPULATION OF GERALDTON AND GREENOUGH, 1971-1991

	1971	1976	1981	1986	1991
Geraldton	15118	16007	17200	18801	20587
Greenough	1910	2897	4359	5853	7652
TOTAL	**17028**	**18904**	**21559**	**24654**	**28239**

Source: Australian Bureau of Statistics (ABS), Census Data.

The population statistics (including Chapman Valley and Northampton Shires) show a gradually increasing rate of population growth, rising from 9% in the 1971 to 1976 period to 14% in the 1986 to 1991 period.

The State Planning Commission has projected population increases to 2006 for the City of Geraldton and Shire of Greenough Government areas, as summarised in Table 8.3.

TABLE 8.3

POPULATION PROJECTIONS FOR GERALDTON AND GREENOUGH, 1996 TO 2001

	1996	2001	2006
Geraldton	22200	23400	24800
Greenough	9500	11300	12000
TOTAL	**31700**	**34700**	**36800**

Source: State Planning Commission "The Population of Western Australia 1976-2021".

There is some indication however, that the population growth in Geraldton and Greenough may have peaked and will decline from the present level of 14% every five years, to 7% in the first five years of next century.

8.3.2 Labour Force

Labour statistics for the Geraldton region (comprising the Local Government areas of Geraldton, Greenough, Chapman Valley and Northampton) are summarised in Table 8.4. These figures provide an indication of labour availability.

TABLE 8.4

EMPLOYMENT STATISTICS FOR LOCAL GOVERNMENT AREAS IN THE GERALDTON AREA

	Resident Population	Employed	Unemployed	Labour Force
Geraldton	20587	7553	1686	9239
Greenough	7652	3126	529	3655
Chapman Valley	782	413	33	446
Northampton	3546	1410	218	1628
TOTAL	**32567**	**12502**	**2466**	**14968**

Source: Australian Bureau of Statistics (ABS), Census Data.

Selected occupations of the labour force are given in Table 8.5, together with comparative information for Perth and Western Australia.

TABLE 8.5

SELECTED OCCUPATIONS OF THE LABOUR FORCE

	PERCENTAGES					
	Managers & Administration	Professionals	Trades	Plant Machinists	Labourers	Other
Geraldton	9.3	9.7	16.6	7.6	13.6	43.2
Greenough	16.4	9.5	13.7	6.9	11.5	42.0
Chapman Valley	48.4	6.2	6.4	7.2	11.0	20.8
Northampton	31.0	6.7	12.0	4.0	15.9	30.4
Perth Statistical Div.	8.8	12.2	16.0	6.5	13.8	42.7
W.A.	12.1	10.8	15.9	7.8	14.8	38.6

Source: Australian Bureau of Statistics

The high percentage of managers and administrators in the Chapman Valley, Northampton and Greenough Shires reflects self-employed farmers and those in farm enterprises. Overall, there is a markedly lower percentage of professionals and slightly lower percentage of labourers than in the Perth Statistical Division. The figures suggest a reasonable pool of trade skills available to new industries establishing in the area. There is also a pool of labourers for whom there is more likely to be work in the construction phase of new industries.

In 1991 there were 2400 unemployed (16.5% of the labour force) within the Geraldton region. The highest levels of unemployment are in the rural, service manufacturing and construction industries. Table 8.6 shows the occupations of registered unemployed.

TABLE 8.6

OCCUPATIONS OF UNEMPLOYED IN THE GERALDTON AREA

MAJOR OCCUPATIONAL GROUP	REGISTERED WITH CES
Managers and Administrators	31
Professionals	58
Para-Professionals	76
Tradespersons	223
Clerks	336
Salespersons and Personal Service Workers	557
Plant and Machine Operators, and Drivers	240
Labourers and Related Workers	1255
TOTAL	2776

Source: Commonwealth Employment Service, March 1995.

8.3.3 Housing

The Geraldton-Greenough area offers variety of single residential and large lot rural-residential properties for new housing development.

Based on current population trends, the anticipated number of new houses required by the year 2011 is between 3300 and 4300. The 1989 Geraldton Region Plan listed the available residential zoned land at 18,600 lots, well in excess of anticipated requirements. About 90% of available residential land in the Geraldton-Greenough urban area is within the Shire of Greenough.

Therefore, although the MWIS Project may attract a number of new residents to Geraldton and Greenough any demand for residential land will be easily met by the potential supply.

8.3.4 Temporary Accommodation

During construction of the GSP, the workforce is expected to peak at 1,200 personnel. This workforce may place demands on temporary accommodation, which is currently provided by a number of motels, hotels, hostels, guest houses and caravan parks.

Temporary accommodation figures for the Geraldton-Greenough area from the September to December 1994 quarter are given in Table 8.7.

It can be assumed that caravan and guesthouse facilities will be the most keenly sought form of temporary accommodation. It is difficult to anticipate the number of people that may arrive in the area seeking employment, and it is therefore difficult to determine the extra demand placed on temporary accommodation facilities. However, the current caravan park occupancy rate of 38.7% indicates considerable potential for accommodating a significant population influx.

TABLE 8.7

TEMPORARY ACCOMMODATION FIGURES FOR GERALDTON-GREENOUGH AREA SEPTEMBER TO DECEMBER 1994

	Hotels/Motels	Caravans/Guesthouses
Number of establishments	12	7
Capacity (number of rooms, units, powered sites, etc)	413	1100
Occupancy rates	65.2%	38.7%

Source: WA Tourism Commission

8.3.5 Community Services

Educational Facilities

Geraldton has two State Senior High Schools and seven State Primary Schools. Some of the State Primary Schools in the area can accommodate an increase in enrolments without the need for additional facilities but others are at or near capacity. High school enrolments exceed capacity and a third high school may be required in Geraldton within six years. The enrolment and capacity of Government Schools in Geraldton, as at 2nd Semester 1994, are shown in Table 8.8.

TABLE 8.8

ENROLMENTS & CAPACITY OF GOVERNMENT SCHOOLS IN THE GERALDTON AREA, SEMESTER 1, 1994

School	Enrolments	Capacity
Allendale Primary	446	430
Beachlands Primary	205	270
Bluff Point Primary	546	530
Geraldton Primary	348	400
Mt Tarcoola Primary	514	460
Rangeway Primary	575	590
Waggrakine Primary	407	430
John Willcock S.H.S.	754	780
Geraldton S.H.S.	1096	1080

Source: Department of Education.

Additionally, there are a number of primary and/or secondary non-Government schools, including:

- St Francis Xavier - Geraldton (Kindergarten - Year 7)
- St Lawrence's - Bluff Point (Kindergarten - Year 7)
- St Mary's - Northampton (Kindergarten - Year 10)
- St John's - Rangeway (Kindergarten - Year 7)
- Strathalbyn (Kindergarten - Year 10)
- Nagle Catholic College (Year 8 - Year 12)

The information presented above suggests that while there are a number of schools with available places for enrolments in the Geraldton area, the increase in population due to the MWIS Project may create a need for additional educational facilities at some schools.

Health Facilities

Two major hospitals service the Geraldton region, the 112 bed Geraldton Regional Hospital and the 74 bed St John of God Hospital. Both hospitals have accident and emergency facilities. The Royal Flying Doctor Service provides air ambulance services to Perth in critical cases.

In terms of bed spaces per head of population, the Geraldton region is well served, and there are no current plans for expansion. Some limitations on a full range of health services exist, due to the limited number of medical specialists in the region.

8.4 Social Profile of the Shire of Mullewa

8.4.1 Population

Population trends for the Shire of Mullewa from Australian Bureau of Statistics data since 1971 are shown in Table 8.9. The population has declined significantly over this period.

TABLE 8.9

POPULATION OF MULLEWA SHIRE 1971-1991

	1971	1976	1981	1986	1991
Population	1849	1868	1681	1389	1396

Source: Australian Bureau of Statistics

8.4.2 Labour Force

Labour statistics for the Shire of Mullewa are summarised in Table 8.10. These give an indication of labour availability. Whereas the labour force represents 36% of the Shire population, about 14% of the labour force are currently unemployed.

In February, 1995, there were 84 registered unemployed in the Mullewa Shire. The highest levels of unemployment are for rural and general labourers. The occupations of registered unemployed in the Mullewa Shire are listed in Table 8.11.

TABLE 8.10

LABOUR FORCE STATISTICS FOR MULLEWA SHIRE

	PERSONS
Resident Population	1396
Employed	492
Unemployed	84
Labour Force	576

Source: Australian Bureau of Statistics, 1995

TABLE 8.11

UNEMPLOYMENT DATA FOR MULLEWA SHIRE

OCCUPATION	PERSONS	OCCUPATION	PERSONS
Farmhand	35	Drillers Offsider	1
General Labourer	17	Gardener	1
Cleaner	5	Service Station Attendant	1
Clerk	5	Hairdresser	1
Sales Assistant	5	Child Care	1
Shearer	4	Sewing Machinist	1
Teacher's Aide	2	Metal Trade Assistant	1
Truck Driver	1	Apprentice Carpenter	1
Plant Operator	1		
Hotel Manager	1	TOTAL	84

Source: Commonwealth Employment Service, February 1995

Selected occupations of the labour force in the Shire of Mullewa are listed in Table 8.12.

TABLE 8.12

SELECTED OCCUPATIONS OF THE LABOUR FORCE IN MULLEWA SHIRE

OCCUPATION	PERCENTAGE
Managers and Administrators	33.3
Professionals and Para Professionals	10.0
Trades	8.9
Clerks and Salespersons	14.0
Plant Machinists	6.5
Labourers	20.3
Others	6.9
TOTAL	100

Source. Australian Bureau of Statistics, 1995

8.4.3 Housing

Development control within the town of Mullewa is exercised by the Mullewa Shire Council through the Mullewa Town Planning Scheme.

Vacant land is available in the town for residential, industrial, commercial and rural uses. There are 21 vacant residential lots which are serviced or partly serviced, and owned either privately or by the State Government. There are 10 unserviced vacant industrial lots, one serviced or partly serviced industrial lot, and 26 vacant commercial lots either partly or fully serviced.

8.4.4 Community Facilities

Educational Facilities

Two schools located in Mullewa serve children from ages 5 to 15. Mullewa District High School is operated by the Education Department, with a full time teaching staff of twelve including the principal and deputy principal. The school provides for children from pre-primary through to Year 10. A breakdown of total enrolment in Semester 2, 1994, is given below together with maximum numbers that could be catered for using existing infrastructure (in brackets):

- Pre-primary 39 (50)
- Year 1 to 7 89 (120)
- Year 8 to 10 43 (85)

Our Lady of Mt Carmel is a Catholic primary school with 87 students enrolled in pre-primary to Year 7 in Semester 2, 1994. The school has a maximum capacity of 160 students, and a staff of five.

The Christian Brothers Agricultural School, a boarding school for Years 8 to 10 boys, is located 40km south-east of Mullewa. Semester 2, 1994 enrolments totalled 48 students, and there are seven teaching staff. The school has a capacity of 90 students.

Health Facilities

Mullewa District Hospital is a primary medical referral centre, operated by the Health Department and managed by a local Hospital Board.

The hospital has a 20 bed capacity, including two maternity, five paediatric, and 13 adult beds (three adult beds are used for longterm nursing care patients). A full time nursing staff of 12 including the Director of Nursing supports the hospital, and a local GP services the community from a surgery located at the hospital.

Facilities available within the hospital include pathology, X-ray (limited services), ECG, a labour ward, operating theatre, and out-patients. Two St John Ambulances service the hospital as does the Royal Flying Doctor Service, providing secondary and tertiary referral to Geraldton and Perth.

8.5 Aboriginal Communities

Kingstream Resources NL & Pavilly Pty Ltd have liaised with representatives of the Aboriginal communities at Geraldton and Mullewa since they began to examine the feasibility of the MWIS Project. The proponents have made a formal commitment to these communities that special provisions will be made to provide opportunities for Aboriginal people to be employed by the Project.

8.6 Discussion

The review of social data presented above, indicates that most of the infrastructure and services available at Geraldton and within the Shires of Greenough and Mullewa have adequate capacity to accommodate any population increase associated with the establishment of the MWIS Project. However, there may be a need to expand educational facilities at some schools in Geraldton depending on the size of population increase and where people choose to live in the City.

The data also suggest that there are significant opportunities for Mid West communities to benefit from the project through reduction in unemployment and recruitment of school leavers into the workforce.

9. CONCLUSIONS

The analysis presented in this PER indicates that the GSP will have no significant environmental implications. The site of the GSP is zoned for industrial development and is suitable in terms of land use capability. Ground level concentrations of atmospheric emissions from the GSP, in combination with emissions from existing industries, will be well within generally accepted criteria and noise emissions will comply with regulations at nearby houses within the Narngulu Industrial Estate.

The GSP will generate no wastewater and will either recycle solid wastes or dispose of such wastes at the Tallering Peak iron ore mine.

Finally, the review of social data presented in the PER indicates that community services and facilities are generally adequate to cope with any increase in population associated with the MWIS Project. The Project will also offer significant employment opportunities as up to 450 jobs will not require previous experience in steel making industries and therefore will be available to local residents.

Kingstream Resources NL and Pavilly Pty Ltd intend to work closely with Local Authorities, community representatives and State Government Agencies to optimise local advantages and opportunities from the project.

10. SUMMARY OF COMMITMENTS

A number of commitments are made in this section by Kingstream Resources NL and Pavilly Pty Ltd regarding the provision and operation of the GSP. These commitments are intended to provide assurance that the GSP will be built and operated in accordance with the description provided in this PER and therefore that the environmental performance of the GSP will be as described.

It is expected that the commitments will be converted by the Minister for Environment into conditions which will apply to the project under the provisions of the Environmental Protection Act, 1986.

The commitments are as follows;

- Kingstream Resources NL and Pavilly Pty Ltd will ensure that the Geraldton Steel Plant is designed and constructed in accordance with the descriptions provided in this PER. [Timing - prior to and during construction].
- Kingstream Resources NL and Pavilly Pty Ltd will ensure that the construction and operation of the GSP conforms with environmental conditions and regulations as determined by the Minister for Environment. [Timing - prior to construction and during the life of the Project].
- Kingstream Resources NL and Pavilly Pty Ltd will continue to liaise with local communities, local authorities, and government agencies to provide information about the MWIS Project and in order to promote benefits to the Mid West Region. [Timing - prior to construction and during the life of the Project].
- Kingstream Resources NL and Pavilly Pty Ltd will appoint an Environmental Manager who will be responsible for environmental management of the construction and operation of the GSP. [Timing - prior to construction].
- Kingstream Resources NL and Pavilly Pty Ltd will establish an atmospheric emissions monitoring program to the satisfaction of the DEP in order to ensure that all emissions and ground level concentrations are within established criteria. The results of the monitoring program will be reported to the DEP and will be available to the public. [Timing - throughout the life of the Project].
- Kingstream Resources NL and Pavilly Pty Ltd will incorporate specific noise attenuation measures in the detailed design of the GSP which will ensure that the requirements of the Environmental Protection Act, 1986 Regulations or any new Regulations with respect to noise are complied with. These measures will be to the satisfaction of the DEP. [Timing - detailed design phase of the Project].
- Kingstream Resources NL and Pavilly Pty Ltd will implement regular noise monitoring studies to the satisfaction of the DEP in order to provide information relating to noise levels at nearby residences. The data from the studies will be reported to the Shire of Greenough and to the DEP and will be available to the public. [Timing - throughout the life of the Project].

- Kingstream Resources NL and Pavilly Pty Ltd will investigate opportunities for the use of solid wastes generated by the GSP. [Timing - prior to and during the operation of the GSP].

- Kingstream Resources NL and Pavilly Pty Ltd will establish landscape plantings around the perimeters of the GSP site adjacent to roads and small property holdings. The landscape treatment will be developed in consultation with the Shire of Greenough and will be to the satisfaction of the DEP. [Timing - prior to and during construction of the GSP].

- Kingstream Resources NL and Pavilly Pty Ltd will liaise with the Shire of Greenough regarding aircraft operations at Geraldton Airport. [Timing - prior to construction].

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GLOSSARY

μg/m^3	micrograms per cubic metre
μm	micrometres (microns)
AHD	Australian Height Datum
CAA	Civil Aviation Authority
CO_2	carbon dioxide
CSP	Compact Strip Production
dB(A)	decibels "A" weighted
DEP	Department of Environmental Protection
EAF	Electric Arc Furnace
EPA	Environmental Protection Authority
EPP	Environmental Protection Policy
ft	foot/feet (one foot equals 0.3048 metres)
g/m^3	grams per cubic metre
g/sec	grams per second
Gj/hr	gigajoules per hour
GPA	Geraldton Port Authority
GSP	Geraldton Steel Plant
ha	hectares
kg/hr	kilograms per hour
kg/m^3	kilograms per cubic metre
kL/year	kilolitres per year
km	kilometres
km^2	square kilometres

kPa	kilopascals
kV	kilovolts
kW	kilowatts
L_{10}	percentile level noise level exceeded for 10% of each hourly time interval.
Level of Service	The ability of a road to maintain a defined traffic flow.
LF	Ladle Furnace
limit	Atmospheric emission concentration which should not be exceeded.
M	million
m/sec	metres per second
m^3/day	cubic metres per day
m^3/hr	cubic metres per hour
m^3/tonne	cubic metres per tonne
mg/L	milligrams per litre
Mm^3/hr	million cubic metres per hour
MW	megawatts
NOI	Notice of Intent
NO_x	oxides of nitrogen
NPC	Net Present Cost. This is an economic indicator which allows economic comparison of values at a particular discount rate.
OLS	Obstacle Limitations Surface. The height above ground level above which any protruding structures may interfere with aircraft approaches.
PER	Public Environmental Review
PM_{10}	particulates below 10μm in size
PM_{50}	particulates below 50μm in size
rpm	revolutions per minute

SO_2	sulphur dioxide
STEL	Short Term Exposure Limit. This is a 15 minute average which should not be exceeded more than four times a day for occupational health.
t	tonnes
TJ/day	terajoules per day
tpa	tonnes per annum
TPS	Town Planning Scheme
WALA	Western Australian Land Authority
WAWA	Water Authority of Western Australia

FIGURES

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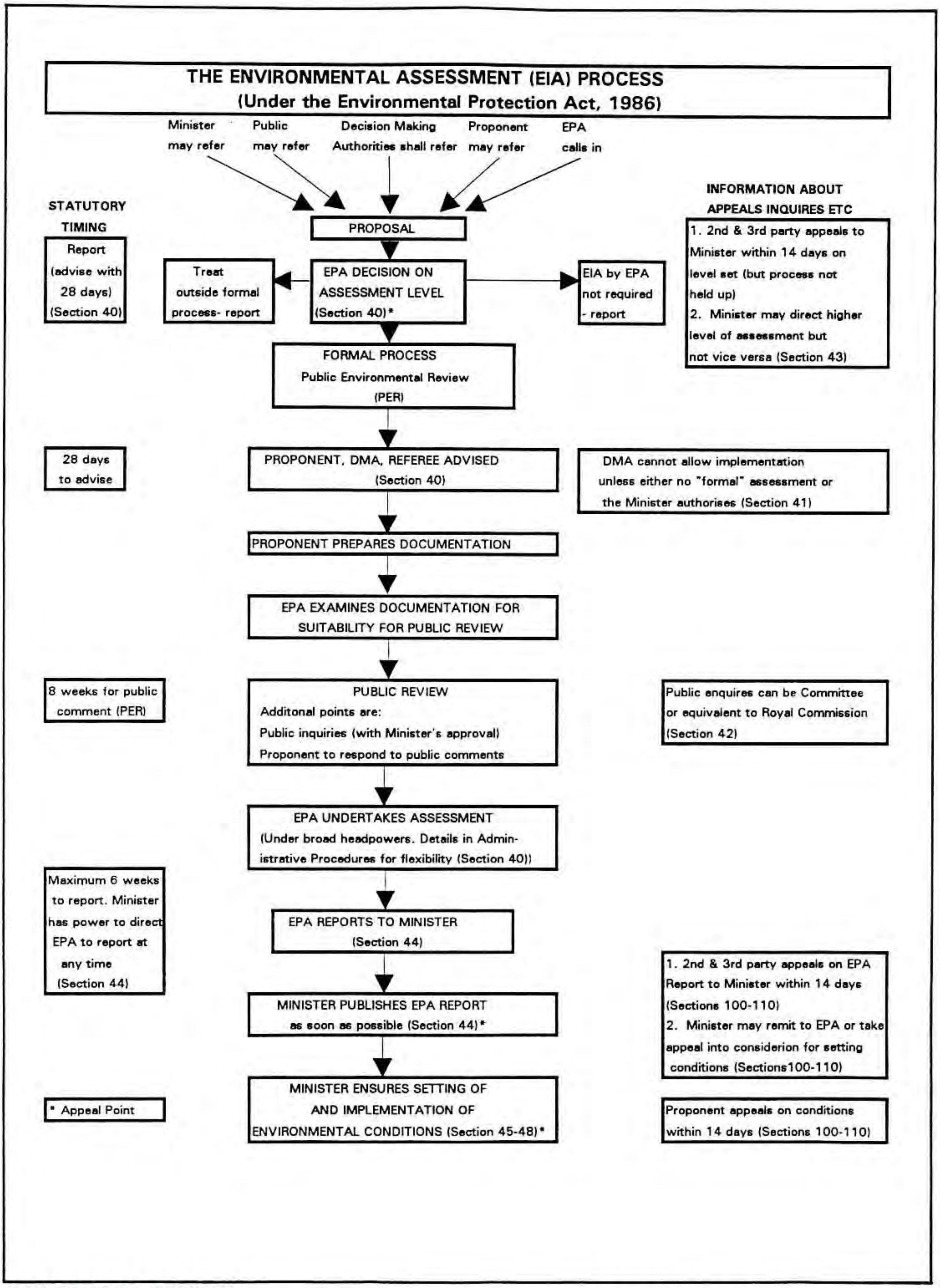
MID WEST IRON & STEEL PROJECT
LOCATION OF KEY COMPONENTS
FIGURE 1



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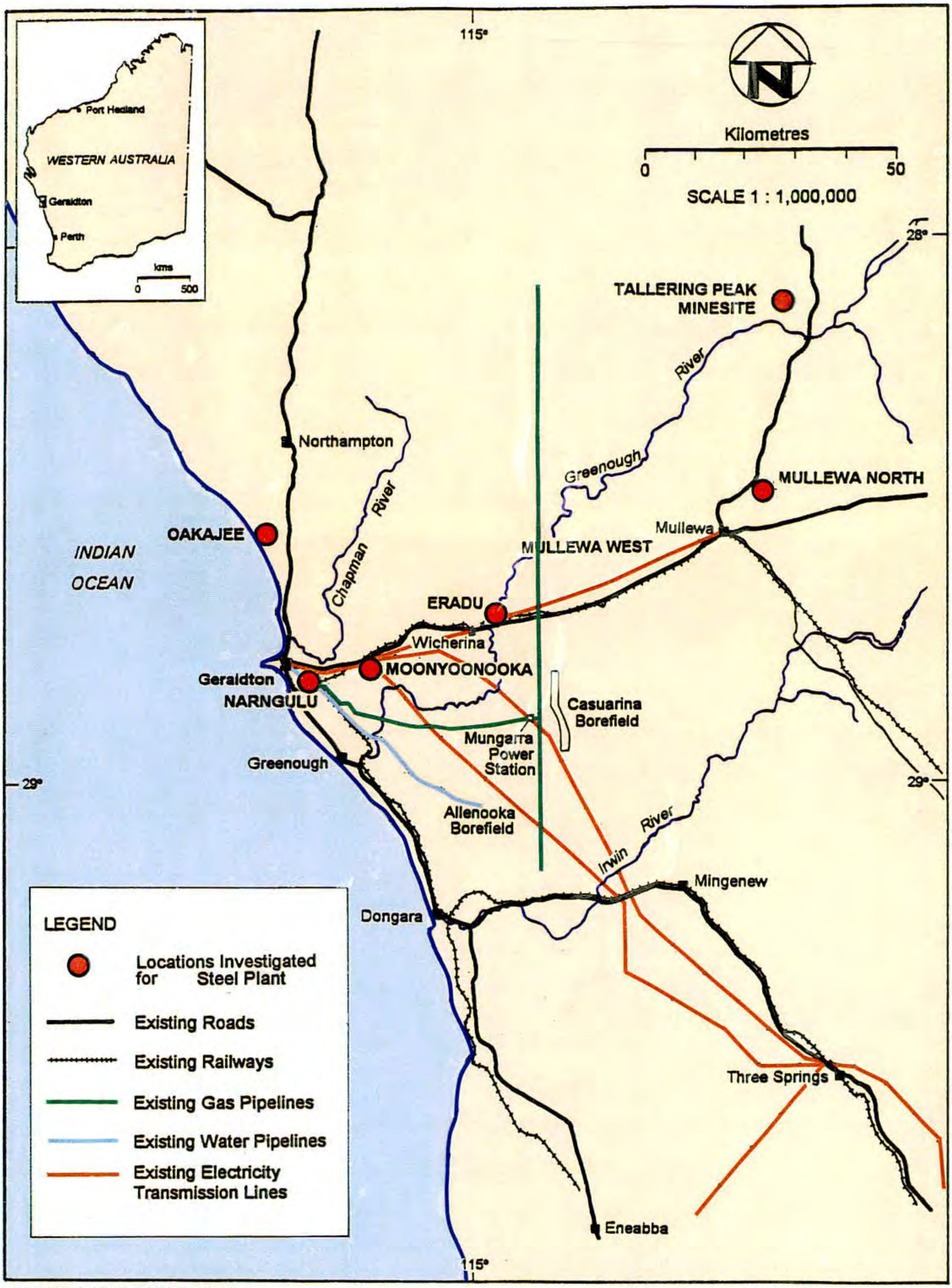
GERALDTON STEEL PLANT
THE PUBLIC ENVIRONMENTAL REVIEW (PER) PROCESS
FIGURE 2



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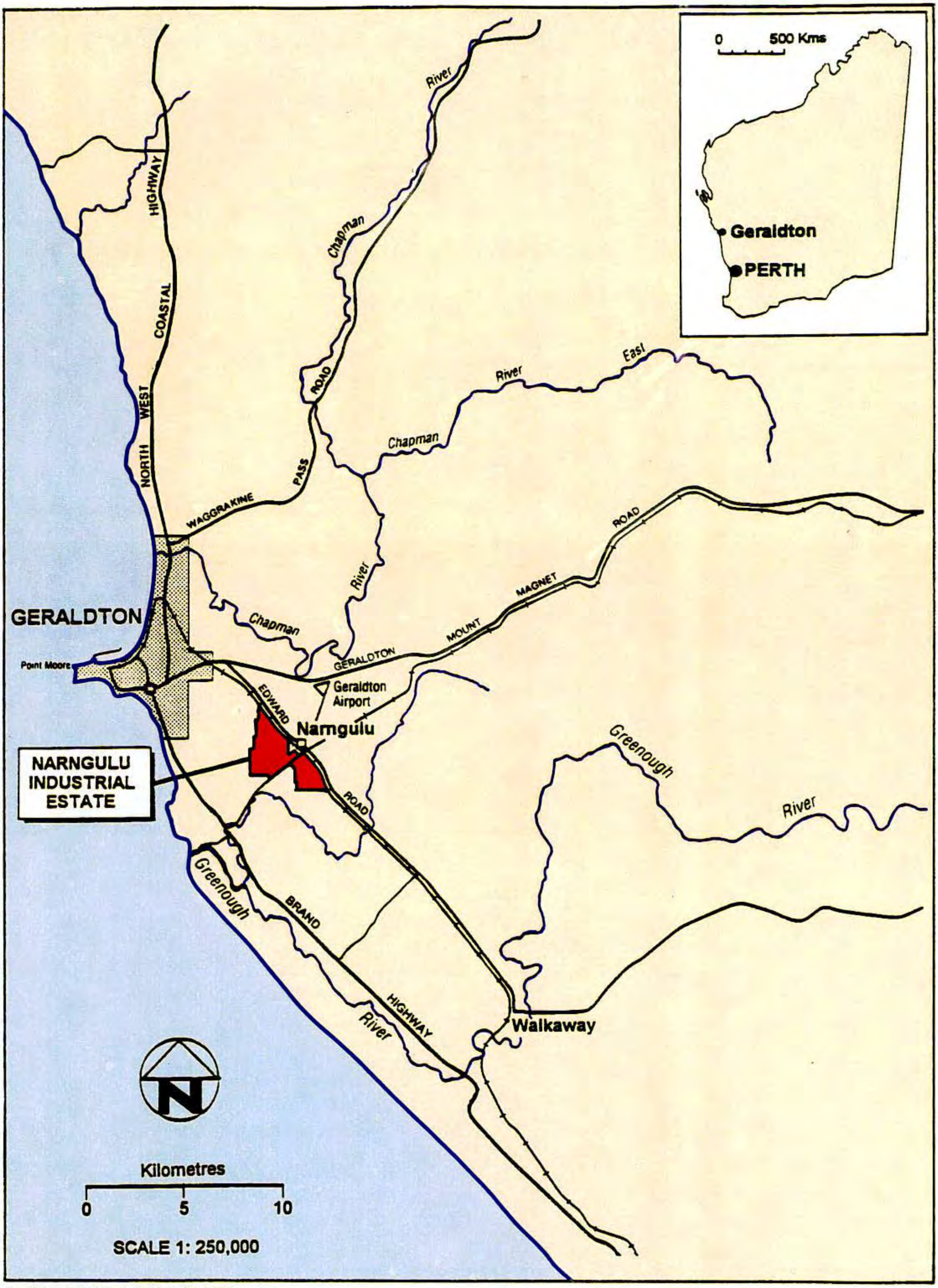
MID WEST IRON & STEEL PROJECT
LOCATIONS INVESTIGATED FOR THE GERALDTON STEEL PLANT
FIGURE 3



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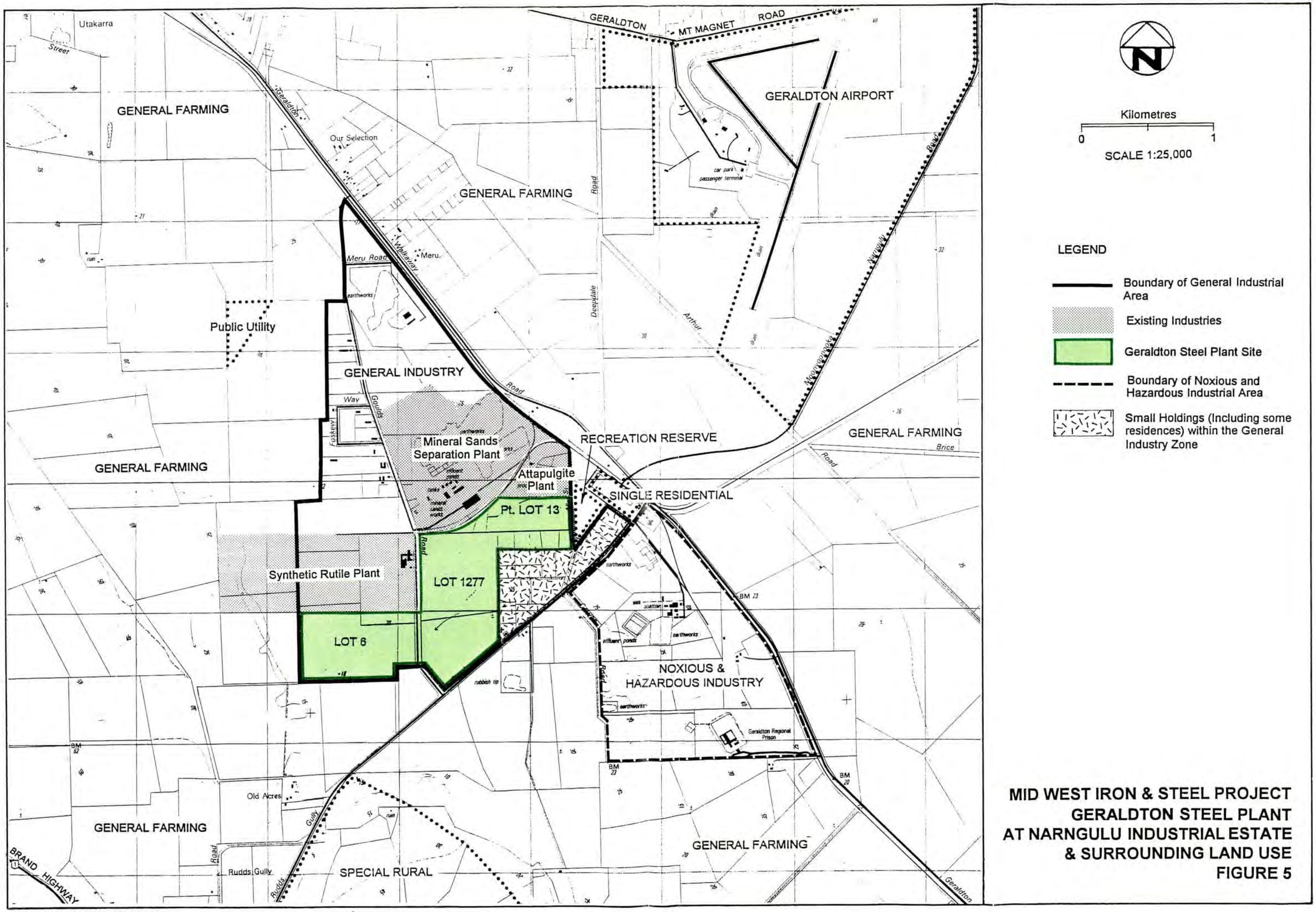
MID WEST IRON & STEEL PROJECT
LOCATION OF NARNGULU INDUSTRIAL ESTATE
FIGURE 4



MID WEST IRON & STEEL PROJECT
GERALDTON STEEL PLANT
AT NARNGULU INDUSTRIAL ESTATE
& SURROUNDING LAND USE
FIGURE 5

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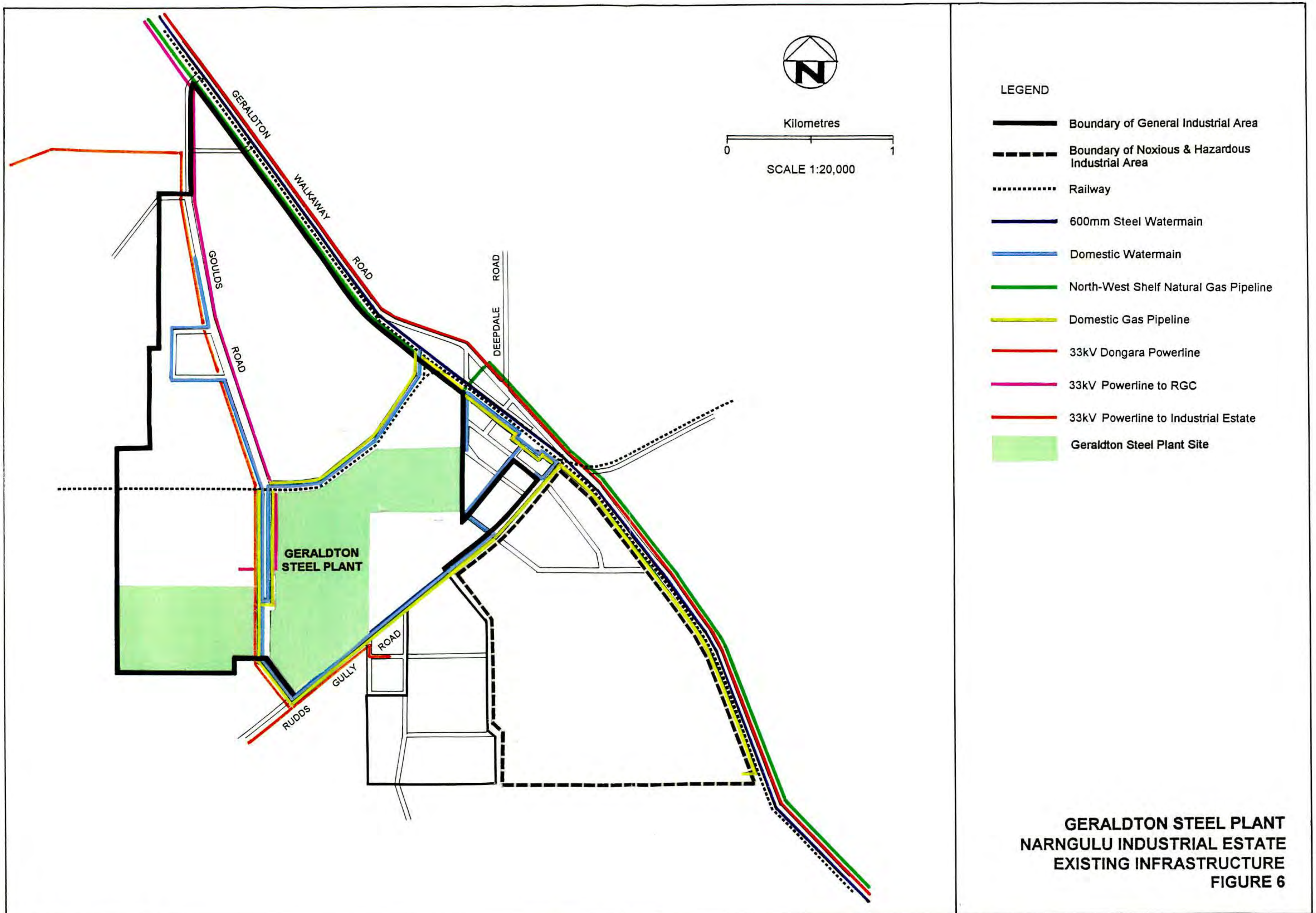

GERALDTON STEEL PLANT
NARNGULU INDUSTRIAL ESTATE
EXISTING INFRASTRUCTURE
FIGURE 6

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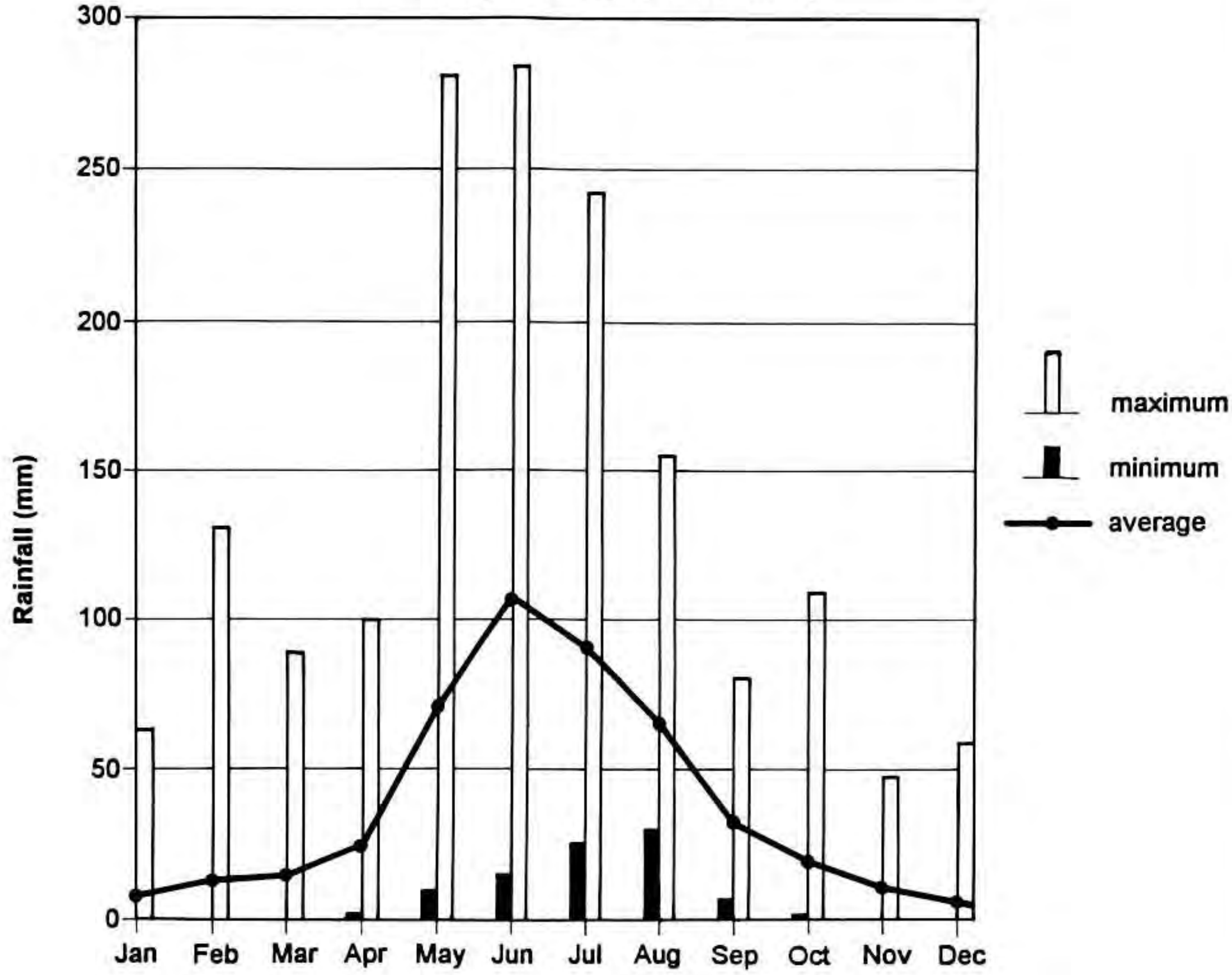
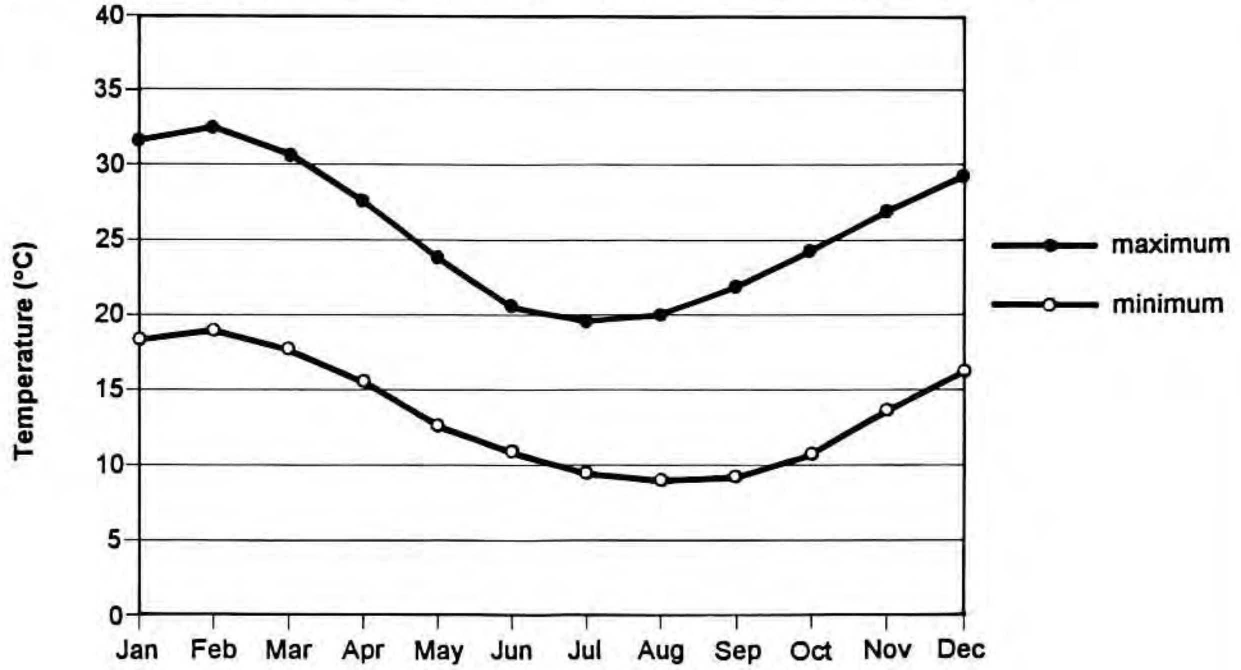
A Rainfall data for Geraldton, including max. and min. rainfall and monthly average (1941-1993)



B Mean daily max. and min. temperature at Geraldton (1941-1993)



DATA SOURCE: BUREAU OF METEOROLOGY, GERALDTON

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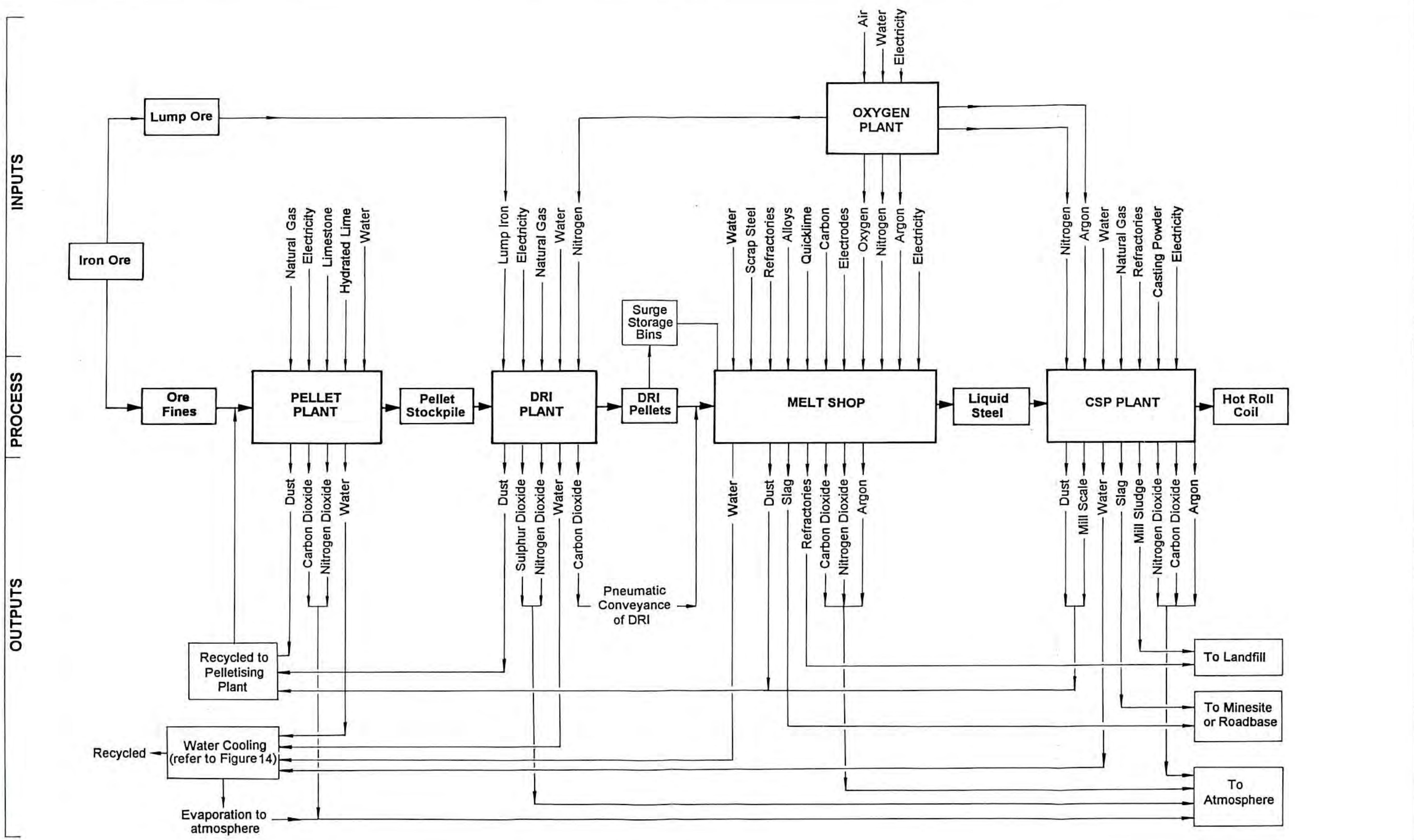
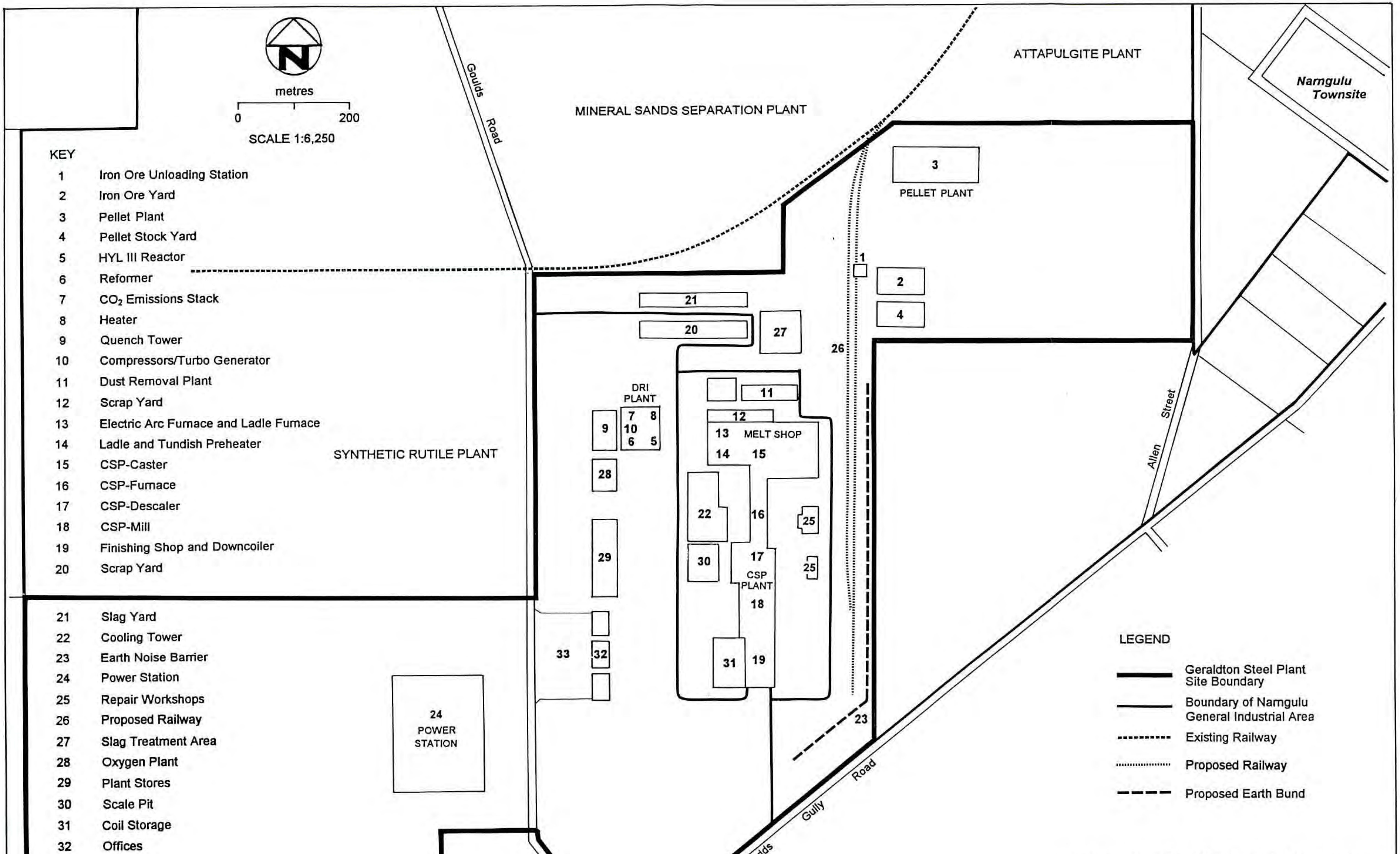
GERALDTON STEEL PLANT
CLIMATE DATA FOR GERALDTON
FIGURE 7



GERALDTON STEEL PLANT
OVERALL PROCESS DIAGRAM
FIGURE 8



MID WEST IRON AND STEEL PROJECT
LAYOUT OF THE GERALDTON STEEL PLANT
NARNGULU INDUSTRIAL ESTATE
FIGURE 9

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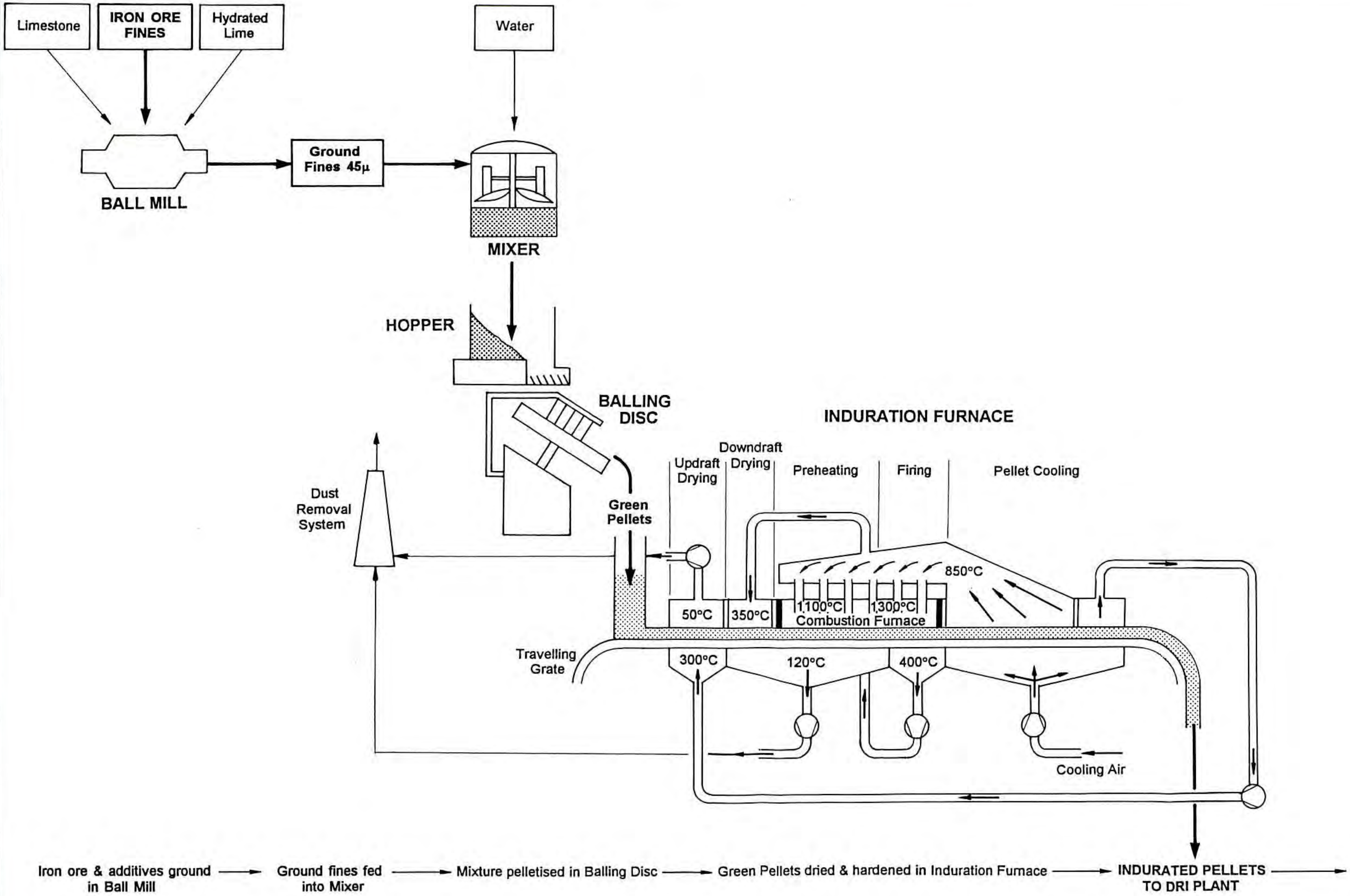
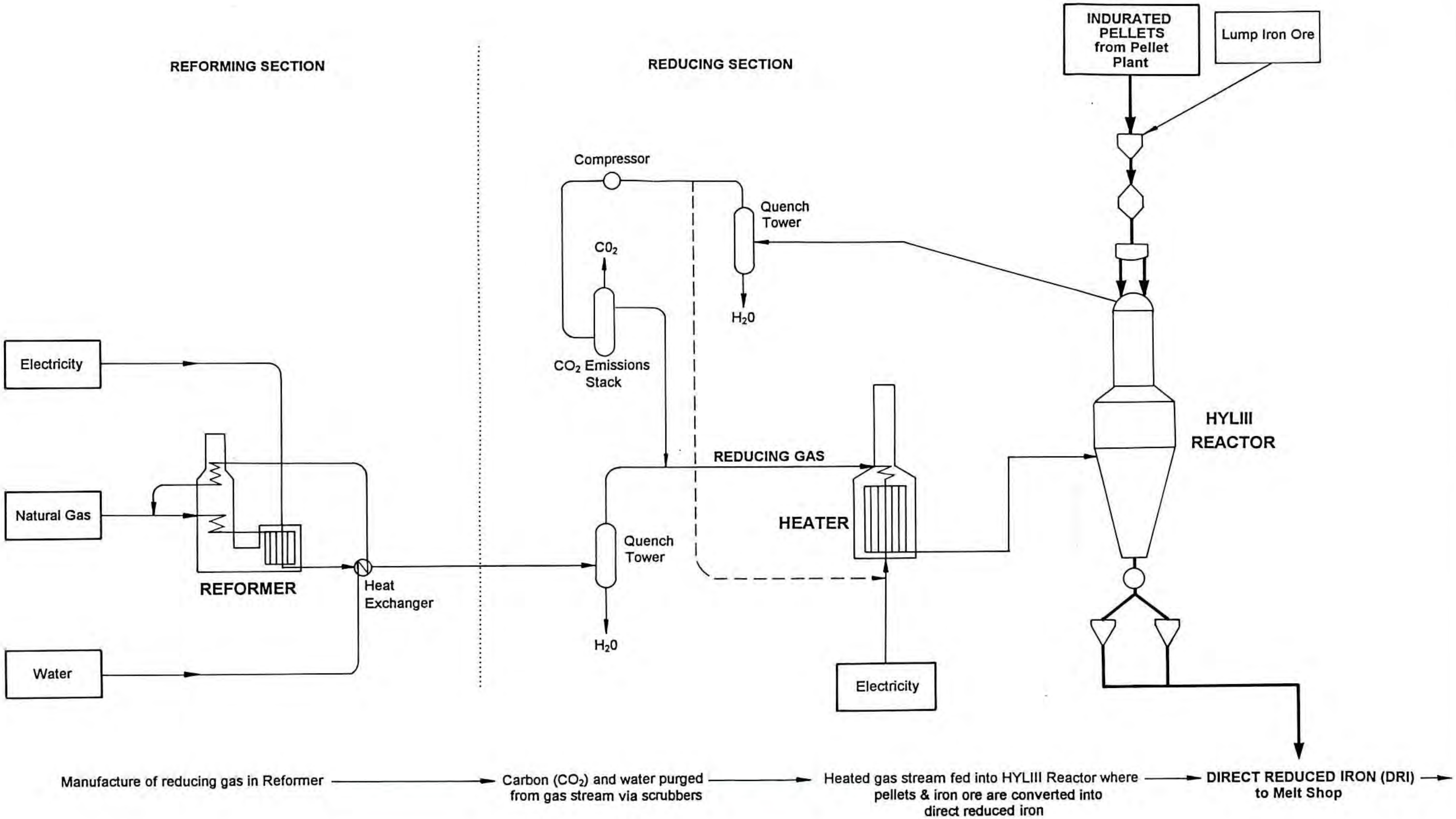
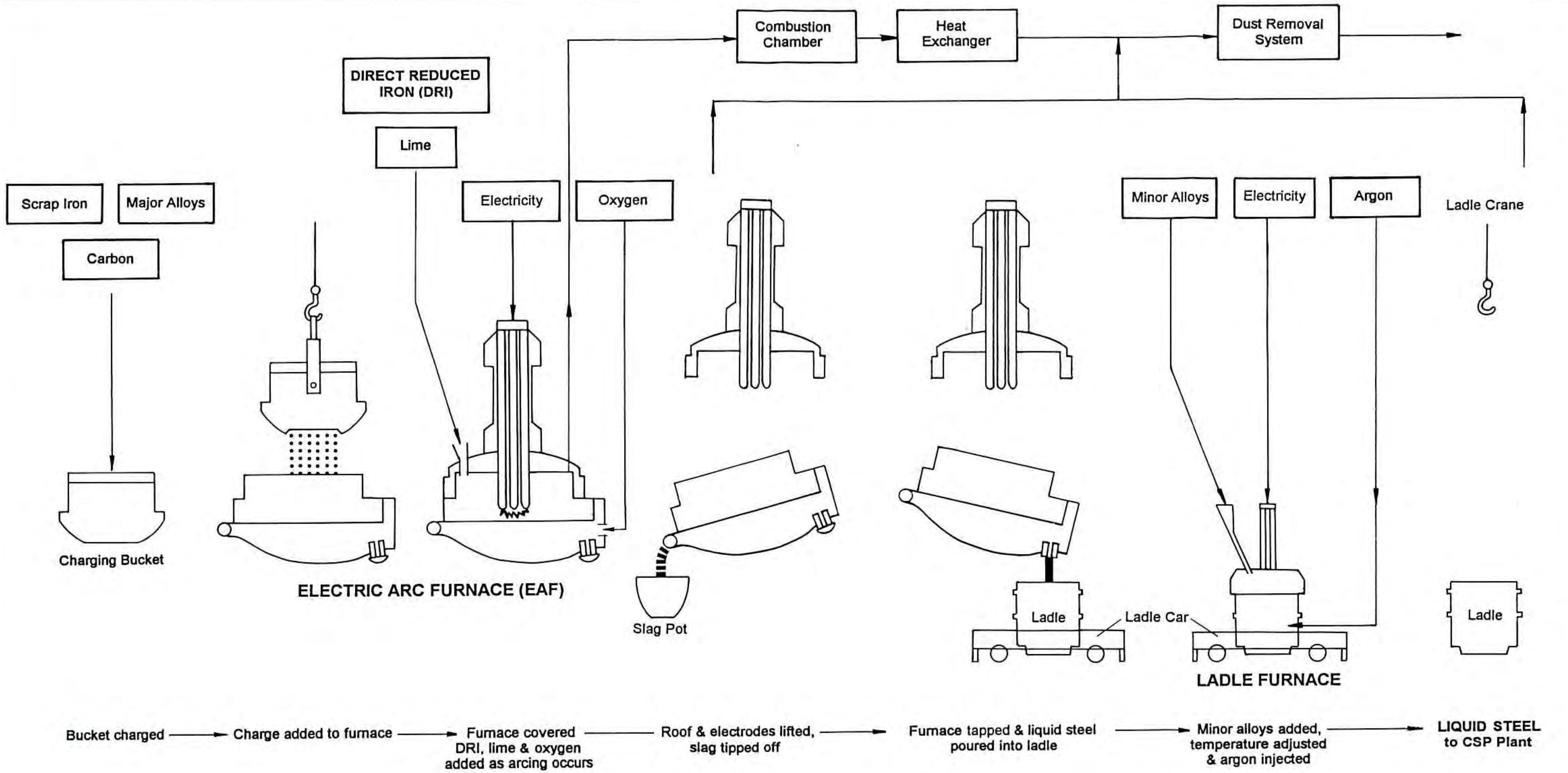


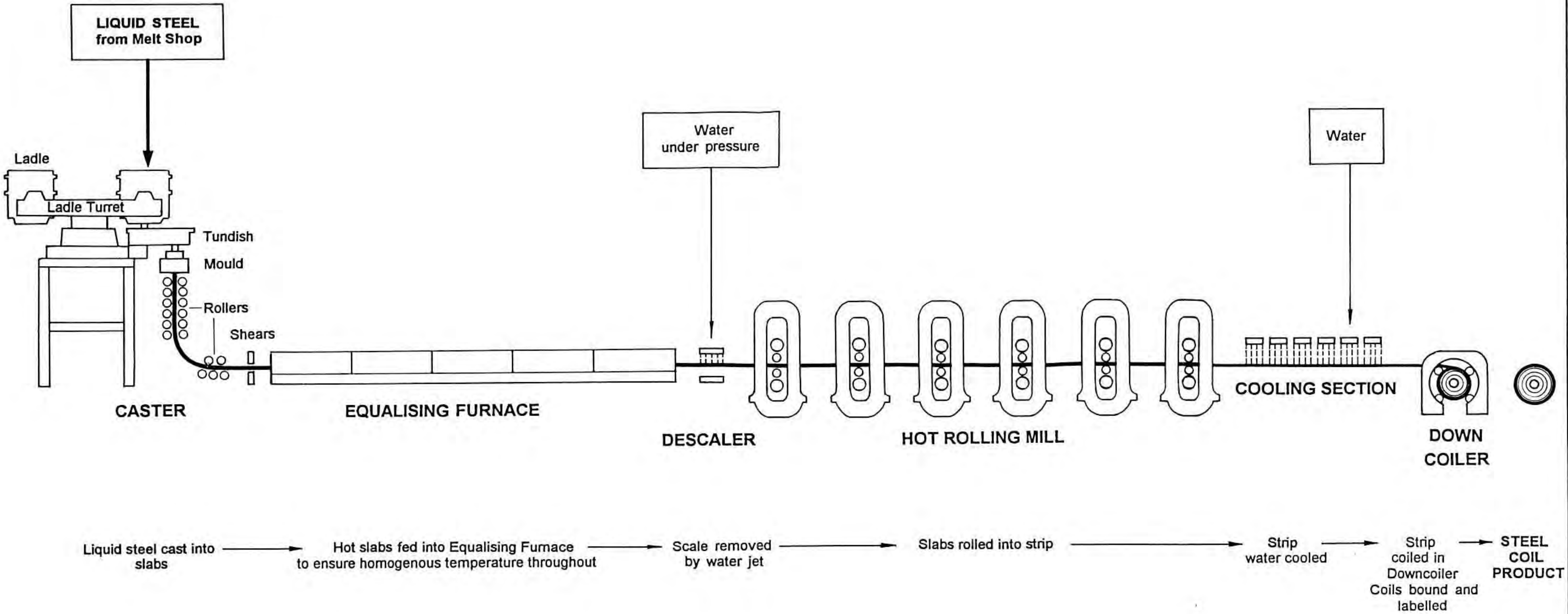
GERALDTON STEEL PLANT
PELLET PLANT PROCESS DIAGRAM
FIGURE 10



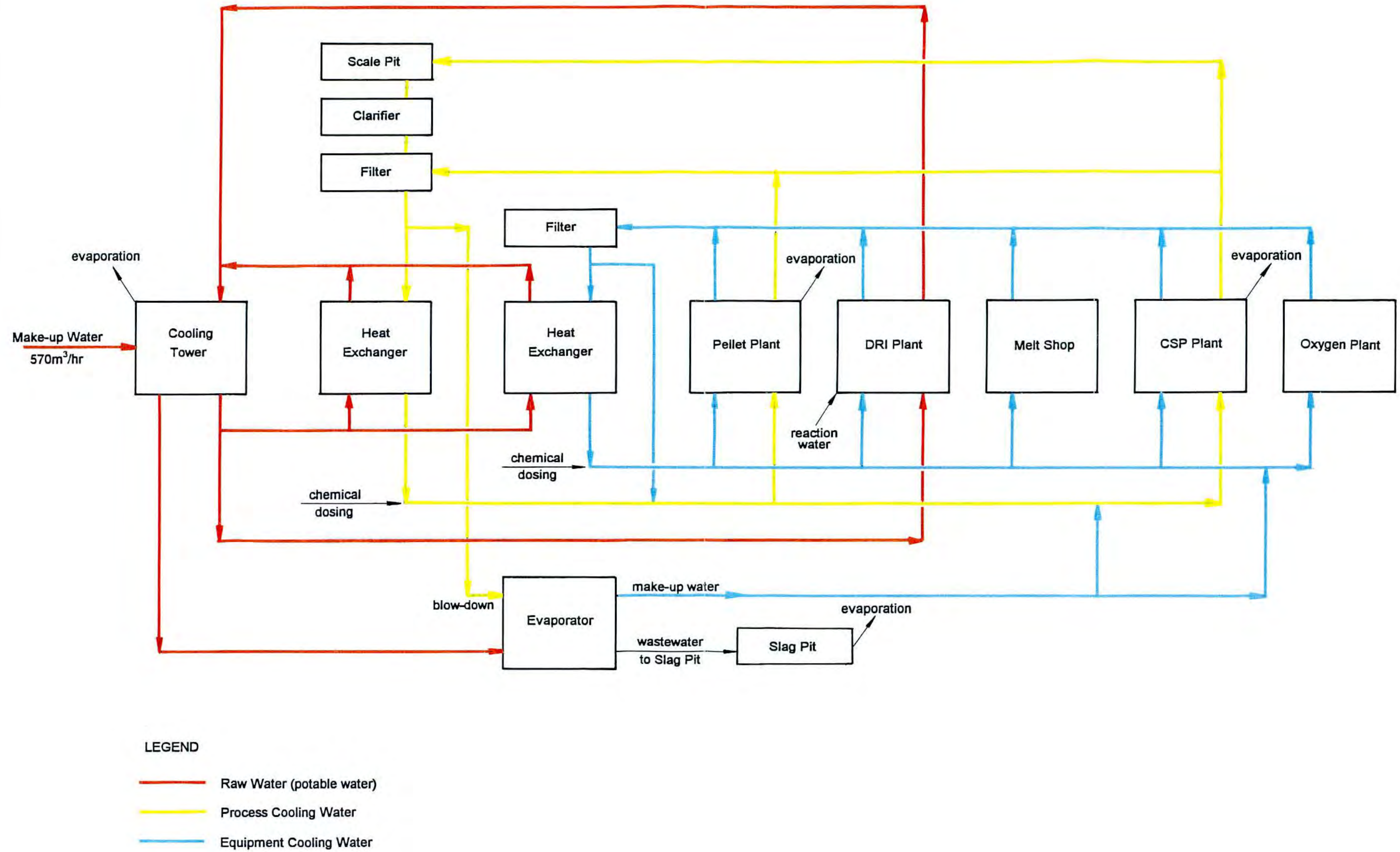
GERALDTON STEEL PLANT
DIRECT REDUCTION (HYLIII) PROCESS DIAGRAM
FIGURE 11



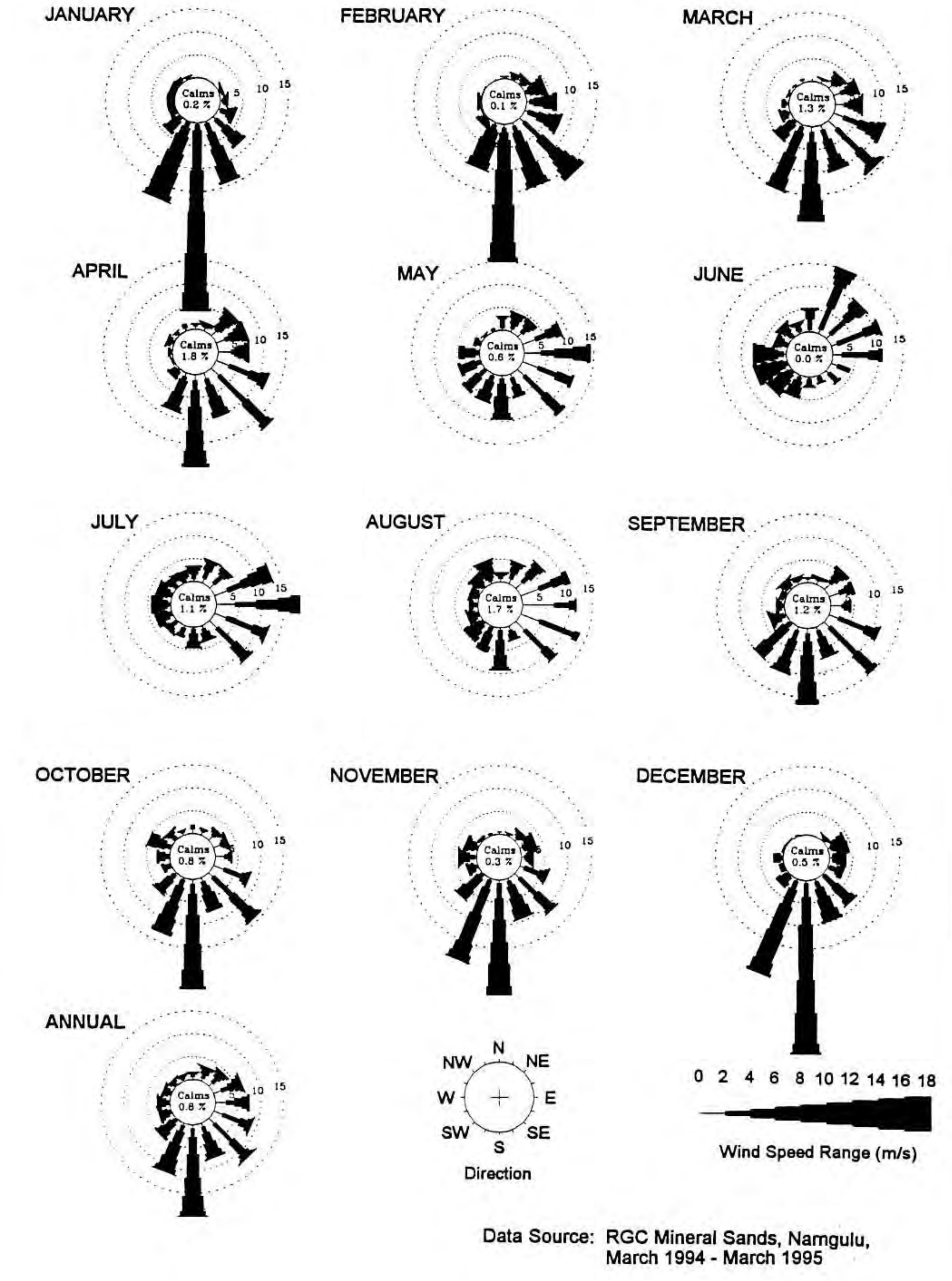
GERALDTON STEEL PLANT
MELT SHOP PROCESS DIAGRAM
FIGURE 12



GERALDTON STEEL PLANT
COMPACT STRIP PRODUCTION (CSP) PROCESS DIAGRAM
FIGURE 13



GERALDTON STEEL PLANT
WATER BALANCE FLOW CHART
FIGURE 14



SOURCE: WNI SCIENCE & ENGINEERING, 1995

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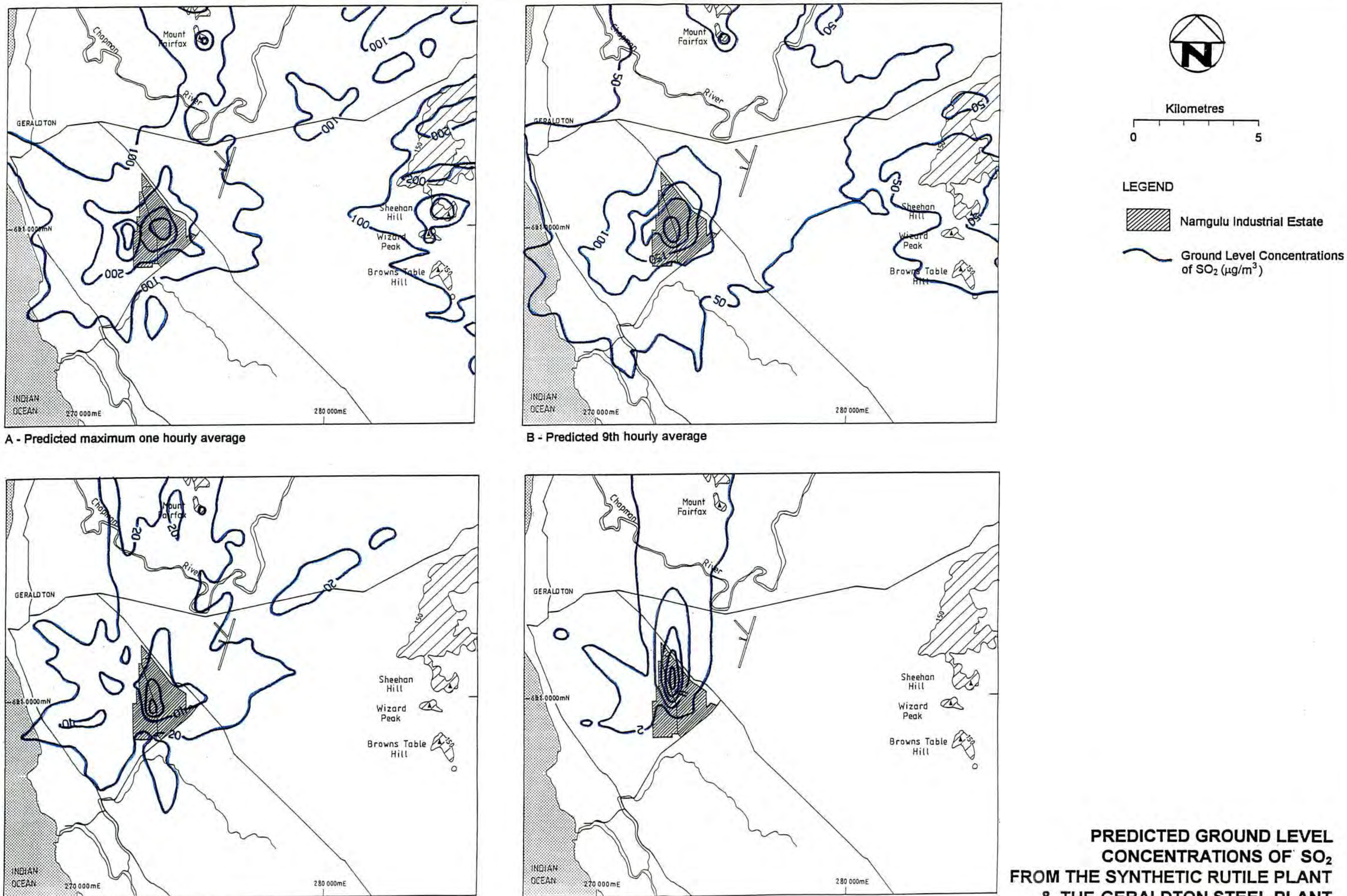
ANNUAL & SEASONAL WIND ROSES FOR NARNGULU
FIGURE 15



A - Predicted maximum one hourly average

B - Predicted 9th hourly average

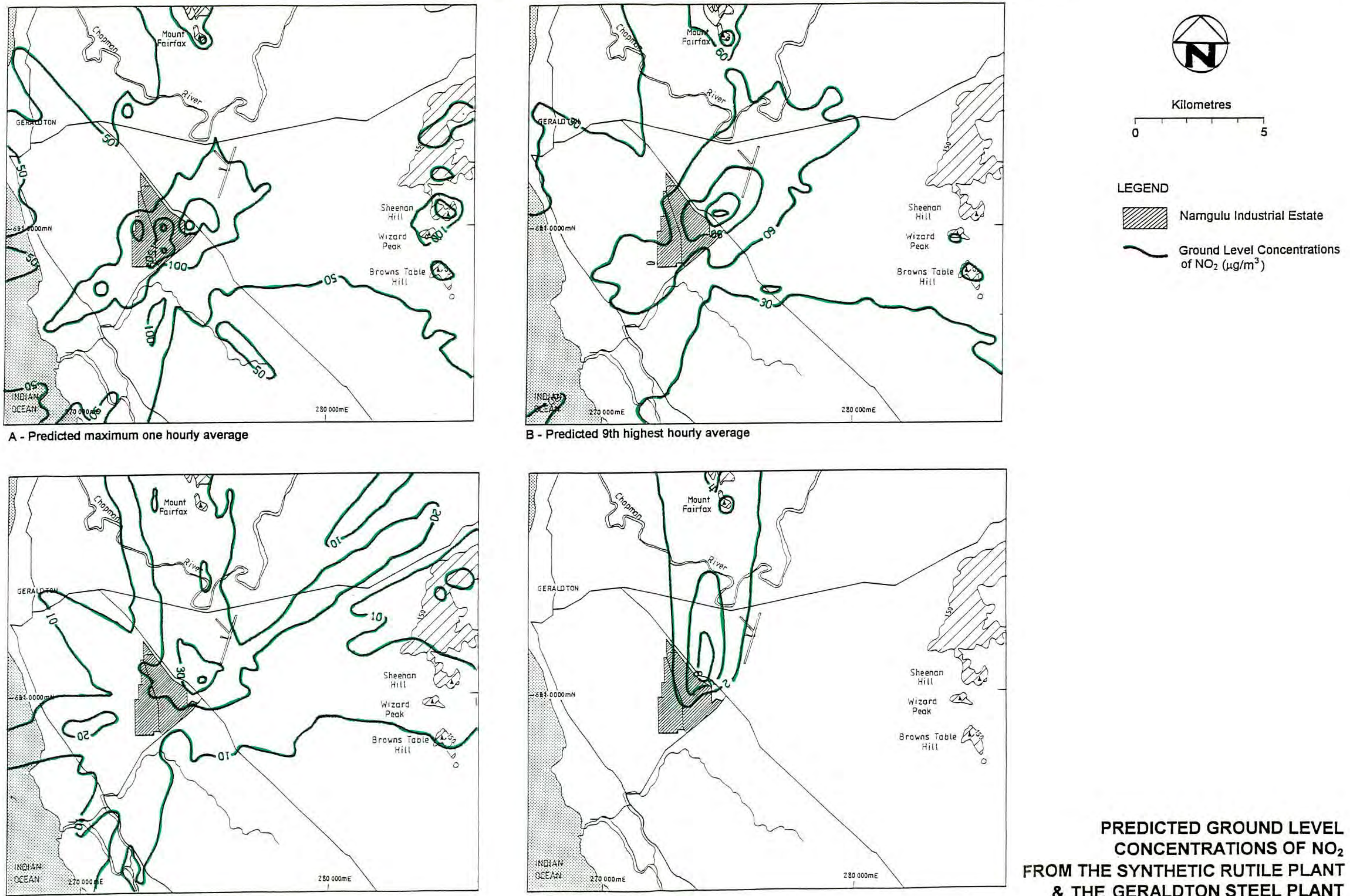
C - Predicted maximum 24 hour average

D - Predicted annual average

PREDICTED GROUND LEVEL CONCENTRATIONS OF SO_2 FROM THE SYNTHETIC RUTILE PLANT & THE GERALDTON STEEL PLANT

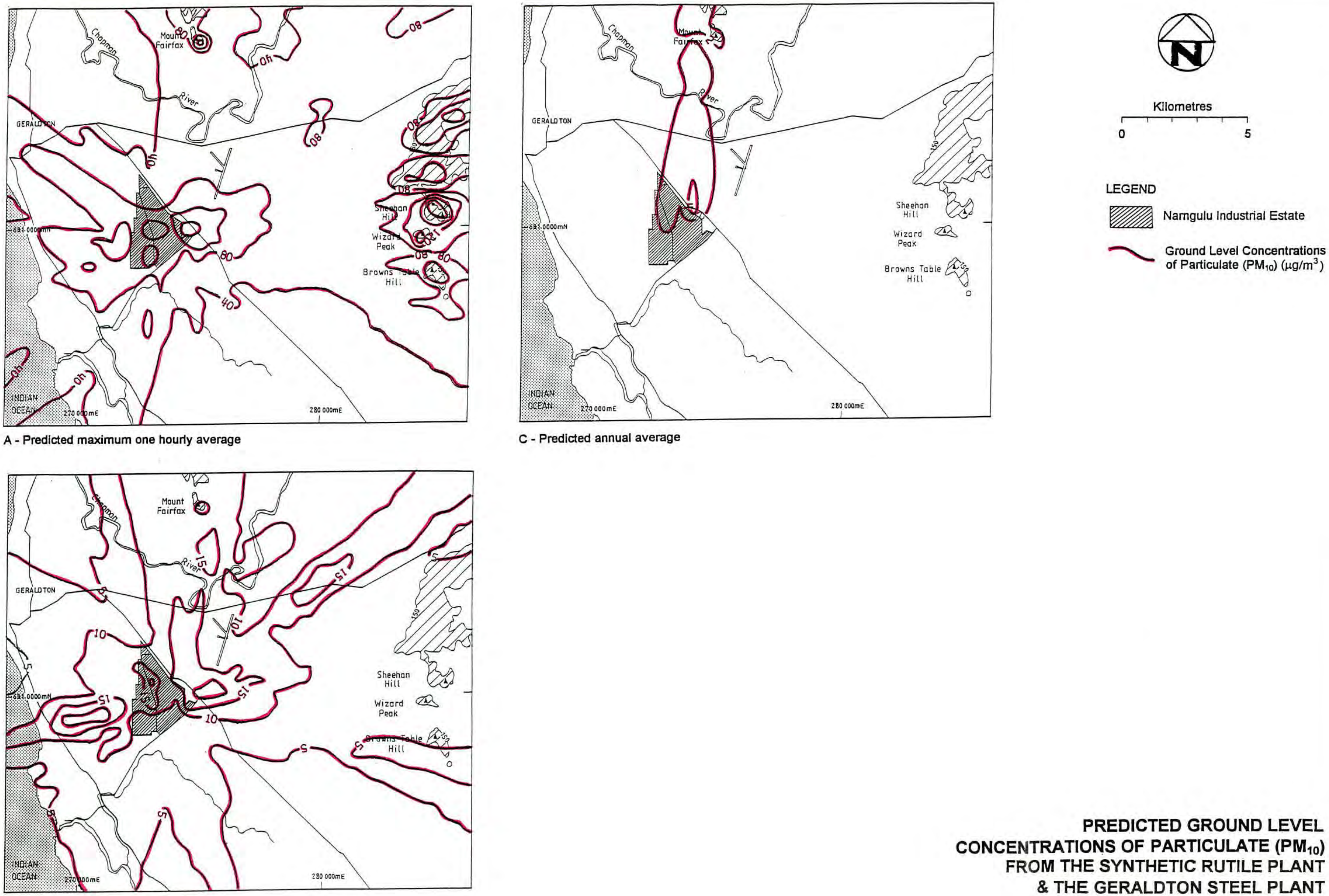
FIGURE 16

SOURCE: WNI SCIENCE & ENGINEERING, 1995



PREDICTED GROUND LEVEL CONCENTRATIONS OF NO_2 FROM THE SYNTHETIC RUTILE PLANT & THE GERALDTON STEEL PLANT
FIGURE 17

SOURCE: WNI SCIENCE & ENGINEERING, 1995



A - Predicted maximum one hourly average

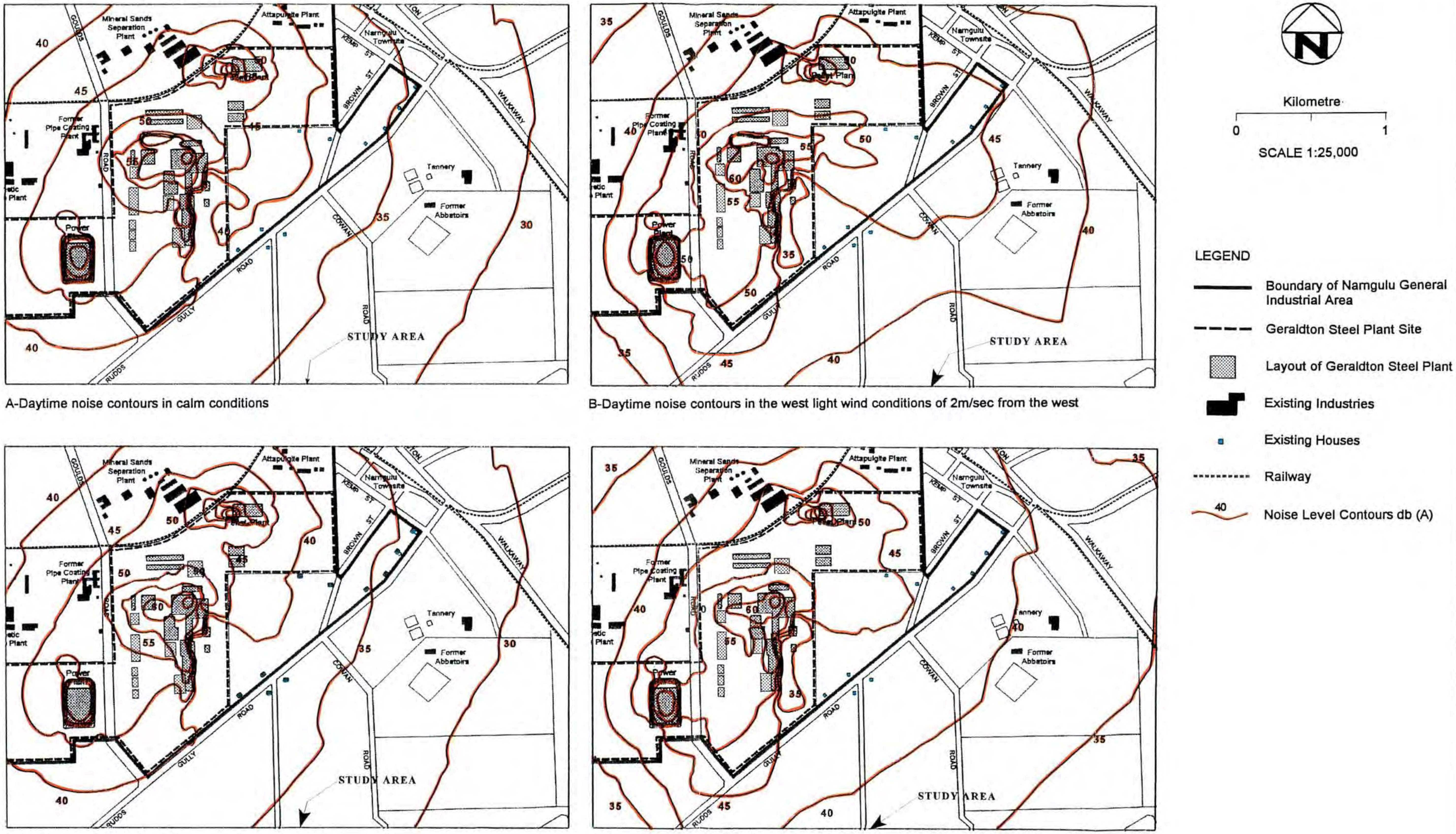
C - Predicted annual average

B - Predicted maximum 24 hour average

PREDICTED GROUND LEVEL CONCENTRATIONS OF PARTICULATE (PM_{10}) FROM THE SYNTHETIC RUTILE PLANT & THE GERALDTON STEEL PLANT

FIGURE 18

SOURCE: WNI SCIENCE & ENGINEERING, 1995



A-Daytime noise contours in calm conditions

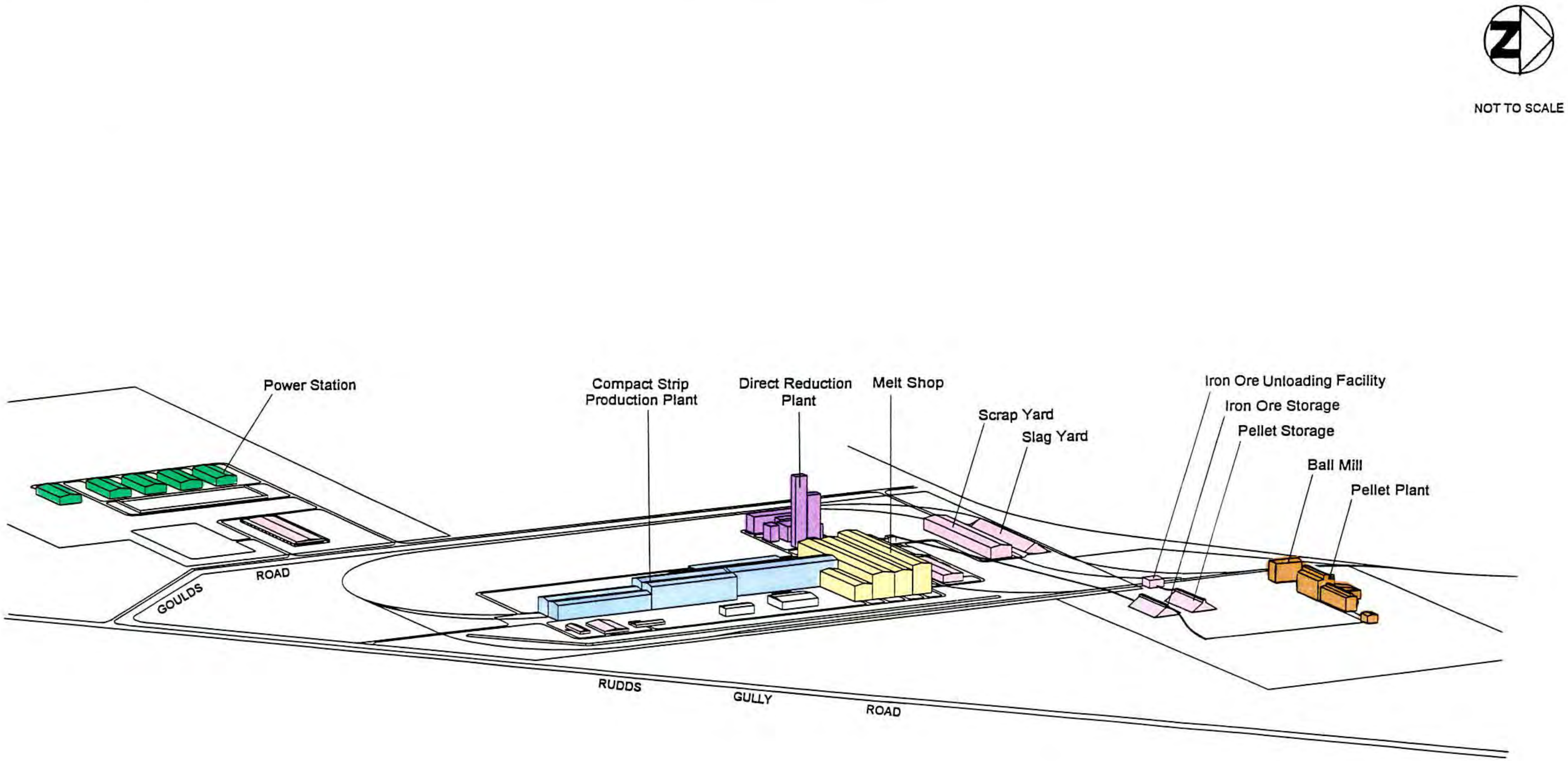
B-Daytime noise contours in the west light wind conditions of 2m/sec from the west

C-Night time noise contours in calm conditions

D-Night time noise contours in light wind conditions of 2m/sec from the west

NOISE LEVEL CONTOURS
FOR THE GERALDTON STEEL PLANT
ATTENUATED PLANT MODELLING
FIGURE 19

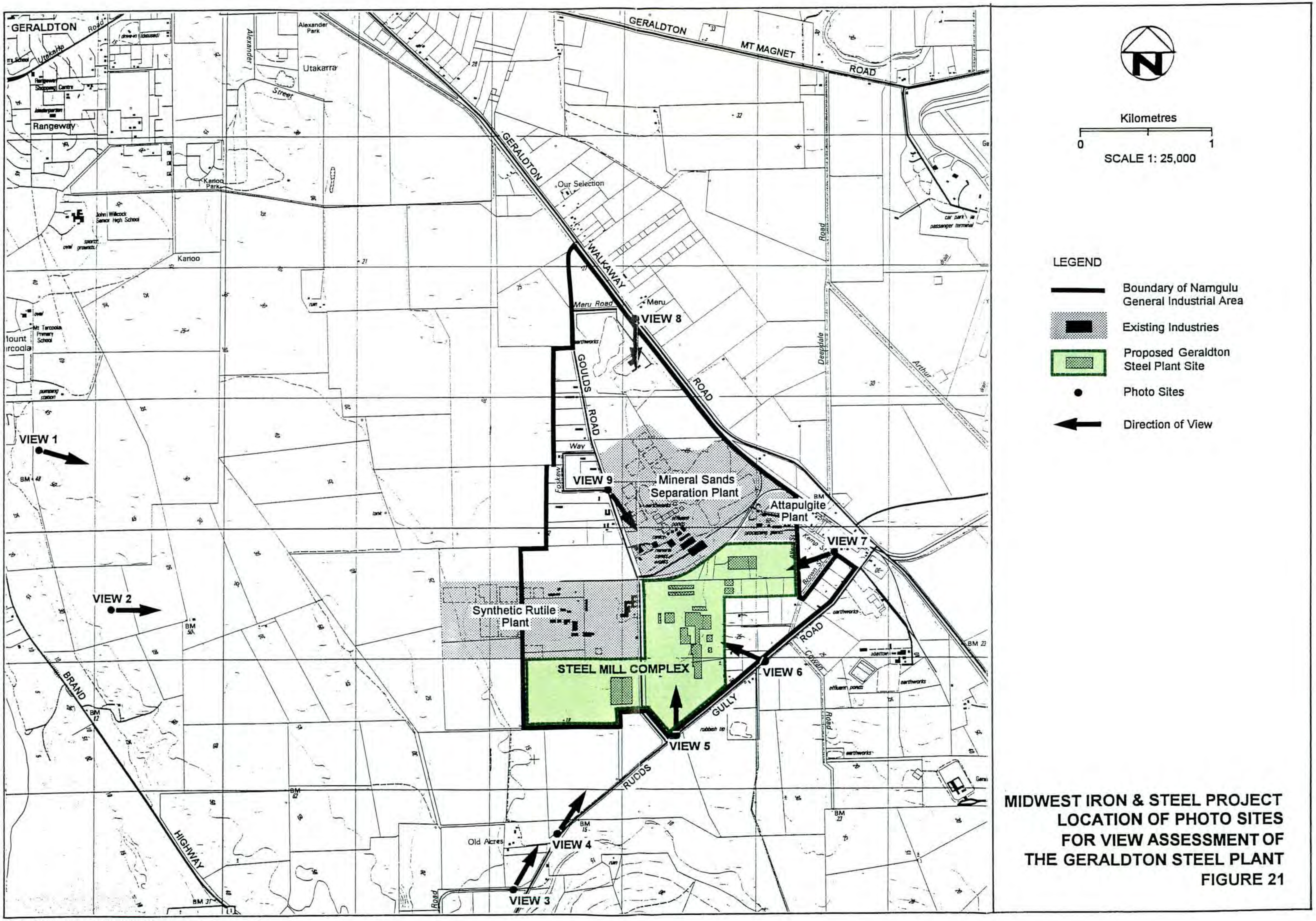
SOURCE: HERRING STORER ACOUSTICS,1995



MID WEST IRON & STEEL PROJECT
PICTORIAL VIEW OF
THE GERALDTON STEEL PLANT
FIGURE 20

SOURCE: SIGNET ENGINEERING PTY LTD, 1995

ALAN TINGAY & ASSOCIATES



MIDWEST IRON & STEEL PROJECT
LOCATION OF PHOTO SITES
FOR VIEW ASSESSMENT OF
THE GERALDTON STEEL PLANT
FIGURE 21

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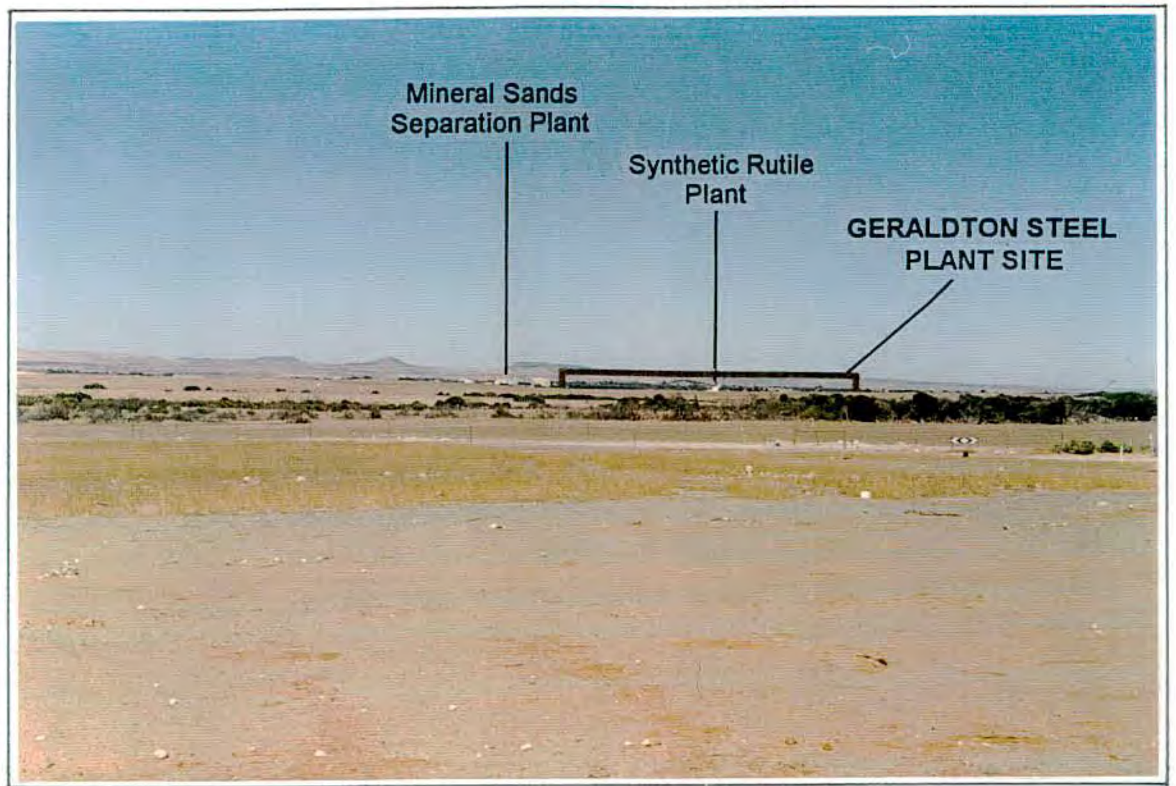
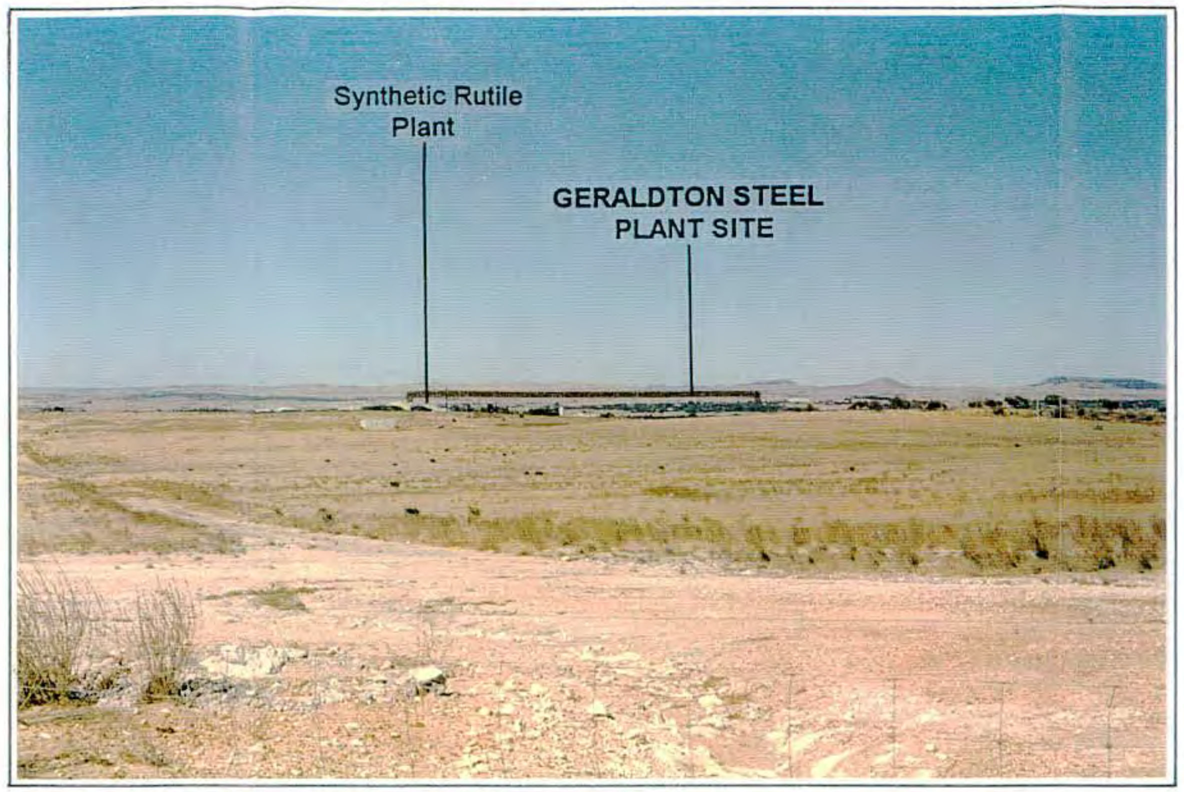
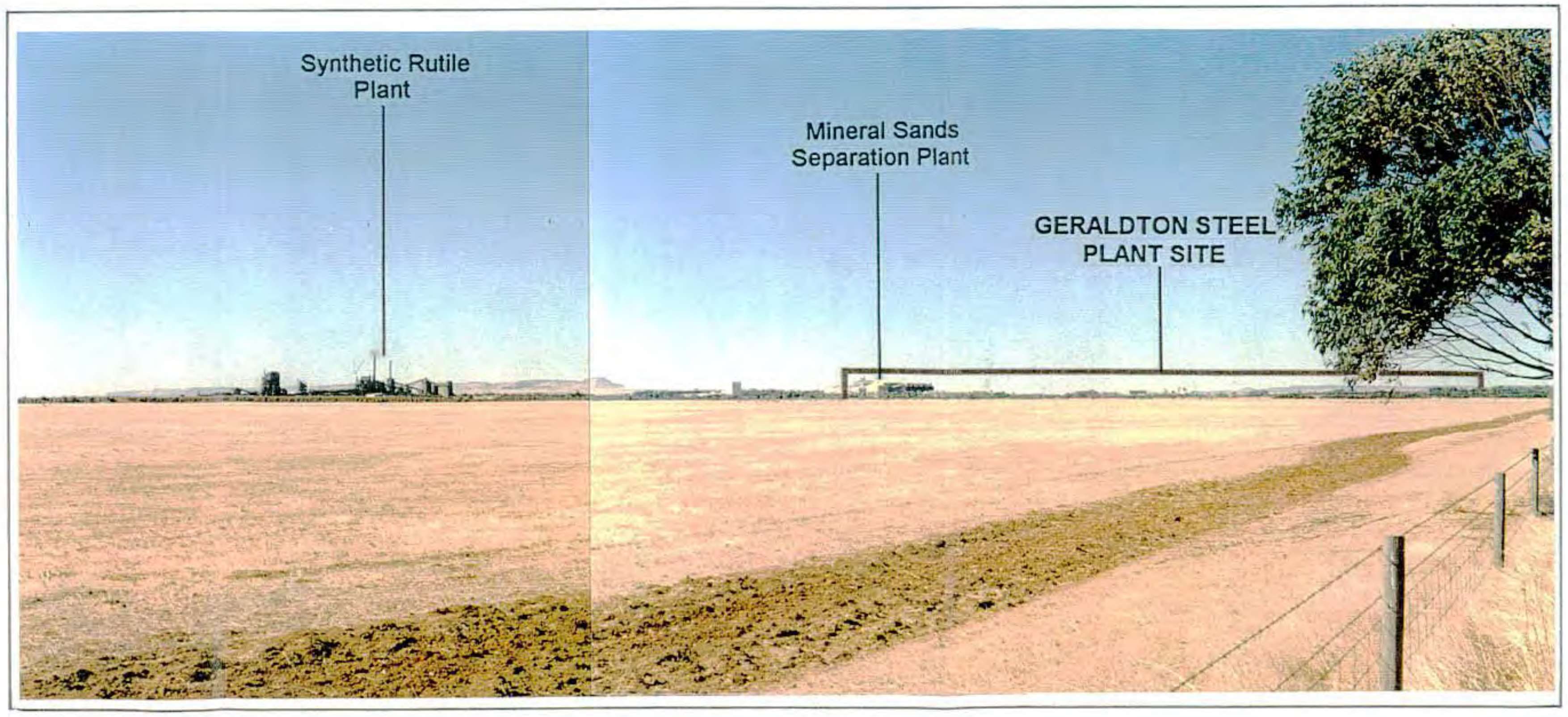


VIEW 1 - East from Wandana Heights Subdivision



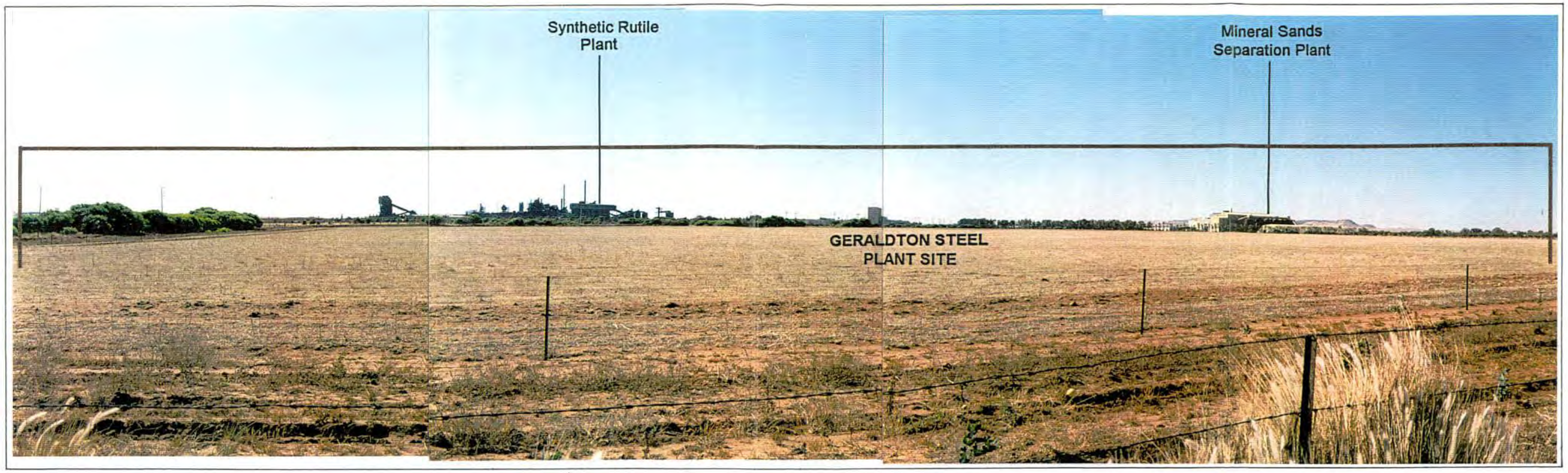
VIEW 2 - East from Ocean Ridge Subdivision

VIEW 3 - North-east from Rudds Gully Road

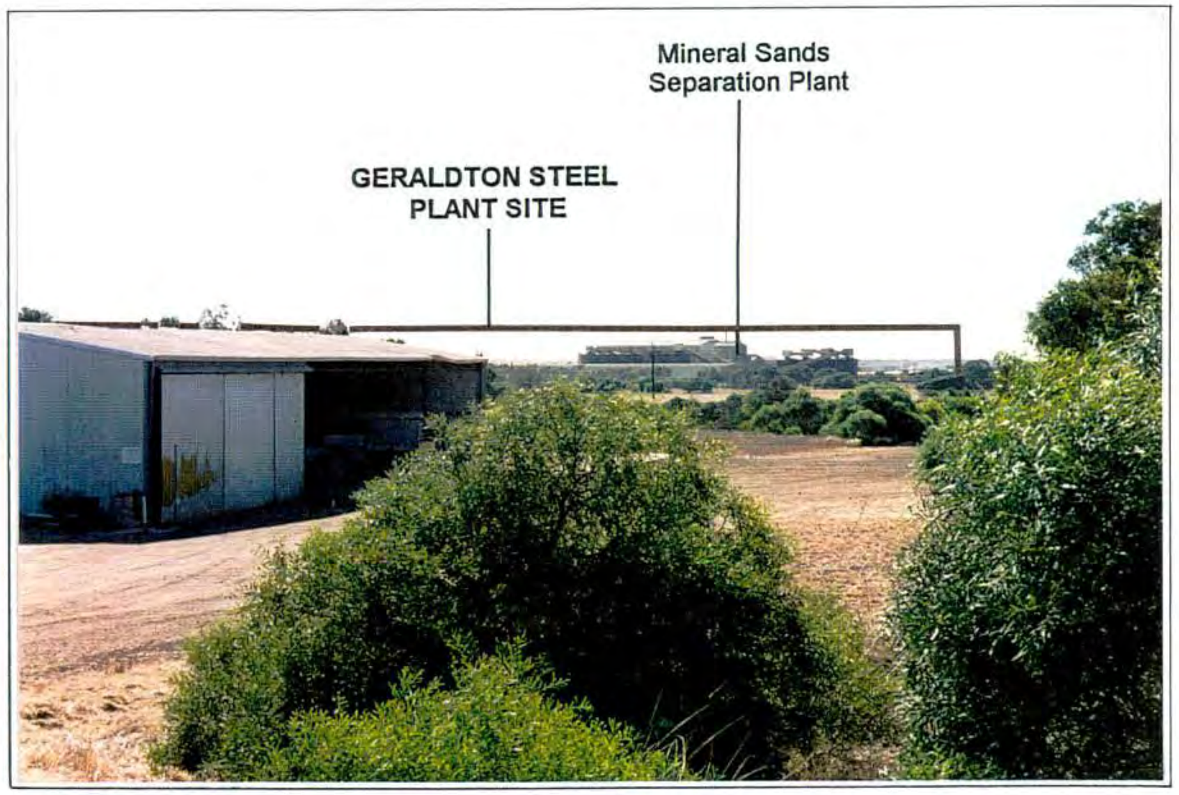


VIEW 4 - North-east from Rudds Gully Road

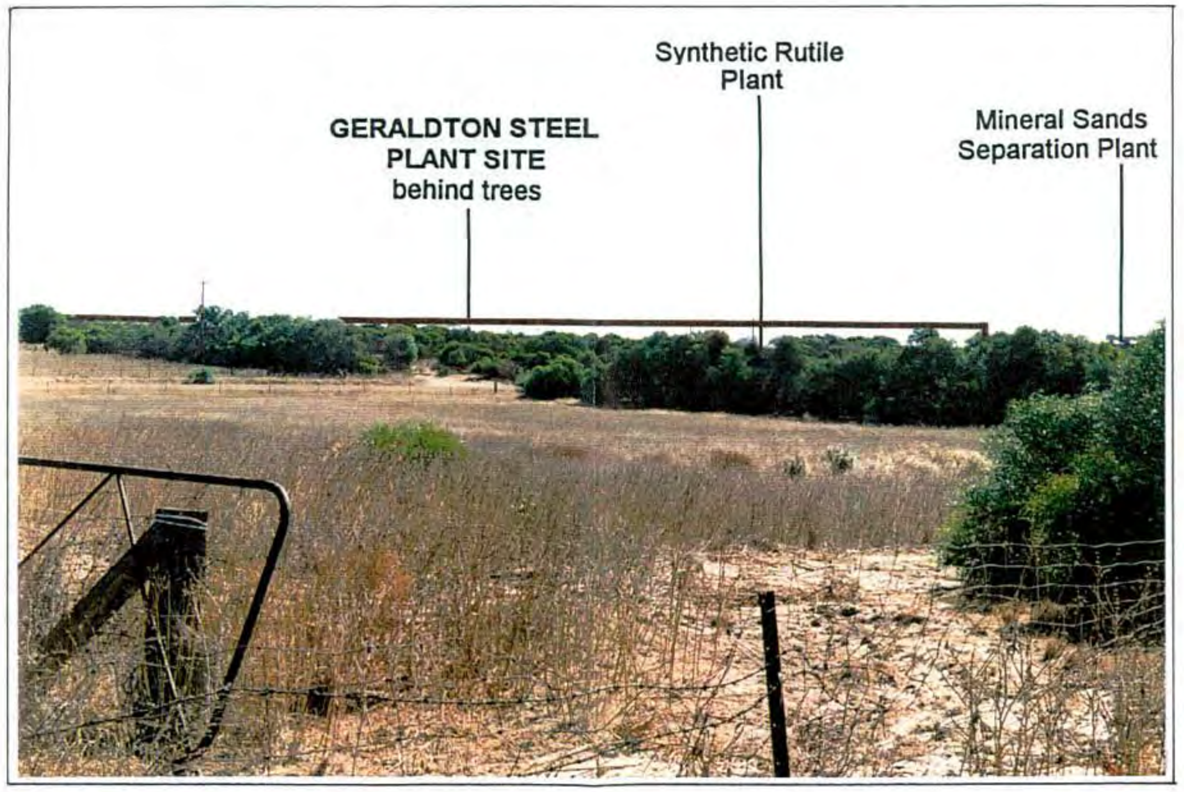
VIEWS OF THE GERALDTON STEEL PLANT SITE FROM NEARBY LOCATIONS
FIGURE 22A



VIEW 5 - North from Rudds Gully Road



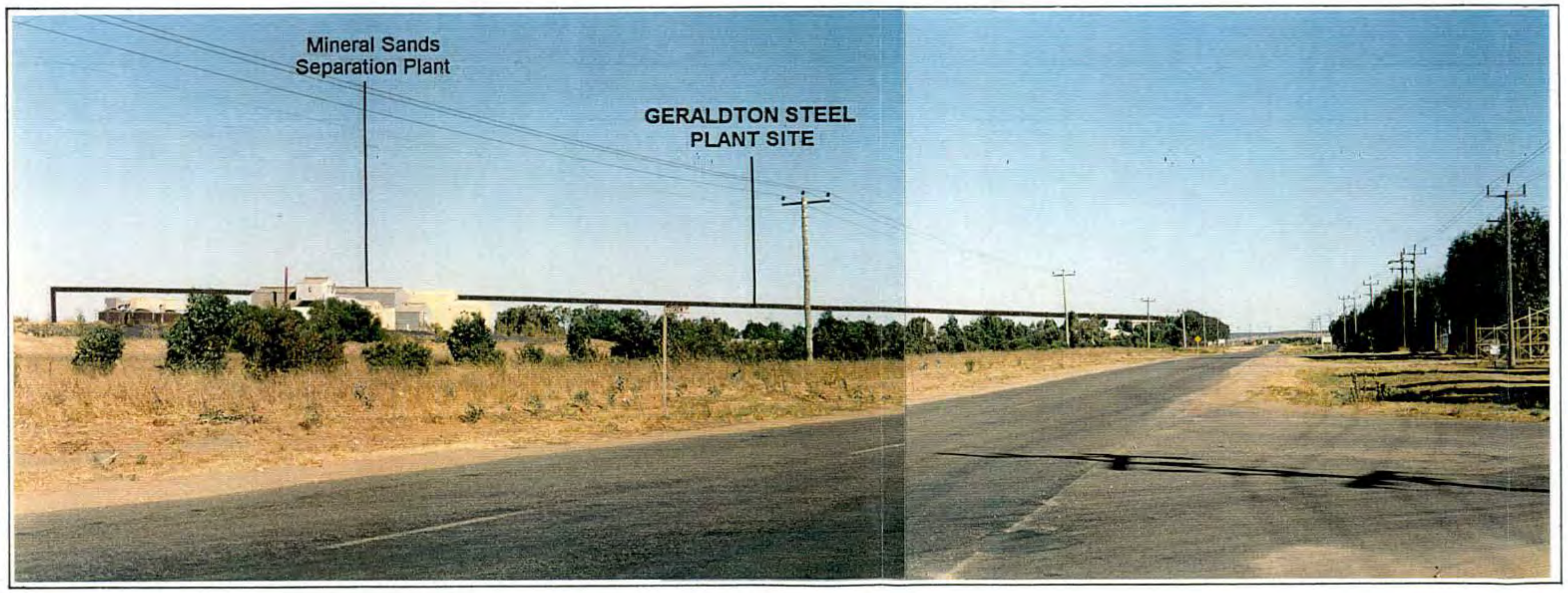
VIEW 6 - North-west from Rudds Gully Road



VIEW 7 - West from Narngulu Townsite

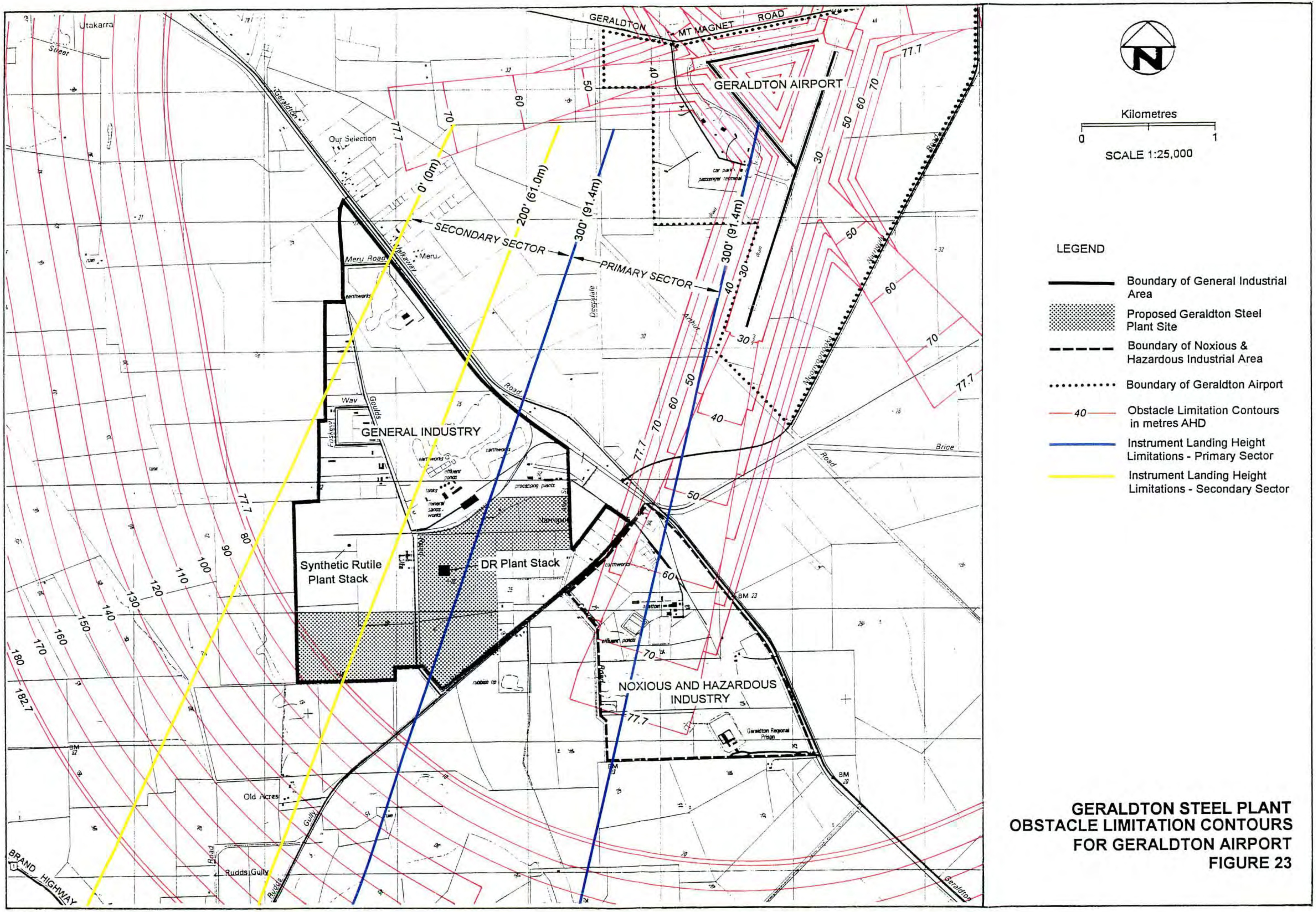
VIEWS OF THE GERALDTON STEEL PLANT SITE FROM NEARBY LOCATIONS
FIGURE 22B

VIEW 8 - South-west from Geraldton-Walkaway Road



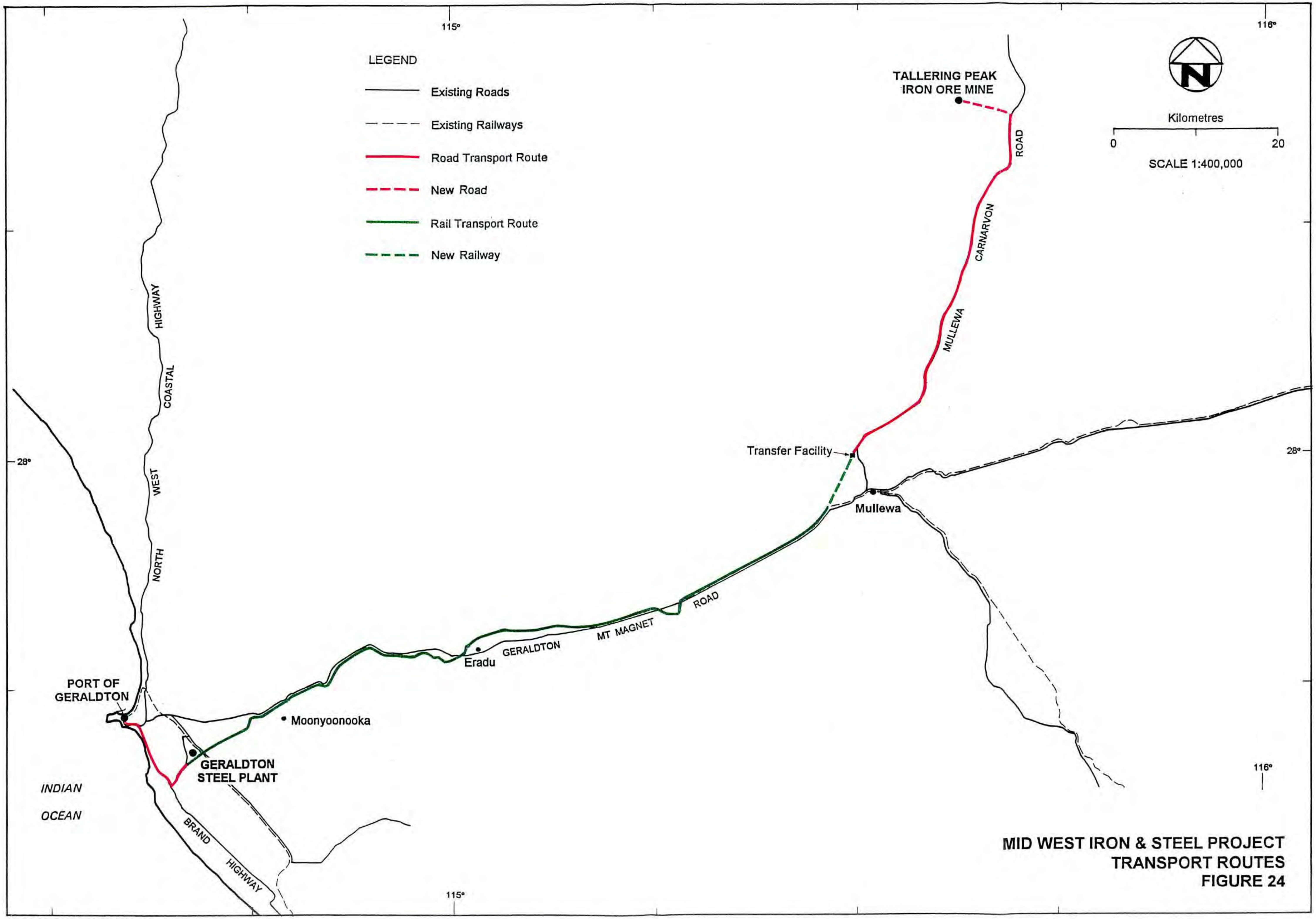
VIEW 9 - South-east from Goulds Road

VIEWS OF THE GERALDTON STEEL PLANT SITE
FROM NEARBY LOCATIONS
FIGURE 22C



GERALDTON STEEL PLANT OBSTACLE LIMITATION CONTOURS FOR GERALDTON AIRPORT FIGURE 23

ALAN TINGAY & ASSOCIATES



MID WEST IRON & STEEL PROJECT
TRANSPORT ROUTES
FIGURE 24

ALAN TINGAY & ASSOCIATES

APPENDIX 1

EPA GUIDELINES

GUIDELINES FOR THE PUBLIC ENVIRONMENTAL REVIEW ON THE MIDWEST IRON AND STEEL - STEEL MILL AND ASSOCIATED 210 MW POWER STATION AT NARNGULU, GERALDTON.

OVERVIEW

In Western Australia all environmental reviews are about protecting the environment. The fundamental requirement is for the proponent to describe what it proposes to do, to discuss the potential environmental impacts of the proposal, and then to describe how those environmental impacts are going to be managed so that the environment is protected.

If the proponent can demonstrate that the environment will be protected then the proposal will be found environmentally acceptable; if the proponent cannot show that the environment would be protected, then the Environmental Protection Authority (EPA) will recommend against the proposal.

Throughout the process it is the aim of the EPA to advise and assist the proponent to improve or modify the proposal in such a way that the environment is protected. Nonetheless, the environmental review in Western Australia is proponent driven, and it is up to the proponent to identify the potential environmental impacts and design and implement proposals which protect the environment.

For this proposal, protecting the environment means that the natural and social values associated with the surrounding environment such as the air shed, groundwater, amenity and surrounding residents are protected from the impacts of noise, dust, air emissions and odours and solid and liquid waste disposal. The issue of establishing appropriately sized buffer zones around the steel mill and its associated power station will need to be considered. Where these above values cannot be protected, proposals to mitigate the impacts are required.

GENERAL COMMENTS FOR DOCUMENT PREPARATION

The Public Environmental Review (PER) should facilitate public review of the key environmental issues. These guidelines identify issues that should be addressed within the PER. The PER is intended to be a brief document: its purpose should be explained, and the contents should be concise and accurate as well as being readily understood. Specialist information and technical description should be included where it assists in the understanding of the proposal. It is appropriate to include ancillary or lengthy information in technical appendices.

The PER should have the following objectives:

- to place this project in the context of the regional environment and the progressive development of resources in the region, including the cumulative impact of this development;
- to explain the issues and decisions which led to the choice of this project at this place at this time;
- to set out the environmental impacts that the project may have; and
- for each impact, to describe any environmental management steps the proponent believes would avoid, mitigate or ameliorate that impact.

The PER should focus on the major issues for the area and anticipate the questions that members of the public will raise. Data describing the environment should be directly related to the discussion of the potential impacts of the proposal. Both should then relate directly to the actions proposed to manage those impacts.

Where specific information has been requested by a Government Department or the Local Authority, this should be included in the document.

The PER should examine the justification for the proposal, especially in its relationship to the development on the existing site. Broad costs and benefits of the proposal at local and regional levels could also be discussed.

1. SUMMARY

The PER should contain a brief summary of:

- salient features of the proposal;
- technology considered;
- description of receiving environment if any and analysis of potential impacts and their significance;
- environmental monitoring and management programmes, safeguards and commitments; and
- conclusions.

2. INTRODUCTION

The PER should include an explanation of the following:

- identification of proponent and responsible authorities;
- background and objectives of the proposal;
- brief details of the scope and timing of the proposal;
- relevant statutory requirements and approvals; and
- scope purpose and structure of the Environmental Review.

3. NEED FOR THE PROPOSAL

The primary function of the PER is to provide the basis for the Environmental Protection Authority to provide advice to Government on protecting the environment. An additional function is to communicate clearly with the public so that EPA can obtain informed public comment. As such, environmental impact assessment is quite deliberately a public process. The PER should set out the series of decisions taken to develop this proposal at this place and time and why.

4. PROPOSED LOCATION

The location is to be described, including:

- cadastral information;
- adjacent land uses and location of any nearby residents;
- location of structures to be built on the site;
- provision of services, including drainage and transport routes for the import and export of materials; and
- existing on-site uses.

5. PROCESS DESCRIPTION

There should be a clear description of each stage of the steel making process using diagrams where appropriate. It is not necessary to discuss proprietary technology in detail. An indication of the ultimate proposed capacity of the plant should be provided. Operational times should also be outlined. Full details should also be provided about the associated natural gas fired power station.

6. GASEOUS EMISSIONS, NOISE, WASTEWATER, SOLID WASTE AND WASTE DISPOSAL

Due to the site's proximity to Geraldton and residential developments, gas emissions would need to be managed properly. Particular emphasis should be placed on the management of SO_2 and greenhouse gases such as CO_2 and CH_4, as well as, photochemical smog producing gases such as nitrogen oxides (NO_x). Similar emphasis should also be placed on the management of noise emissions emanating from the steel mill and the power station. The PER should discuss the treatment and disposal of waste gases (and dust), solids, effluent and the methods that would be employed to manage noise emissions. To this end, the PER should include:

- a description of the quantity, nature and composition of emissions including: gaseous, liquid, heat, solid, particulate and dust;
- a description of the sources, magnitude and characteristics of noise emissions from the steel mill and the associated power station and advice on how compliance with the relevant noise legislation will be achieved;
- a description of the nature of the wastes from all sources, including volume and composition;
- a description of the treatment of the wastes, if necessary, including the design basis used to determine the size of each component of the treatment process and the rationale for selection of the particular treatment process;
- a review of alternative waste disposal methods and strategies considered, leading to the rationale for the selected option;
- a description of the method of disposal of waste including the frequency, location and composition of waste (eg slag, gaseous emissions and cooling water);
- an indication of the extent to which waste will be recycled;
- an outline of any backup treatment and disposal system; and
- environmental controls for materials handling systems.

7. SITE, POTENTIAL ENVIRONMENTAL IMPACTS AND MANAGEMENT

This section should describe the overall effect on the environment from the steel making plant and associated power station. Impacts during construction and commissioning should be addressed separately from potential impacts of the plant once fully operational. Impacts should be quantified where possible, and criteria for making assessments of their significance should be demonstrated.

Given the proximity of the steel mill and power station sites to Geraldton, it is important that the proponent describes the rationale for determining the size of the buffer zones around the steel mill and the power station, as they are required. Additionally, the proponent should describe how these buffer zones would be managed. The report should also discuss the potential impacts on the nearby airport activities if very tall structures such as chimney stacks are built.

7.1 GAS EMISSIONS AND ODOURS

One of the major issues which could have an environmental impact is that of gas emissions (including dust/ particulates) and odours emanating from the steel mill and its associated power station. The likelihood of odours and a visible steam cloud being generated from the evaporative disposal of wastewater via the quenching of hot slag, should also be discussed. The PER should indicate approaches that will be adopted to ameliorate and manage the identified impacts. If waste gas is consumed by a utility other than the proponent, the proponent should explain how that will be managed so that it does not cause an environmental impact elsewhere. Refer to Appendix 1 for guidelines on air quality and air pollution modelling normally undertaken in assessing the potential impacts of gaseous emissions and odours.

7.2 TRANSPORTATION / NOISE

The issue of noise emissions arising from the transportation of materials to and from the site is considered to be very important. Specific attention would need to be given to the management of noise and how that would impact on existing residents and future planning for the area. The details and potential impacts of the transport corridor connecting the steel mill to the port of Geraldton will need to be assessed. Such considerations should also address noise attenuation under various atmospheric conditions. In addressing the traffic and noise issue, hours of operation and predicted noise levels would need to be discussed so that it was clear that both could be managed properly.

7.3 WATER SUPPLY, COOLANT WATER AND GROUNDWATER

Steel mills can consume large volumes of water for coolant purposes. The source, quality and volume of this water to be used should be given. For disposal of coolant water, it is important to describe its composition and volume. If it is intended to discharge it into the environment, a rationale should be given, as to why the receiving environment (including groundwater) will not be impacted upon by either contaminants or thermal pollution. If the water is cooled and recycled using an extensive thermal-loss ponding system, a clear description of the ponding system should be given as the site is sandy and groundwater contamination could occur via leaks and seepage. The diesel fuel storage area within the power station site which will cater for gas supply emergencies, could also be a potential source of groundwater contamination. Accordingly, details of the measures (such as bunding etc) that would be taken to prevent waste diesel fuel contaminating the groundwater beneath the site will need to be provided.

7.4 SOLID WASTE DISPOSAL

Steel mills produce solid waste (slag and dust). If the coolant water is recycled, it would have a build-up of contaminants which would probably be recovered as solid waste. It is important to describe the anticipated nature and volume of the waste and give a rationale given for the method of disposal.

7.5 SITE MANAGEMENT

The proposed site is located within the Narngulu Industrial Estate. The poor integrity of this sandy site for retaining pollutants (site leakage) and for waste disposal would need to be addressed if solid waste disposal were to take place there, or if wastewater holding ponds were to be built. To this end procedures to be adopted for management of such practices should be clearly explained as well as the management of stormwater management.

7.6 BUFFER ZONE

There are several competing land-use interests in this area, such as residential development, and the Geraldton Airport, in addition to industry. It is critical to describe the size of the buffer zone for the steel mill site and the associated power station site. In this description, it should be clear how the size of the buffer zone was chosen, and how it would be ensured that other competing land uses are not impacted upon.

8. SOCIAL ISSUES

As a result of the proximity of the proposed site to an expanding Geraldton , the following social issues would need to be addressed:

- The impact of the construction and operation workforces and attendant population on existing communities (eg the use of community facilities/services, impacts on lifestyle, community character and stability);
- The potential effects of the transport of materials should be examined. This should include an assessment of any potential conflicts with other road users as well as any associated social impacts;
- Local employment opportunities should be examined;
- Workforce accommodation during both construction and operation phases; and
- Impacts of the proposal's operational effects (eg noise, night lighting, dust, gas emissions) on residential, commercial or community uses in the vicinity of the site or transport corridor.

9. PUBLIC PARTICIPATION

A description should be provided of the public participation activities undertaken by the proponent in preparing the PER (such as discussions with government agencies, the Shire/Council, local communities, or nearby residents). This section should be cross referenced with the environmental impacts and management section which should clearly indicate how each community concern has been addressed. Where these concerns are dealt with via other departments or procedures, outside the Environmental Protection Authority's process, these can also be noted and referenced here.

10. MONITORING

Key environmental impacts such as the air and noise emissions, and cooling water and solid waste disposal (if any) will require monitoring to ensure that they meet EPA requirements. The specification of the monitoring systems should be given and responsibility for the operation of that system should be assigned.

11. CONCLUSION

ADDITIONAL INFORMATION

GUIDELINES

A copy of these guidelines should be included in the document.

REFERENCES

All references should be listed.

APPENDICES

Where detailed technical or supporting documentation is required, this should be placed in appendices.

COMMITMENTS

Where an environmental problem has the potential to occur the proponent should cover this potential problem with a commitment to rectify it. Where appropriate, the commitment should include (a) who will do the work, (b) what is the nature of the work, (c) when the work will be carried out and (d) to whose satisfaction the work will be carried out, and when appropriate (e) where the work will be carried out.

Commitments should be numbered.

GLOSSARY

A glossary should be provided in which all technical terms, and unfamiliar abbreviations and units of measurement are explained in everyday language.

HOW TO MAKE A PUBLIC SUBMISSION

The Environmental Review should include instructions to the public how it can make a submission. These instructions should be at the beginning of the document.

APPENDIX 1

Air Quality and Air Pollution Modelling Guidelines

1 The proponent is responsible for identifying and quantifying all emissions to atmosphere with a potential to have non-trivial impact on the environment (including impact on human health, nuisance, amenity, vegetation - natural and agricultural, fauna - natural and agricultural). Emissions of potential concern include SO_2, CO_2, CH_4 and NO_x, volatile organic compounds, fluorides, hydrogen sulphide, particulates, odorous gases, heavy metals and other toxic compounds, unless these are trivial (to be justified). Additionally, the formation and impact of secondary pollutants such as photochemical smog should be assessed if applicable.

2 For all primary and secondary pollutants which cannot be dismissed as being trivial, the proponent must provide predictions of the impact of various emissions on the various elements of the environment, in the form of concentrations or rates of deposition over the range of time scales (averaging periods) normally considered for each pollutant, and assess the magnitude of this impact against guidelines/goals/standards determined from local and international literature and/or field investigations of environmental sensitivity. Data from experiments or justifiable extrapolations from published literature will also be required on the susceptibility of natural vegetation and crops. In the case of each such pollutant, the assessment must account for existing concentrations caused by other sources and therefore estimate the cumulative concentration. The proponent is invited to carry out "worst case" analyses (eg simplified conservative pollution modelling techniques) in order to prove to the DEP that comprehensive modelling procedures for particular pollutants are not warranted.

3 For pollutants requiring comprehensive modelling the proponent will need to obtain at least one (preferably two) year's data on the meteorology of the area, with high data recovery and verifiable data accuracy, plus data from field experiments as prove to be necessary, in order to obtain the following data set of 10-minute averages (longer averaging periods require justification):

- wind speed;
- wind direction;
- direction standard deviation;
- air temperature;
- relative humidity or a related parameter;
- surface layer sensible heat flux, moisture flux and friction velocity determined via methods acceptable to the DEP;
- mixing height (considering morning temperature inversions, nocturnal boundary layers, thermal internal boundary layers in onshore flow, and sea breezes), estimated or measured via methods acceptable to the DEP;
- strength of capping inversions above mixed layers, estimated by methods acceptable to the DEP; and
- atmospheric stability (a derivative of parameters mentioned above) estimated by a method acceptable to the DEP.

Apart from providing a data base for conventional dispersion modelling, the data mentioned above will be essential for analysis/modelling of the following important phenomena:

(a) trapping of plumes in mixed layers of limited height or, alternatively penetration of plumes through elevated temperature inversions;
(b) vertical plume dispersion in convective conditions; and

(c) fumigation of plumes into encroaching mixed layers (onshore and offshore winds). Investigations of this phenomenon will require estimates of wind direction shear in stable layers.

The proponent is invited to demonstrate to the DEP that complicated or costly monitoring programs and/or modelling procedures for particular meteorological parameters are not warranted.

NOTES:

(i) The data set described above would be the minimum necessary for comprehensive modelling; the proponent is responsible for assessing the full range of pollution dispersion issues and designing an appropriate monitoring program.

(ii) Where items of data are not based on the results of continuous monitoring (eg. based instead on intermittent field experiments or unverified hypotheses), the uncertainty of estimates must be offset by conservatism in these estimates.

TECHNICAL APPENDICES

APPENDIX A

NOISE IMPACT STUDY
MID WEST IRON & STEEL COMPLEX
NARNGULU, WA

Herring Storer Acoustics
13 June 1995

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P.O. Box 219
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ALLAN HERRING M.I.E. AUST. M.A.A.S.
LYNTON STORER M.A.I.E.A., M.A.A.S.

NOISE IMPACT STUDY

MIDWEST IRON & STEEL COMPLEX

NARNGULU, WA

13 JUNE 1995

REF: 3106-4-95037

CONTENTS

APPENDICES

1.0 INTRODUCTION

A study has been made of the noise emission from the proposed Mid West Iron & Steel complex at Narngulu, W.A. The objective of this study is to predict noise levels at the nearest residential location and assess the impact in accordance with Regulatory criteria.

This report sets out the methods of determining the noise emissions propagation and the assessment criteria. Noise impacts are assessed in accordance with the Environmental Protection Act 1986 Regulations and where necessary recommendations are made for management and control.

Consideration has also been given to noise associated with trucking of the finished product (Coil Steel) to the Port of Geraldton as well as rail transport from the Minesite to Narngulu.

2.0 CONCLUSION

Computer modelling has shown that excessive levels of noise would be generated to residents in the vicinity of the proposed plant and Narngulu if the plant did not incorporate effective noise control measures and that under maximum propagation conditions, the impact would be severe.

However, utilising relatively standard forms of noise control in the form of silencers, building treatment and barriers, the noise level emission can be reduced to comply with the Regulatory criteria and cause minimal impact.

The controls must be engineered into the design of the plant and the maximum sound power levels set out in this study report incorporated in the design specification.

Noise associated with trucking movements along the route from the plant to the Port are within the 'acceptable' guidelines, at a distance of 20m or more from the roadway.

Noise impact from train movement associated with ore transport will be minimal as the increase in noise over existing rail traffic is very small.

3.0 ACCEPTABLE CRITERIA

Unless otherwise noted all stated noise levels are L_{10} percentile levels in dB(A).

Under the current Regulations, being the Environmental Protection Act Regulations 1986 - Regulations of the repealed Noise Abatement (Neighbourhood Annoyance) Regulations 1979, residences in the vicinity of the proposed plant can fall into categories ranging from A2 to B3. As an overview these categories assign night time levels ranging from 35 to 50 dB(A). The Department of Environmental Protection are finalising a new set of Regulations which are currently out for public review. Under these Regulations a similar allocation of assigned levels would apply, ranging from 38 to 50 dB(A).

In assigning 'acceptable' levels, the existing Regulations take into account ambient noise levels, generally stating that any introduced noise should not exceed the ambient levels by more than 5 dB(A).

To assist in this assessment, ambient noise levels were measured in the outer areas of Narngulu. The graphical presentation of the recorded levels over a one week period are shown in Appendix 1. From this data it can be seen that the minimum levels range from over 40 dB(A) to less than 30 dB(A). The L_{10} percentile values range from 30 dB(A) to over 50 dB(A), but typically the average is around 45 dB(A) and rarely drops below 40 dB(A) at night.

It should be pointed out that the L_{10} percentile level is the descriptor used for measuring intrusive noise and is the level of noise that is exceeded for 10% of the time. By way of explanation, the L_{100} value is the level exceeded for 100% of the time or the minimum, and the L_0 is the level exceeded for 0% of the time, or the maximum level.

Considering the above, the surrounding nearest residences to the industrial estate, would fall under the following categories of assigned outdoor noise levels.

These levels are set down utilizing the L_{10} values that are utilized in the proposed Regulations.

The proponent shall ensure that noise emissions do not exceed:

Narngulu Township - Residential Zoning

- *40 $dBL_{A10,1\ hour}$ slow between 2200 hours and 0700 hours on any day when measured on any noise-sensitive premises;*
- *45 $dBL_{A10,1\ hour}$ slow between 1900 hours and 2200 hours on Sundays and gazetted public holidays, when measured on any noise-sensitive premises;*
- *50 $dBL_{A10.1\ hour}$ slow between 0700 and 1900 hours on Monday to Saturday inclusive, when measured on any noise-sensitive premises; and*

Residents North of Rudds Gully Road - General Industrial Zoning

- *50 $dBL_{A10,1\ hour}$ slow between 2200 hours and 0700 hours on any day when measured on any noise-sensitive premises;*
- *55 $dBL_{A10,1\ hour}$ slow between 1900 hours and 2200 hours on Sundays and gazetted public holidays, when measured on any noise-sensitive premises;*
- *60 $dBL_{A10.1\ hour}$ slow between 0700 and 1900 hours on Monday to Saturday inclusive, when measured on any noise-sensitive premises; and*

Residents Immediately South of Rudds Gully Road - General Farming Zone

- *45 $dBL_{A10,1\ hour}$ slow between 2200 hours and 0700 hours on any day when measured on any noise-sensitive premises;*

- *50 $dBL_{A10,1\ hour}$ slow between 1900 hours and 2200 hours on Sundays and gazetted public holidays, when measured on any noise-sensitive premises;*

- *55 $dBL_{A10.1\ hour}$ slow between 0700 and 1900 hours on Monday to Saturday inclusive, when measured on any noise-sensitive premises; and*

The proponent shall ensure that noise emissions from those activities which are of concern to occupiers of noise sensitive premises do not exhibit tones, amplitude and frequency modulations, and impulsiveness of a nature which increase the intrusiveness of the noise.

Criteria for Trucks

With respect to truck movement noise, Main Roads Western Australia's policy for noise level impact criteria is as follows:

"(a) *Main Roads' design goal for new road projects is to limit traffic noise at residences to less than 68 dB(A) L_{10} (18 hour). To achieve this it may be necessary to include in the design, noise reduction features such as barriers.*

(b) In such cases where a significant increase in noise is predicted to occur (such as in an existing quiet area), Main Roads will consider inclusion of noise reduction features even through predicted levels may be less than 68 dB(A). In this instance a design guide of 63 dB(A) is to be adopted for investigating these features in this noise study."

The Department of Environmental Protection considers that lower levels than those noted above are desirable. In particular, for the night time period 2200hrs to 0600 hrs should not exceed an L_{10} (for any one hour) of 58 dB(A).

It is considered that the L_{10} 18hr value of 63 dB(A) is appropriate as the design guide for roads from the plant to Brand Highway, however, the levels should be closer to 58 dB(A) for the night time period. The study uses the L_{10} 1hr values throughout, which effectively is a lower value than the L_{10} 18hr.

Criteria for Trains

The presently recognised criteria (of the Department of Environmental Protection) for residential acceptance of train noise is:

24 hr L_{eq}	$[LA_{eq}(_{24\ hour})]$	55 dB(A)
Maximum Level	$[LA_{max}]$	80 dB(A)

These criteria are based on the State Pollution Control Council of NSW Environmental Noise Control Manual 1988, Part J "Rail Traffic Noise" criteria and are guidelines for planning levels.

The maximum acceptable levels are set down as 5 dB(A) above these values.

The Department of Environmental Protection has recently expressed concern that the 80 dB(A) criteria is too high and where practicable should be as low as 65 dB(A).

4.0 METHOD

Noise level propagation was modelled using the computer program E.N.M. (Environmental Noise Model). This program was developed by R.T.A. Software Pty Ltd for the N.S.W. State Pollution Control Commission and utilises well recognised algorithms for calculations. This program is endorsed by the Australian Environmental Council and the Department of Environmental Protection in W.A.

Input for this program in the way of equipment and general plant sound power levels was determined from overall sound pressure levels or equipment performance data provided by Signet Engineering and some file data. The frequency make-up of the sound data was determined from file information or assumed to be broad band.

Topographical information was digitised and the computer model run for various atmospheric conditions and plant set up. Initially propagation was predicted for a plant with no noise attenuating features. Standard and practically achievable attenuation methods for equipment and buildings were then considered and applied to the computer model.

Noise level monitoring was carried out at the north eastern edge of the proposed site, approximately 500 metres from the township of Narngulu. An automatic noise data logger was used recording percentile levels from L_0 to L_{100} and Leq values every hour for approximately 7 days.

Calculations of road traffic noise were based on Department of Road Transport - Welsh Method. The volume of truck movements is taken to be 200 vehicles/day. The overall traffic volume is taken to be 250 vehicles day along the route from the plant to Brand Highway.

The source of train noise is based on information from the earlier mentioned report of the Geraldton Deep Water Port where monitoring of existing train noise was undertaken.

5.0 RESULTS

The results of the noise level monitoring are given in Appendix 1 and a summary of the L_{10} values in dB(A) using statistical accumulation theory for the **night time** periods 2400 hours to 0700 hours is given below.

DATE		TIME	L_{10}	L_{90}	Leq
TUESDAY	21.02.95	0000 - 0700 HRS	44.5	30.7	40.6
WEDNESDAY	22.02.95	"	42.1	31.2	39.4
THURSDAY	23.02.95	'	40.5	31.4	37.7
FRIDAY	24.02.95	"	47.3	34.4	43.6
SATURDAY	25.02.95	"	47.1	36.0	43.6
SUNDAY	26.02.95	"	43.9	33.9	41.0
MONDAY	27.02.95	"	38.4	28.1	37.9
TUESDAY	28.02.95	"	44.5	30.7	40.6
WEDNESDAY	01.03.95	"	41.7	29.0	39.0

Results of the computer noise level propagation are shown in Appendix 2 in the form of noise level contours for various scenarios of plant configuration and wind conditions. The sound power levels used in the modelling are given in Appendix 3.

Ranking of noise sources for various scenarios (to Narngulu Townsite) is given in Appendix 4. Wind data is given in Appendix 5.

Based on 20 vehicles per hour at an average speed of 90 kph and a heavy vehicle content of 80%, the noise level (L_{10}1hr) at 10 metres is 63 dB(A). For a distance of 20m the level is 58 dB(A).

Measured noise levels of train movement at Geraldton gave the following results for 16 movements per day at a distance of 15 metres:

$LA_{eq\ 24\ hour}$	55 dB(A)
LA_{max}	88 dB(A)

The existing rail traffic from Mullewa to Narngulu is 4 movements per day and the increase in rail due to ore transport will be 4 movements per day.

Based on the Geraldton levels the noise levels associated with the Mullewa/Narngulu line are as follows at 15 metres:

TRAIN MOVEMENT	LAeq 24 hour	LA max
4	49 dB(A)	88 dB(A)
8	52 dB(A)	88 dB(A)

Obviously the maximum levels will not change, no matter how many movements per day occur.

6.0 DISCUSSION

For a "standard" unattenuated plant, in terms of the Narngulu residents, noise levels under calm conditions would be in excess of 50 dB(A). The noise would likely be tonal particularly due to various fans within the plant having high level stack discharges. With an attenuated plant, corresponding noise levels would be 35 dB(A) and non tonal. Noise from scrap handling may be impulsive but would be intermittent.

Under wind conditions of 2m/s from the west, noise levels of the attenuated plant to Narngulu would be up to 44 dB(A). This is considered to be maximum propagation conditions to Narngulu. Wind roses for this area are shown in Appendix 5 and it can be seen light winds from the west are not a common occurrence, i.e. less than 5% of the time. Nevertheless, under these conditions the noise levels are excessive for the night time assigned criteria.

One of the major noise source from the attenuated plant under the above conditions is the scrap metal handling facilities. This source alone is contributing 37 dB(A) to the overall levels (refer Appendix 4). It is possible the noise from tipping of scrap could be impulsive in nature which would attract penalties due to the annoying characteristics. Most scrap would be prepared off site and generally bundled. However, should the noise prove impulsive then there is provision to roof the holding bin and add acoustic absorptive lining which would minimise any breakout.

The most practical solution therefore to comply with the 'acceptable' criteria under the worst case propagation conditions is to limit outside scrap handling to a day time activity. It should be noted that the outside scrap handling is a back up facility only and that the main storage and handling is within the building.

Without the scrap handling noises, worst case propagation to Narngulu would be up to 43 dB(A). The conditions for this to occur however, are rare. Conditions of southerly breezes at a speed less than 3m/s occur less than 5% of the time.

The other major source is the main Ball Mill, contributing 38 dB(A) to Narngulu under maximum propagation conditions. Should this source ultimately prove to be excessive, there is provision for semi enclosure which would reduce levels by at least 5 dB(A). With this control, noise levels to Narngulu would be 39 dB(A) under maximum propagation conditions.

Within the General Industrial Zone and the General Farming Zone noise levels at night would be up to 50 dB(A) and 43 dB(A) respectively, under maximum propagation conditions. These levels are within the criteria set down for these zones.

Techniques employed in modelling the attenuated plant noise levels include:

1. Discharge silencers to:

   Pelletising Plant Waste Gas Fan, Feed End and Discharge End De-dust Fans
   D.R. Plant Heater Combustion Air Fan and Reformer Fan
   Melt Shop - De-dust Fan

2. Four metre high solid wall around the outside scrap handling facility. This operation would still be limited to day time only.

3. Some earth bunds along the eastern side of the main complex and southern side of the Pelletising plant and northern and southern side of the Mills.

4. General building attenuation including internal absorptive lining particularly for the Melt Shop Descaling and Refractory Demolition operations.

5. The Gas Turbines have been based on the standard proprietary acoustic packages supplied and installed by the Manufacturer.

Provision is also made for roofing the scrap handling bunker and semi-enclosing the Ball Mill.

The actual attenuation applied is not so important in itself except to prove that these are reasonable and relatively standard noise control techniques. Empirical formulae and assumptions have been made in determining the plant noise level emissions. The final design is likely to vary the model considerably, particularly with respect to building layouts as these can provide screening or barrier effects to some noise sources.

The exercise has been to show that noise emissions can be reasonably limited to minimise any impact to the surrounding areas.

The sound power levels quoted in this report would form the basis for design of the plant with respect to noise emission. As a guide, no source should exceed a sound pressure level of 85 dB(A) at 1 metre which would also ensure compliance with the Western Australian Occupational Health Safety and Welfare Regulations.

Truck noise has been shown to be within the acceptable guidelines and therefore would cause minimal impact. Reference is made to the study (Ref: HSA 225-93103) for the Deep Water Port at Geraldton. This report highlights a problem of traffic noise along Portway Road within the townsite of Geraldton. Truck noise associated with the Steel Plant would not add to this problem as comparatively there are over 20 trucks per hour from the plant against some 65 other trucks per hour as determined in the above study.

Noise levels associated with the increased rail traffic, at a distance of 15 metres from the line, are within the acceptable criteria for the daily LA_{eq} values. At such distances however, the maximum level may exceed the 80 dB(A) criteria. However, there will be no change to the existing maximum levels due to an increase of 4 to 8 trains per day, therefore the impact will be minimal.

for HERRING STORER ACOUSTICS

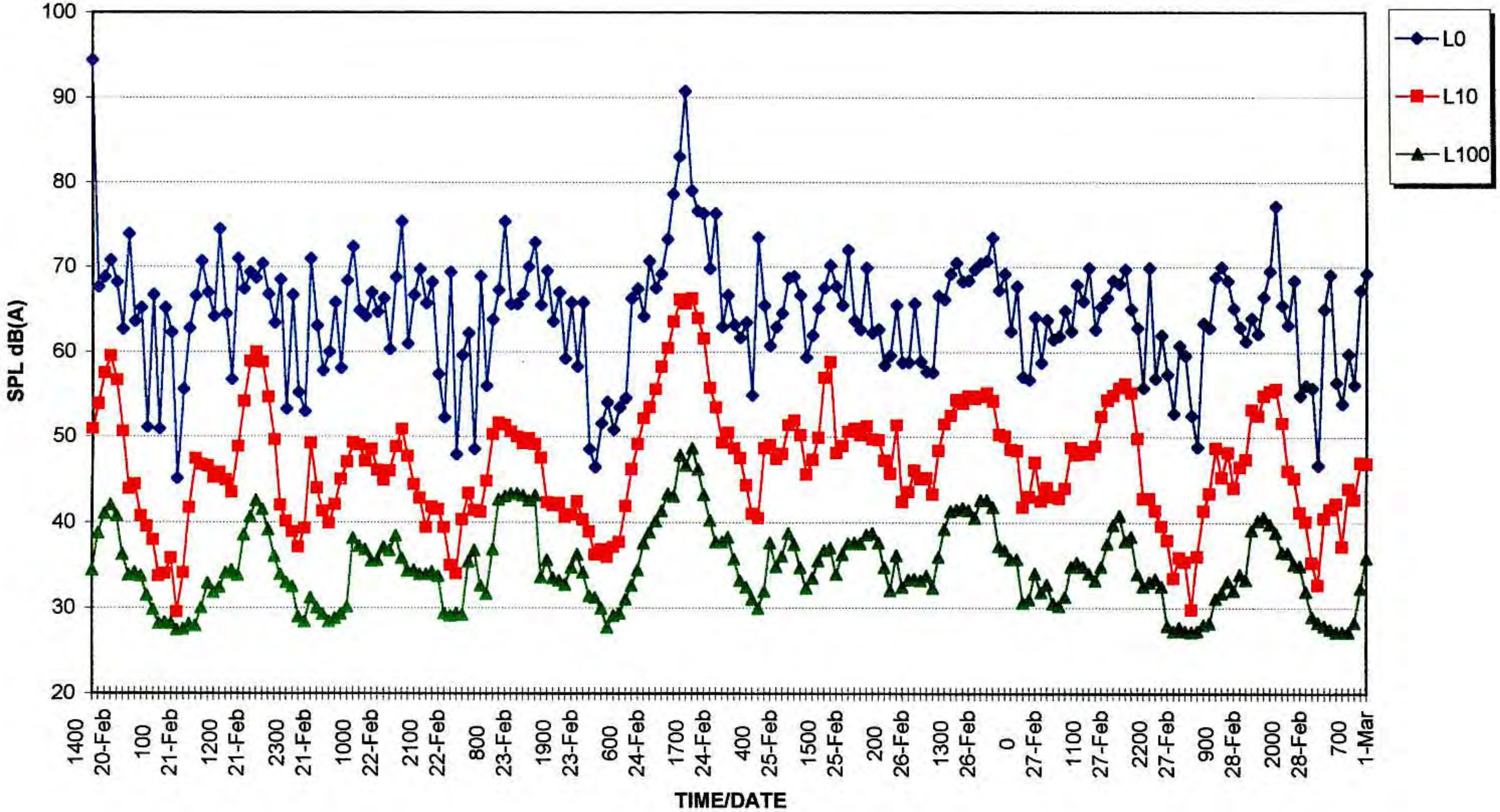
Lynton Storer
Noise Officer Approval No.9404484

14 June 1995

APPENDIX 1

NOISE MONITORING DATA

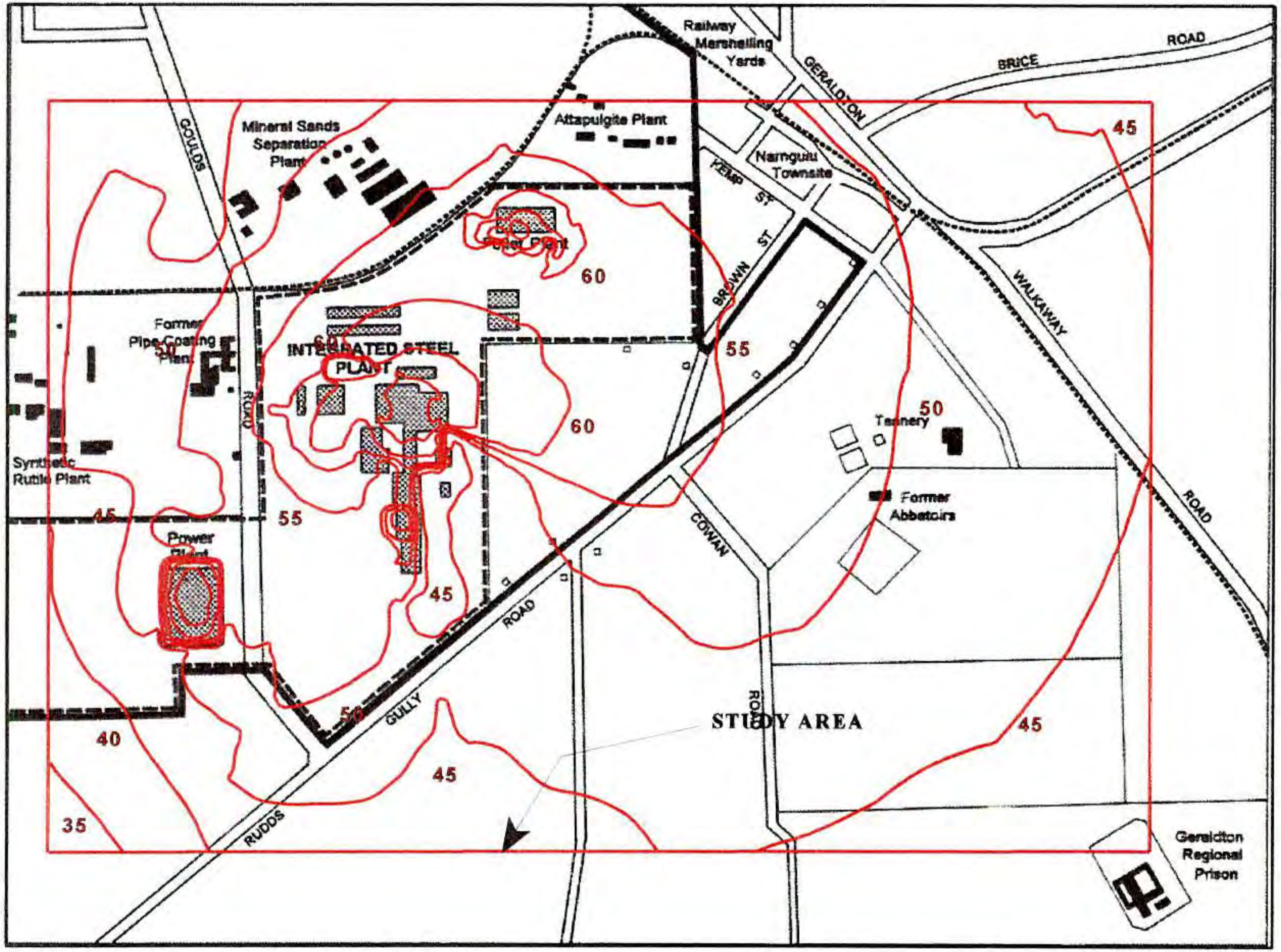
MIDWEST IRON AND STEEL



SHEET 95037/01

APPENDIX 2

PREDICTED NOISE EMISSION CONTOURS &
GENERAL LAYOUT DRAWINGS - DRGS 95037/01 TO 95037/04

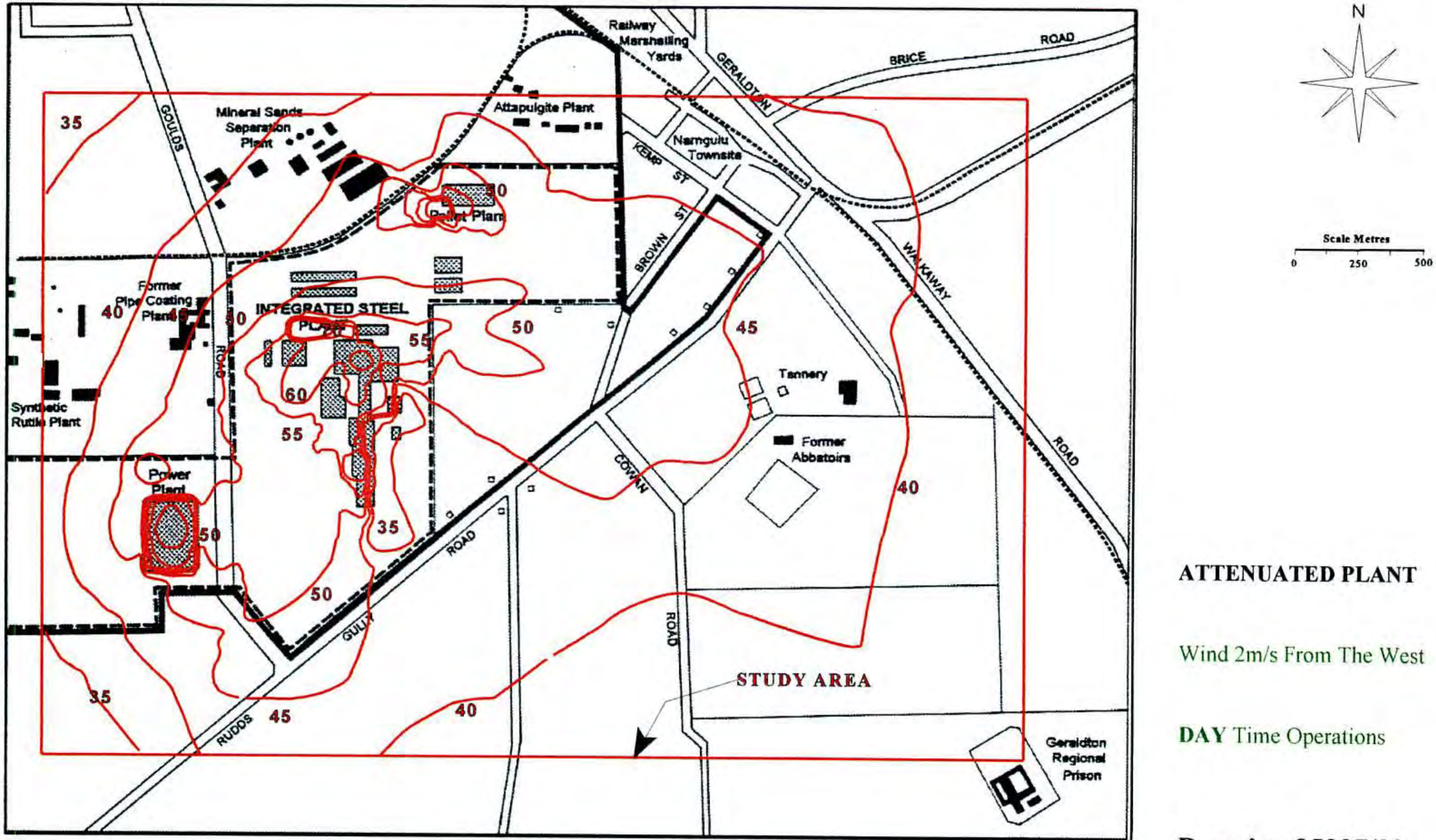


UNATTENUATED PLANT

Wind 2m/s From The West

DAY Time Operations

Drawing 95037/01

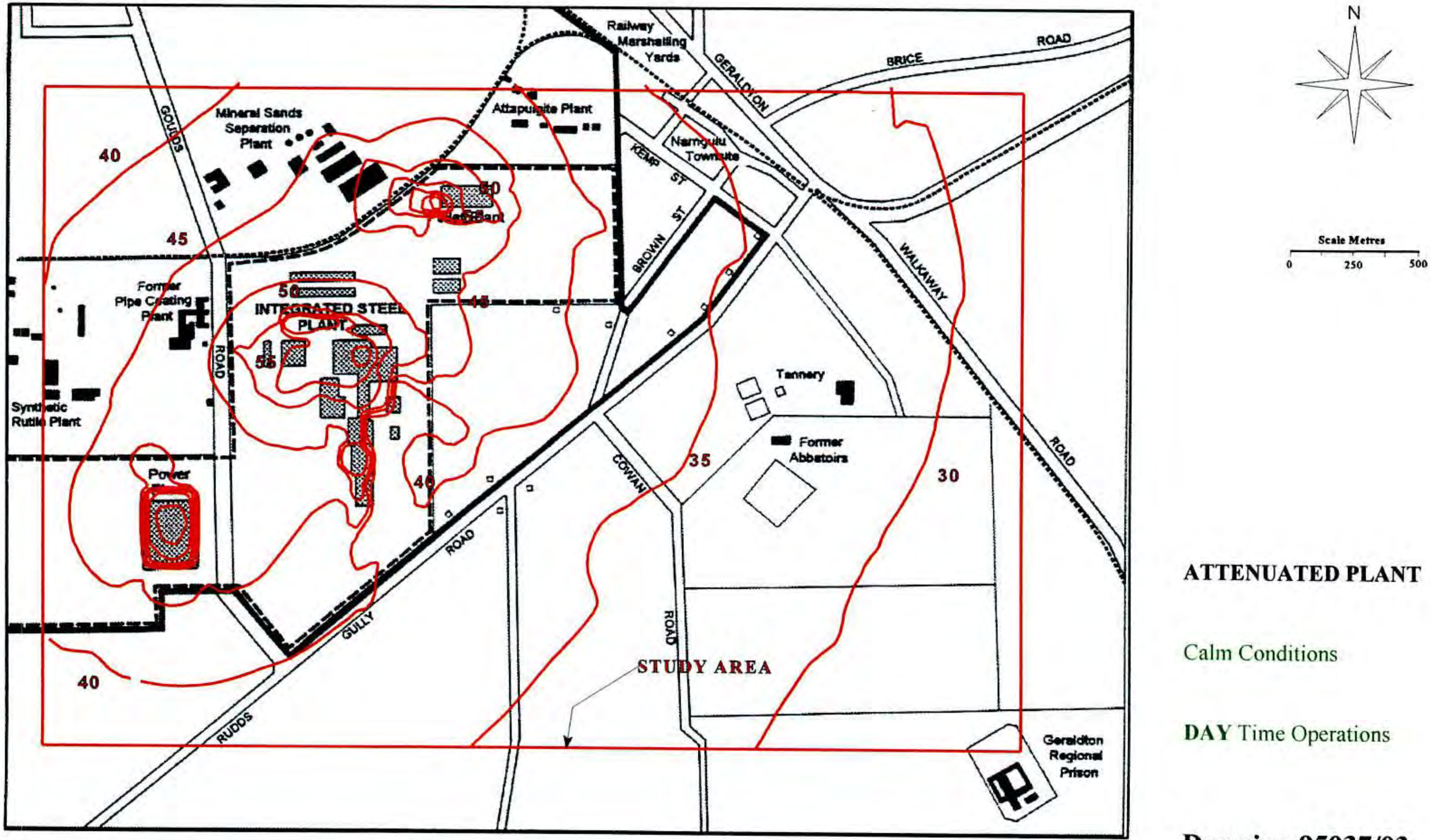


ATTENUATED PLANT

Wind 2m/s From The West

DAY Time Operations

Drawing 95037/02

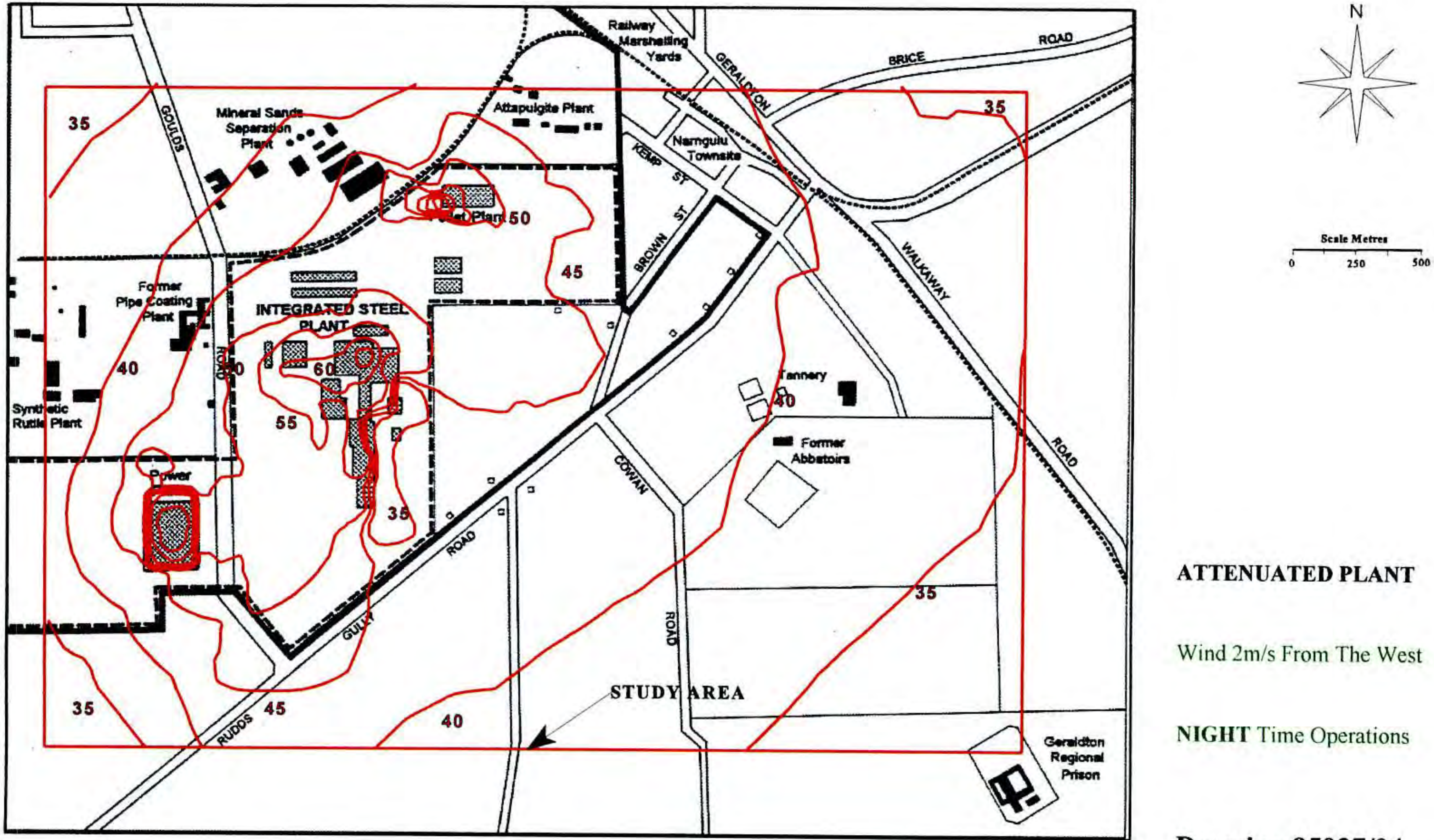


ATTENUATED PLANT

Calm Conditions

DAY Time Operations

Drawing 95037/03

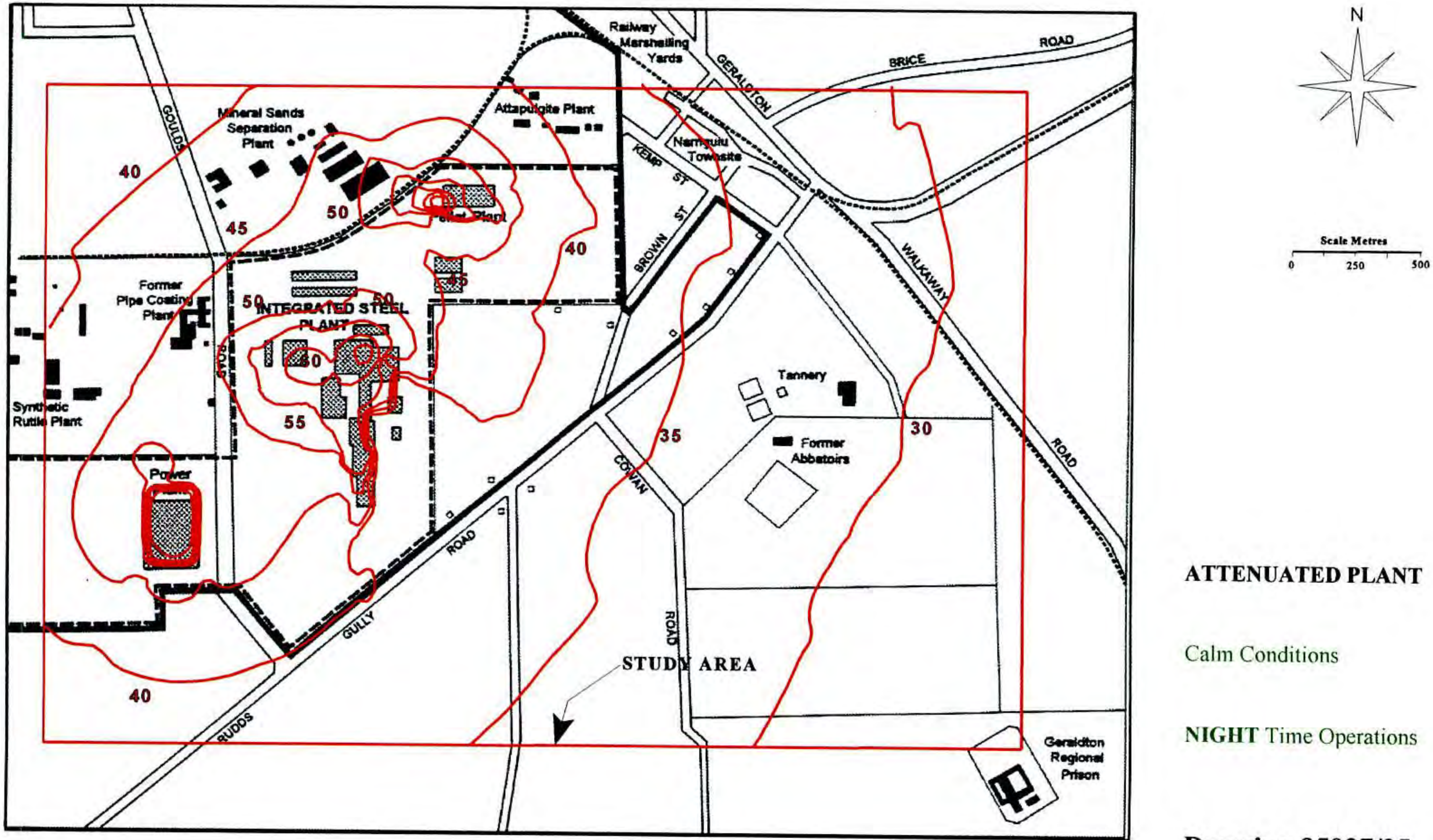


ATTENUATED PLANT

Wind 2m/s From The West

NIGHT Time Operations

Drawing 95037/04

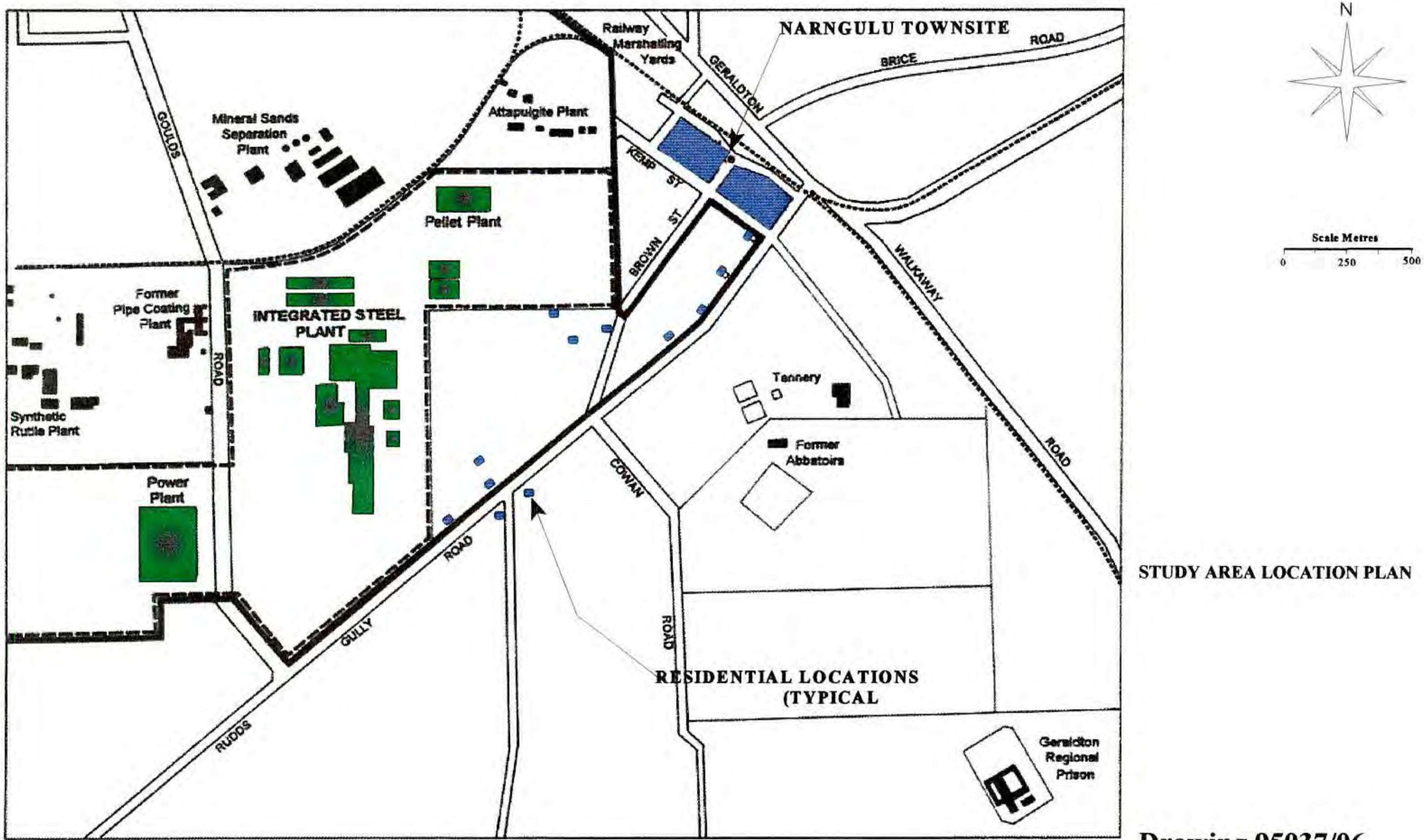


ATTENUATED PLANT

Calm Conditions

NIGHT Time Operations

Drawing 95037/05



STUDY AREA LOCATION PLAN

Drawing 95037/06

APPENDIX 3

SOUND POWER LEVELS

APPENDIX 3 Ref: 3106-3SP

MIDWEST IRON & STEEL
SOUND POWER LEVELS - STANDARD PLANT

NO		FREQUENCY (HERTZ)								
		31.5	63	125	250	500	1K	2K	4K	8K
1	WASTE GAS FAN DISCHARGE	116	113	112	113	108	103	98	93	93
3	FEED END DISCHARGE	108	105	104	105	100	95	90	85	85
4	DISCHARGE END DE-DUST	112	109	108	109	104	99	94	89	89
6	MILL	115	119	115	111	108	104	101	95	87
7	HEATER FLUE DISCHARGE	108	108	107	108	103	98	93	88	88
8	HEATER COMBUSTION AIR FAN	108	108	107	108	103	98	93	88	88
12	REFORMER	111	111	110	111	106	101	96	91	91
13	COOLING TOWER	96	96	95	94	91	87	86	79	79
14	DE DUST STACK	123	123	122	123	118	113	108	103	103
15	DE DUST FAN	103	103	102	103	98	93	88	83	83
17	FURNACE & RERACTORY DEMOLITION *	106	103	98	96	96	93	87	72	57
18	DE-SCALING *	117	115	110	104	98	92	86	80	78
19	COOLING TOWER	99	99	98	97	94	90	89	82	82
20	SCRAP STOCKPILE	111	111	111	111	111	111	111	111	111
21	TURBINE INTAKE	116	109	102	96	93	90	87	89	87
22	TURBINE ENCLOSURE	120	115	112	105	104	99	99	97	92
23	TURBINE EXHAUST	132	129	125	115	111	105	98	91	82
24	TURBINE FIN FAN	116	113	108	103	102	99	96	94	91

* SOUND POWER LEVEL OF BUILDING SURFACE

MIDWEST IRON AND STEEL
SOUND POWER LEVELS - ATTENUATED PLANT

NO		FREQUENCY (HERTZ)								
		31.5	63	125	250	500	1K	2K	4K	8K
1	WASTE GAS FAN DISCHARGE	116	111	100	91	86	85	83	81	88
3	FEED END DISCHARGE	108	105	104	95	90	89	87	84	85
4	DISCHARGE END DE-DUST	112	109	99	90	85	84	82	80	84
6	MILL	115	119	15	90	85	84	82	80	84
7	HEATER FLUE DISCHARGE	108	108	107	108	103	98	93	88	88
8	HEATER COMBUSTION AIR FAN	114	110	104	98	92	87	86	86	88
12	REFORMER	111	111	105	103	97	91	86	83	86
13	COOLING TOWER	96	96	95	94	91	87	86	79	79
14	DE DUST STACK	123	121	110	101	96	95	93	91	98
15	DE DUST FAN	103	103	102	103	98	93	88	83	83
17	FURNACE & RERACTORY DEMOLITION *	106	103	98	97	95	91	83	68	56
18	DE-SCALING *	117	115	110	104	98	92	86	80	78
19	COOLING TOWER	99	99	98	97	94	90	89	82	82
20	SCRAP STOCKPILE	111	111	111	111	111	111	111	111	111
21	TURBINE INTAKE	116	109	102	96	93	90	87	89	87
22	TURBINE ENCLOSURE	120	115	112	105	104	99	99	97	92
23	TURBINE EXHAUST	132	129	125	115	111	105	98	91	82
24	TURBINE FIN FAN	116	113	108	103	102	99	96	94	91

* SOUND POWER LEVEL OF BUILDING SURFACE

APPENDIX 4

PREDICTED SOURCE SOUND LEVEL RANKING

APPENDIX 4 Ref: 3106-3-4AP

MIDWEST IRON & STEEL
SOURCE RANKING As predicted to Narngulu Townsite

ATTENUATED PLANT - DOWN WIND PROPAGATION 2m/s - NIGHT TIME

NO	DESCRIPTION	SOUND PRESSURE LEVEL
6	MILL	25.1
23	TURBINE EXHAUST	37.2
7	HEATER FLUE DISCHARGE	31.4
14	DE DUST STACK	30.3
16	BOOSTER FAN	16.3
15	DE DUST FAN	16.1
3	FEED END DE DUST	31.4
18	DESCALING	29.3
4	DISCHARGE END DE DUST	27.7
1	WASTE GAS FAN DISCHARGE	27.6
12	REFORMER	26.2
17	FURNACE & REFRACTORY DEMOLITION	25.7
22	TURBINE ENCLOSURE	27.5
8	HEATER COMBUSTION AIR FAN	22.5
24	TURBINE FAN COOLER	26.1
13	COOLING TOWER	20.2
21	TURBINE INTAKE	17.5
19	COOLING TOWER	8.7
	TOTAL	**42.7 dB(A)**

APPENDIX 4 Ref: 3106-3-4UP

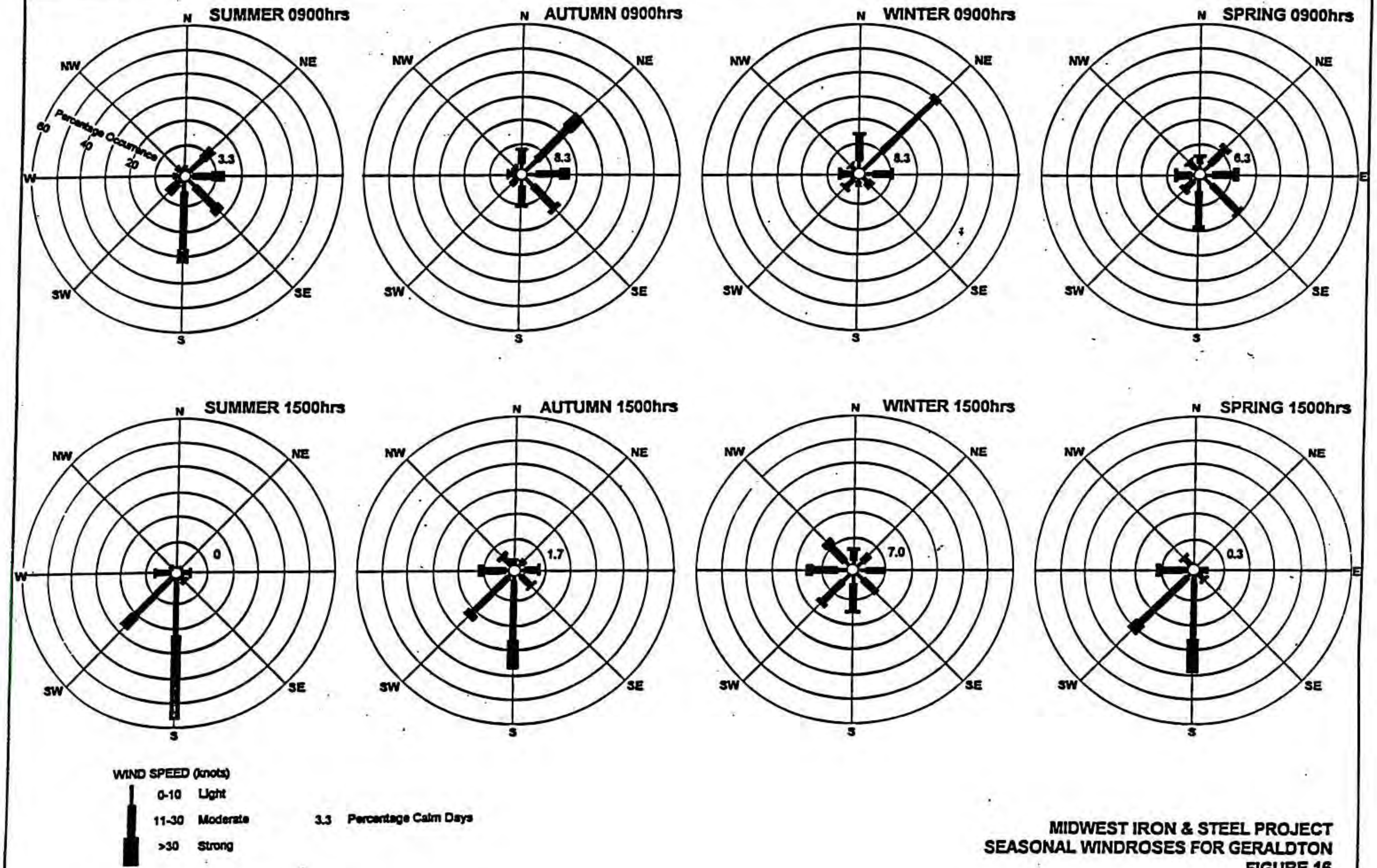
MIDWEST IRON & STEEL
SOURCE RANKING As predicted to Narngulu Townsite

UNATTENUATED PLANT - CALM CONDITIONS

NO	DESCRIPTION	SOUND PRESSURE LEVEL
14	DE DUST STACK	49.4
1	WASTE GAS FAN DISCHARGE	44.3
4	DISCHARGE END DE DUST	41.7
6	MILL	18.2
3	FEED END DE DUST	32.5
20	SCRAP STOCKPILE	27.5
12	REFORMER	30.4
23	TURBINE EXHAUST	22.7
8	HEATER COMBUSTION AIR FAN	19.4
7	HEATER FLUE DICHARGE	27.8
16	BOOSTER FAN	13.1
15	DE DUST FAN	12.9
18	DESCALING	32.1
17	FURNACE & REFRACTORY DEMOLITION	14.4
22	TURBINE ENCLOSURE	10.5
24	TURBINE FAN COOLER	8.0
13	COOLING TOWER	9.5
21	TURBINE INTAKE	0
19	COOLING TOWER	1.0
	TOTAL	**52.4 dB(A)**

APPENDIX 5

WIND ROSES



MIDWEST IRON & STEEL PROJECT
SEASONAL WINDROSES FOR GERALDTON
FIGURE 16

DATA SOURCE: BUREAU OF METEOROLOGY, GERALDTON AIRPORT, 1941-1992

ALAN TINGAY & ASSOCIATES

APPENDIX B

AIR QUALITY ASSESSMENT
PROPOSED MID WEST IRON & STEEL COMPLEX
AT NARNGULU

WNI Science & Engineering
28 June 1995

Air Quality Assessment

Proposed Mid West Iron and Steel Complex at Narngulu

Prepared for

Alan Tingay and Associates

Version	Description of Issue	Prepared by	Reviewed by	Approved by
A	Draft	R O Pitts	M McCormack	R O Pitts
0	Final	R O Pitts	S J Lang	R O Pitts
		Owen Pitts		Owen Pitts

WNI Science & Engineering
28 June 1995
Job No. 1745
Report No. R739
Copy No. 3

WNI science & engineering
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28 June 1995

Alan Tingay and Associates
35 Labouchere Road
SOUTH PERTH WA 6151

Attention: Mr Alan Tingay

Dear Sir

AIR QUALITY ASSESSMENT
PROPOSED MID WEST IRON AND STEEL MILL COMPLEX AT NARNGULU

We enclose herewith three copies of our final report R739, (2 bound copies and 1 unbound copy) assessing the air quality impact of a proposed steel complex at Narngulu, southeast of Geraldton.

The report commences with an introduction. Chapter 2 details meteorological data available and the methods used to construct an air quality data base. Chapter 3 describes the air quality models used with chapter 4 detailing the plant emissions and chapter 5 the DEP standards that apply. Results of sensitivity modelling for the onshore lapse rate are given in chapter 6 with results from the existing sources and cumulative impacts with the proposed steel complex given in chapter 7. Chapter 8 addresses the issue of early morning fumigation, whilst chapter 9 presents modelling to determine the impact of the heavier than release of CO_2 with Chapter 10 summarising the conclusions.

It is concluded that the proposed steel complex with the existing sources will easily meet the likely ambient air quality standards and limits applicable at Narngulu.

Should you have any queries regarding this report or require additional information, please do not hesitate to contact us.

Yours faithfully
WNI SCIENCE & ENGINEERING

R O Pitts

ROP:RMR:1745:95222

LIMITATIONS OF REPORT

This report was prepared for the use of Alan Tingay and Associates in accordance with generally accepted consulting practice. No other warranty, expressed or implied, is made as to the accuracy of the data and professional advices included in this report. This report has not been prepared for use by parties other than the client, the owner and their respective consulting advisors. It may not contain sufficient information for purposes of other parties or for other users.

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1 INTRODUCTION

1.1 Background

Kingstream Resources NL (Kingstream) is investigating the feasibility of an iron and steel complex at Narngulu, approximately 9 km to the south east of Geraldton (figure 1.1). Kingstream have appointed Alan Tingay and Associates to undertake the preparation of the Environmental Impact Assessment, set at a Public Environmental Review. As part of the study they invited WNI Science and Engineering (WNI) to submit a proposal for modelling the air borne emissions to determine the acceptability of the proposal.

1.2 Scope of Work

As the proposed facility consists of a 210 MW power station as well as the pelletising plant and steel complex, there is the potential to generate significant quantities of oxides of Nitrogen (NO_x). As such, WNI's proposal to undertake a comprehensive modelling approach utilising a yearly data base as well as the Department of Environmental Protection's (DEP) coastal fumigation model DISPMOD was accepted as the scope of work. In particular, the modelling will be conducted for the proposed plant in isolation as well as in combination with the existing industry to determine if the steel complex meets the relevant environmental criteria.

1.2.1 Air Quality Data Base

It was proposed that air quality measurements currently being collected by RGC, at their Narngulu Synthetic Rutile Plant be utilised to construct a yearly data base suitable for DISPMOD. Morning radiosonde traces collected at Geraldton airport by the Bureau of Meteorology would also be purchased and access to RGC's data sought. Using this data, the DEP soil heat flux model SOIL and well mixed layer model WML, will be used to estimate the heat fluxes and mixing depth necessary for DISPMOD.

1.2.2 Model Runs

Using DISPMOD, the Western Australian DEP air pollution model, concentration contours of the maximum hourly, 9th highest hourly, maximum 24 hour concentration and annual average concentration will be predicted. These will be produced for the pollutants released from the proposed plant (NO_2, SO_2 and particulate) in isolation and in conjunction with the existing industries at Narngulu. Additionally, model sensitivity runs will be performed to determine the sensitivity of the concentrations to the onshore lapse rate, with the most conservative estimate used in all following runs.

For the CO_2 dispersal from the CO_2 removal stack, AUSTOX an emergency release model developed by Monash University will be used. This will be performed for a range of artificial meteorological data to determine the worst case ground level concentrations.

1.2.3 Reporting

Collate all the above work into a report, detailing the data used, presenting stability wind roses, wind roses, concentration contours, modelling techniques and summarising the findings.

2 AIR QUALITY DATA

2.1 Availability

Meteorological data suitable for air quality modelling have been specifically collected in the Geraldton region at Oakajee by the Geraldton Midwest Development Authority from 8 June 1990 to 14 March 1994 and at Narngulu by RGC Mineral Sands from 15 March 1994 until the present.

These data consists of wind speed, direction, sigma theta and the maximum 2 second gust measured at 10 m above ground level (agl) and air temperature, relative humidity, differential temperature between 10 and 1.5 m, short wave and net radiation and rainfall. The data were logged as 10 minute averages or totals. For all instruments the sensors were chosen to meet the Australian Standards, such as AS2923 for air quality wind sensors.

Other available meteorological data within the region consists of:

(a) wind speed and direction measurements collected by SECWA at the Geraldton airport, Mumbida, Alanooka Springs, Buller River and Greenough for periods of 1 to 3 years;

(b) measurements undertaken by the Bureau of Meteorology at Geraldton Airport consisting of surface and upper air measurements; and

(c) wind speed, gust, direction, air temperature, relative humidity, barometric pressure and rain at the Geraldton Port Authority since November 1991.

For the development of an air quality data base for the Narngulu site, the onsite data have been chosen as being the most representative and containing all the required data of suitable quality. At present, only 12.5 months of data have been collected which includes a 2 month gap from 17 May to 15 July 1994. Therefore, for this period of missing data, data from the air quality data base developed for Oakajee, north of Geraldton were used (Steedman Science & Engineering, 1993). It is acknowledged this may introduce a slight error as the winds at Oakajee are stronger in sea breezes and onshore flows. However, for this period of the year any sea breezes will be weak and the winds should be controlled by synoptic forces, which usually vary little over the region.

2.2 Data

Annual and seasonal wind roses for the site are presented in figure 2.1. These show that the predominant winds at the site are southerlies which occur mostly in the summer. These winds are due to the seasonal south-southwesterly to southerly sea breezes which occur in the region.

2.3 Air Quality Parameters

Air quality parameters such as heat fluxes, Monin Obukhov lengths and friction velocities were derived using the WA DEP pre-processor model to DISPMOD, SOIL, and also the profile method as described by Van Ulden and Holtslag (1985). The heat budget model SOIL has been described in detail in Rayner (1987) and simulates the soil surface temperature and soil moisture to provide estimates of turbulent fluxes of heat, moisture and momentum. The model requires surface meteorological measurements comprising wind speed and direction, sigma theta, air temperature, humidity, rainfall, short wave radiation and net radiation.

The profile method of Van Ulden and Holtslag (1985) uses the differential temperature between two levels, the wind speed at one level together with an estimate of the surface roughness to derive the surface fluxes. From inspection of the vegetation of the area (which consists of seasonal grasses) and from comparison to the sigma theta measurements a value of 0.02 m was chosen.

Comparison between the heat flux estimates from the two methods generally indicated very good agreement, with the profile method being slightly more consistent. Therefore, the yearly heat flux file was obtained from the profile technique except for the period of missing data from 15 May to 14 July when the Oakajee data were used, and the period 15 July to 9 September when the differential temperature sensor malfunctioned, where the results from SOIL were used.

The resultant Pasquill stability classes derived from this combined data set are presented in table 2.1. These were derived from the predicted Monin Obukhov lengths, a surface roughness of 0.02 m and the monogram of Golder (1972). The Pasquill stability classes are a measure of the dispersive capacity of the atmosphere. They range from highly unstable class A conditions which occur under strong insolation and low wind speeds where the plume is rapidly dispersed, through to highly stable class F conditions which occur at night with clear skies and light winds where the plumes remain relatively compact. Table 2.1 shows that neutral conditions predominate at the site due primarily to the frequency and strength of the sea breezes. Stability wind roses for the 6 classes are presented in figure 2.2. These indicate that the majority of moderate to very unstable conditions occur for west to southwest and easterly winds, with neutral conditions occurring predominantly under southerly winds and stable conditions under land breezes.

Mixing depths and the strength of the capping inversions were derived using the WA DEP well mixed layer (WML) model (Rayner, 1987 and Rayner and Watson, 1991). This model uses surface heat flux estimates and with a morning atmospheric temperature profile calculates the growth of the turbulent mixed layer during the day and the development of the nocturnal boundary layer at night. For the modelling, the temperature profile was obtained from the morning radiosonde sounding taken at Geraldton airport, with any missing soundings substituted with the trace from the nearest day.

The resultant available data suitable for input to DISPMOD consisted of 361 complete days or 98.9% of the year.

3 MODELLING SYSTEM

3.1 Outline

The air quality impacts from the proposed steel complex were determined using DISPMOD, the WA DEP dispersion model (EPAWA, 1992), the fumigation model of Deardorff and Willis (1982) and AUSTOX, an emergency response and preparedness model (Centre for Applied Mathematical Modelling, 1994).

DISPMOD was used to simulate all the positively buoyant plumes from the steel complex. These plumes with enough buoyancy, or those emitted from tall stacks, have the potential to interact with the thermal internal boundary layer (TIBL), which develops down wind of the coast for onshore winds. The TIBL is a region (see figure 3.1) of convective turbulence which grows with distance downwind from the coast and is capped by an inversion or stable layer. Plumes emitted at the coast from tall stacks or very buoyant sources can be emitted into the stable onshore flow and then be brought rapidly to the ground at some down wind distance by the growing TIBL (see figure 3.1). This process is particularly important for tall stacks at the coast and can lead to high ground level concentrations at a particular downwind point for several hours. This typically occurs for sea breezes and has been found to lead to high concentrations around Kwinana (Paparo, 1982). For short stacks and less buoyant plumes the plume will be trapped beneath the TIBL. This again can lead to higher ground level concentrations than otherwise would occur, due to the vertical restriction on dispersion. Therefore a model such as DISPMOD, developed from the Kwinana Air Modelling Study (KAMS), is needed to predict accurately the dispersion of these types of buoyant plumes.

For negatively buoyant plumes, such as from the CO_2 removal stack, the plume will sink instead of rise. As DISPMOD cannot model this, such plumes were modelled by AUSTOX. For these plumes the influence of the TIBL will be minimal especially within 1 km of the source as the negatively buoyant plumes will act approximately as surface level releases.

For assessing the maximum impact due to morning fumigation, the fumigation model of Dardorff and Willis (1982) was used. Morning fumigation typically occurs on mornings with light winds where buoyant plumes or plumes from tall stacks are emitted into the stable air several hundred metres above ground level. After sunrise, the heated ground surface will give rise to a convective boundary layer which will grow throughout the day. When this boundary reaches the height of the elevated plumes they are mixed rapidly to the ground, resulting in high concentrations for a period of 30 to 60 minutes.

3.2 DISPMOD

DISPMOD and its validation have been described in detail in Rayner (1987) and EPAWA (1992) and apart from certain parameters used and model modifications, will not be discussed here.

Model Parameters Used

In running DISPMOD there are various optional formulations for plume penetration and dispersion etc. In the modelling for this report these parameters have been based on those used in the Kwinana EPP modelling where possible (EPAWA, 1992) and are summarized below:

(a) a Cartesian grid of 500 m spacing over 19 by 17 km with the southwestern most grid point set on AMG coordinate 267 000E, 6802 000N;

(b) plume dispersion based on Draxler's (1976) functions using the statistical theory of Taylor (1921);

(c) Manins (1979) plume penetration algorithm;

(d) Briggs (1975) plume rise;

(e) onshore lapse rates were specified as 0.001, 0.01 or 0.02°C m^{-1};

(f) seasonal variation in lapse rates;

(g) an averaging time of 30 minutes for the meteorological data from which 30 minute average concentrations are calculated and then combined to form hourly average concentrations; and

(h) building wake effects.

An example of the prompts to model options and responses used and the control file for a typical run is given in appendix A.

Meteorological Data

As input to DISPMOD meteorological data from the WML model were used. These consisted of ten minute data of wind speed and direction, air temperature, sigma theta, the Monin Obukhov length, mixing depth and the temperature jump at the top of the well mixed layer. This temperature jump was further conservatively increased by the increase in potential temperature for 10% of the mixing layer height above the top of the mixed layer.

Model Modification

To account for terrain at the proposed sites, DISPMOD was modified to incorporate the "Egan half height" method (Egan, 1975) as recommended in AUSPLUME. This method adjusts the height of the plume centre line by taking into account the change in terrain height from the source location to the receptor by

$$H = H_0 - \mu.\min(H_0, \delta_z)$$

where H — is the plume height after the correction
H_0 — is the original plume height
δ_z — is the change in terrain elevation from the source to the receptor
μ — a constant, 0.5 for Pasquill stability classes A to D; 0.7 otherwise.

Also as the coastline is not aligned north south, the model was modified to enable it to run for the coastline orientation at Geraldton, which was specified as being aligned along 157° to 337°.

3.3 AUSTOX

Ground level concentrations that result from a heavier than air plume were predicted by AUSTOX (Ross and Koutsenko, 1994; and Centre for Applied Mathematical Modelling, 1994). AUSTOX is a Gaussian puff model specifically designed for accidental releases of toxic and hazardous materials. It can simulate both negative and positively buoyant gas clouds that develop from a number of release scenarios such as pressurised liquid storage at ambient temperature, gas storage, cyrogenic liquid storage and pipeline transport accidents.

To determine the maximum concentration from the steel complex, the worst case modelling procedure after the Victorian EPA (1985) was used. This technique uses artificial meteorological data to determine the "highest concentration" at the "worst affected receptor". For the modelling, wind speeds ranging from 0.5 m s^{-1} to 15 m s^{-1} and Pasquill Gifford stability categories ranging from A to F were used as specified in MAXMOD the WA DEP screening model. Mixing depths (the height to which mixing of the pollutant will occur) has not been incorporated as it is not handled within AUSTOX. Generally the impact of any mixing lid on surface releases or a slumping plume will be minimal until a distance greater than several kilometres downwind from the source. Therefore for a denser-than-air gas this assumption may lead to underprediction of concentrations at distances greater than about 1 km downwind. However, for concentrations particularly at 250 m down wind there should be negligible differences.

Model Assumptions

As AUSTOX cannot model mixtures of gases, CO_2 the primary constituent of the CO_2 removal plume was used. This assumption will lead to a slight error, probably an overprediction of the ground level concentrations as the density will be higher, e.g. CO_2 has a molecular weight of 44, compared to the plume with a molecular weight of 42.

Other assumptions or model parameterisation used are:

(a) an ambient temperature of 20°C;
(b) surface roughness of 0.03 and 0.20 m;
(c) no building wake effects; and
(d) assumption of steady state emissions.

3.4 Early Morning Fumigation Worst Case Modelling

For estimating the expected worst case ground level concentrations due to fumigation the model of Deardorff and Willis (1982) was used. The model identifies the most important meteorological parameters that affect ground-level concentrations as:

(a) wind speed in the convective boundary layer at the time of fumigation;

(b) wind speed in the stable air aloft;

(c) directional wind shear between these two layers;

(d) rate of growth of the convective mixing layer; and

(e) convective velocity scale.

For the worst case fumigation modelling described in this report, these parameters were defined as:

- an entrainment rate of 200 m h^{-1} for the erosion of air of F class stability, and a convective velocity scale of 1.2 m s^{-1}. These are considered appropriate for the inversion heights of around 250 - 350 m, which will be eroded 1 - 3 hours after sunrise;

- a wind shear of 30 deg. This value is found to give typical worst case results from observations at Kalgoorlie (e.g. the comparison between Dames & Moore, 1987, and WA EPA, 1988) and also generates estimates which agree well with the more rigorous approach of Hurley and Physick (1990);

- the initial dispersion coefficients and mixing heights derived from MAXMOD, the WA DEP screening model, and

- the wind speed in the stable air was set equal to the air below in the growing convective boundary layer at 1.5 m s^{-1}.

4 PLANT EMISSIONS

4.1 Steel Complex

Under normal operating conditions the steel complex will emit sulphur dioxide (SO_2), oxides of nitrogen (NO_x), carbon dioxide (CO_2) and particulate matter (dust). These are projected to be emitted from the pelletizing plant, HYL plant meltshop and power station (figure 4.1) and are summarised in table 4.1.

Oxides of nitrogen (NO_x) will be emitted from a number of sources throughout the complex with major sources at the power station and pellet plant. The power station will comprise 3 F6FA gas turbines which generate 70 MW each. The emissions data in table 4.1 are given for a single F6FA turbine operating on base load on North West natural gas fuel. The emission parameters are given at their ISO temperature (15 °C) at which gas turbine manufacturers quote performance data. At the higher temperatures which will occur at the site the emission mass fluxes will be lower. It is noted that in comparison to the older F6 turbine data, used for the Pinjar gas turbine power station (Bowman Bishaw Gorham, 1990), that the F6FA machines emit much less NO_x per MW of generated power. This is a result of the higher firing temperatures which generate more power for proportionately less mass flow.

The NO_2 mass flux has been based on a percentage of NO_2/NO_x of 50%. In practice the ratio of NO_2/NO_x is typically 2 to 22% by volume (Bowman Bishaw Gorham, 1990) upon exit from the stack with the NO converted to NO_2 by chemical reactions as the plume is transported down wind. From field observations (Bofinger et al., 1986) and from the photochemical modelling work done for the Pinjar gas fired power station (Bowman Bishaw Gorham, 1990) an upper limit of 50% will be conservative.

SO_2 emissions from the plant will be negligible comprising a total of 0.45 g s^{-1} from the HYL plant.

Particulate emissions from the stacks and vents at the plant will be emitted primarily from the pellet plant. These will comprise predominantly iron oxide and will be below 10 µm diameter. Fugitive dust from stockpiles and vehicular traffic have not been included as they are too difficult to quantify.

CO_2 will be emitted from most processes within the plant with the largest source being the HYL plant. Total CO_2 production for the steel complex is estimated at 3.61 Mtpa. For two of the plumes, the CO_2 concentration will be such that the plume's density will be equal to or greater than the air density. These plumes, from the heater flue and CO_2 removal stack, will comprise 54% and 90% CO_2 by volume, resulting in neutrally buoyant and heavier than air plumes respectively.

Other emissions from the steel complex will comprise volatile organic compounds. These will be emitted from the meltshop stack at 0.08 g s^{-1}.

For all stacks and vents, except those from the gas fired turbines, the emission concentrations have been designed to be below the AEC/NHMRC (1986) guidelines. The NO_x emissions from the turbines however are up to 3 times higher than the

0.07 g m^{-3} guideline for turbines greater than 10 MW. To achieve such guideline levels control methods using water and steam injection to decrease the exhaust temperatures are necessary. So far this guideline value has been applied only to gas turbine installations in the Perth area (Watson, 1995) to control the formation of photochemical smog. As the installation is approximately 400 km from Perth, is in an area with minimal potential for photochemical smog and the predicted ground level concentrations are well below the ambient criteria (see section 6), the use of control methods are believed to be unjustified.

Upset conditions are predicted not to occur. In the case of a shutdown of the direct reduction plant the gases will be vented via the blow-down stack. The duration of a blow off can be chosen, with 3 shutdowns and blow-offs expected per year. The gases from the blow off will consist of H_2, CO, CO_2, H_2O, CH_4 and N_2.

4.2 Existing Sources

Existing industries within the Narngulu industrial estate consist of a synthetic rutile plant, mineral sands separation plant and attapulgite plant. Of these only the synthetic rutile plant currently emits airborne pollutants through stacks and vents. All three however do produce fugitive dust through their operations which will not be treated in this modelling as they cannot be quantified. Instead they are best addressed by the implementation of suitable management practices.

Besides the industrial estate, the CSBP fertilizer plant in Gerladton is also a potential source of SO_2. This plant however, has been closed for two years and when in operation operated for only 6 weeks per year. Therefore it will not be included as a source.

Stack and emission characteristics for the Narngulu synthetic rutile plant have been obtained from their PER (AMC, 1989), licence conditions (Licence number 4393) and from RGC Narngulu (Price, 1995) and are summarised in table 4.2. It is noted that the SO_2 mass flux are their licence values set by the DEP. In practice under normal operating conditions the SO_2 mass fluxes are approximately 25% of this value. Besides these two main stacks there are a number of vents which emit particulate. These however are considered small sources and as yet have not been quantified.

5 AIR QUALITY OBJECTIVES

5.1 Guidelines and Criteria

Current Government legislation (i.e. the Environmental Protection Act of 1986) does not specify maximum air quality objectives throughout Western Australia. Instead the DEP has promulgated two environmental protection policies (EPP) for atmospheric pollutants, specifically for the Kwinana and Kalgoorlie areas. For new "Greenfield" developments (no existing sources) and for existing plants which are seeking approval for modification the DEP assesses the proposal using the Kwinana EPP's standards and limits as guidelines (EPA WA 1992). These are presented in table 5.1 and are for SO_2 and particulates and were used previously by the DEP in assessing the acceptability of the expansion of the Narngulu Synthetic Rutile Plant (EPAWA, 1989). Here a limit is defined as "a concentration not to be exceeded" and a standard as "a concentration which it is desirable not to exceed". In determining the acceptability of new sources the DEP requires that the predicted 99.9 percentile value at any location be below the standard level. It is believed that this procedure ensures that the actual limit will never be exceeded.

For NO_2, the reactive component of oxides of nitrogen, the DEP has not yet set any limits and standards under an EPP. As such, for the short term one hour averaging period the AEC/NHRMC (1986) guideline will be used. This guideline states that the 320 $\mu g\ m^{-3}$ standard is not to be exceeded more than once a month. This is approximately equivalent to a 99.9 percentile level or 9th highest hourly level that is used by the DEP for the assessment of the one hour SO_2 standard at Kwinana and Kalgoorlie. For the longer averaging periods the World Health Organisation (1987) and USEPA (1977) limits will be used (see table 5.2).

Additionally, for particulates there is now concern that particles below 10 μm diameter, known as PM_{10}, are important in terms of human health. For these, the New Zealand ambient air quality standard of 120 and 40 $\mu g\ m^{-3}$ for 24 hour and annual averages will be used (CASANZ, 1994).

The proposed air quality guidelines are summarised in table 5.2

5.2 Air Quality Modelling Objectives

In determining the acceptability of new sources the DEP recognizes that air quality models cannot accurately predict for short averaging periods the location and magnitude of pollutant concentration. This is due to the turbulent nature of the atmosphere which can only be described statistically. As such for the one hour averaging period the DEP requires that the predicted 9th highest hourly concentration at any point (i.e. the 99.9 percentile value) be below the standard level. This procedure gives a high level of assurance that the one hour limit will not be exceeded in any given year.

For longer averaging periods such as 24 hours the problem of uncertainty is less and the predicted maximum should be fairly accurate.

For such an averaging period the usage of the 99.9 percentile compliance level for the standard implies that there can be one exceedence event per 3 years. As in this assessment only one year of data was modelled and its representativeness in terms of worst case conditions is not known, it will be required that the predicted maximum 24 hour level be below the standard as well as the limit.

Likewise in assessing the long term concentration, comparison between the annual average and the standard for the annual average will be used.

For modelling the very short term particulate concentrations where only a limit is given, comparison between the limit and the maximum 15 minute concentration will be made. These predictions as noted above will have a degree of uncertainty to them and hence should be treated with a little caution.

6 SENSITIVITY TESTS

To estimate the ground level concentrations around the Narngulu industrial estate the rate of growth of the TIBL (see section 3.1) is needed. In DISPMOD the TIBL growth with distance from the coast is determined using the heat flux, wind speed and the temperature profile of the onshore wind. Ideally the onshore temperature profile should be continuously measured, or at least estimated from measurements over a number of days and then extrapolated from derived relationships using parameters such as the synoptic weather pattern. For the Geraldton region however, no data exist on the overwater lapse rate. As such, in the following a sensitivity analysis will be conducted for the range of lapse rates expected to determine an appropriate conservative lapse rate.

Figures 6.1 to 6.12 present the highest hourly, 9th highest hourly, maximum 24 hour and annual average concentrations from the synthetic rutile plant operating under normal conditions and lapse rates of 0.001, 0.01 and 0.02 °C m^{-1}. These indicate that concentrations to the east and north of the site which are influenced by onshore winds increase with the increasing lapse rate. This is as expected with a higher lapse rate leading to lower TIBL heights and therefore greater potential for plume trapping. However, the highest hourly and highest 9th hourly show no change as they occur to the west of the stack or very close to the stacks. Therefore for the purpose of determining the impact of the proposed steel complex in the rest of this report the conservative lapse rate of 0.02 °C m^{-1} will be used.

7 DISPMOD MODELLING RESULTS

Using DISPMOD, the model parameters described in section 3.2, a conservative onshore lapse rate of 0.02°C m^{-1} and the one year data base, predictions of the maximum one hour, 9th highest hourly, maximum 24 hour and annual average concentrations were obtained for SO_2 and NO_2. For particulates, instead of the hourly predictions an estimate of the maximum 15 minute concentration was made. It is noted that for both the maximum 15 minute and maximum one hour concentration there will be a degree of imprecision as atmospheric dispersion models are less accurate at predicting the highest short term concentrations. Therefore, more reliance should be placed on the longer term averages and for the case of hourly predictions the 9th highest hourly concentration.

7.1 Sulphur Dioxide

Predicted ground level concentrations of SO_2 from the existing sources within the area (Narngulu synthetic rutile plant) are presented in figures 7.1 to 7.4. These were predicted assuming conservatively that one of the kilns operates continuously in an upset mode. In reality, upset conditions occur approximately 3 times per year, for periods of up to 1¼ hours and only for a single kiln. Under upset conditions the emissions approach or exceed the license for each kiln of 55 g s^{-1}. Under normal conditions the emissions are about 25% of the license value. Therefore, the assumption that one kiln runs under normal conditions and one continuously at upset conditions will be very conservative and will ensure that the maximum hourly concentrations are predicted.

Figure 7.1 and table 7.1 indicate that the maximum one hour concentration will be 501 µg m^{-3} occurring within the industrial estate, with a secondary slightly lower maximum occurring just to the west of the estate. Other peaks of approximately 350 µg m^{-3} occur on Mount Fairfax and Sheehans Hill indicating that though they are at least 8 km from the site, they are nevertheless important in determining the amount of emissions in the industrial estate.

For the 9th highest hourly, maximum 24 hour and annual average concentrations the highest values all occur to the northeast of the synthetic rutile plant, though within the industrial estate. For the longer averaging periods such as the annual average the concentrations are strongly skewed towards the north due to the persistent southerly winds.

In comparison to the objectives listed in table 5.2 it is seen that the concentrations within and outside the industrial estate fall below the guideline for residential areas. Outside the industrial estate the maximum one hourly, 9th highest hourly, maximum 24 hour and annual average are approximately 480, 220, 50 and
7 µg m^{-3} which are well below the residential objectives of 700, 350, 125 and
50 µg m^{-3}, respectively.

Cumulative impacts from both the existing synthetic rutile plant and proposed steel complex are presented in figures 7.5 to 7.8. These indicate nearly identical concentration plots to those predicted from the synthetic rutile plant alone. This is as expected as the steel complex will only emit 0.45 g s^{-1} of SO_2 or less than 2% of that from the synthetic rutile plant when operating under normal conditions. The peak concentrations as shown in table 7.1 remain unchanged due to the separation between the two plants. For conditions which lead to the peak concentrations the wind direction and separation of the plants is such that no cumulative contributions occur.

7.2 Nitrogen Dioxide

The predicted maximum one hourly average, 9th highest one hourly average, maximum 24 hour and annual average NO_2 concentration from the steel complex alone are presented in figures 7.9 to 7.12 and in table 7.1. These are equivalent to the cumulative concentrations as there are negligible existing NO_2 sources in the region. These figures indicate that the highest concentrations for all but the maximum one hourly averaging period occur approximately 500 m to the northeast of the industrial estate with a secondary lower maximum on Mount Fairfax. Comparison to the air quality objectives in table 4.2 indicate the levels are a factor of 2 to 8 times lower than those for residential areas.

7.3 Particulate (PM_{10})

The predicted maximum 15 minute average, maximum 24 hour and annual average concentration of particulates due to emissions from the existing sources and from the cumulative impacts of the steel complex and existing sources are presented in figures 7.13 to 7.18 and table 7.1. These indicate that the peak concentrations will occur outside the industrial estate, but that these concentrations for the cumulative impacts will be in the range of 4 to 8 times lower than the relevant objectives.

8 MORNING FUMIGATION MODELLING

Predicted maximum one hourly ground level concentrations of NO_2 determined using the model of Deardorff and Willis (1982) are presented in table 8.1. Here NO_2 has been modelled, as it is by far the largest pollutant emitted in the very buoyant plumes likely to undergo fumigation.

The predicted concentrations (table 8.1) are presented for each of the major groups of sources, the Pellet Plant, HYL/Meltshop/CSP area and from the power station. This grouping of all the sources into 3 groups was done to simplify the analysis. Here the source characteristics for each group was assumed to be equal to the lowest emission volume/temperature of any of the stacks within that group, with the NO_2 mass flux equal to the sum of NO_2 emissions. This procedure will ensure that a conservative estimate is made, whilst reducing the number of plumes to be modelled. The results indicate that peak hourly concentrations for any group will be slightly above 60 $\mu g\ m^{-3}$, decreasing slowly with down wind distance. To estimate the combined effect of the plumes, a conservative assumption is to assume that the resultant ground level concentrations from the various plumes can be simply added. This will overpredict the concentrations as the plumes will rise to different heights and therefore travel in slightly different directions and undergo fumigation at different times. The results from this indicate (table 8.1) that a peak hourly concentration from fumigation will be 140 $\mu g\ m^{-3}$ at a down wind distance of 1 km.

Comparison of the maximum concentrations predicted from the fumigation modelling with the maximum concentrations predicted in section 7 from DISPMOD, indicate that the fumigation concentrations are up to 60% lower. This indicates that the dispersion processes modelled in DISPMOD, which include plume trapping under convective conditions and plume impaction on high terrain are of more importance.

Further, comparison of the fumigation modelling results from the gas turbines along with those from the Pinjar gas fired power station using a Lagrangian particle aproach (Manins, 1990) show relatively higher concentrations. Therefore, as stated in the assumptions, the modelling approach may be in fact too conservative and further indicates the morning fumigation will not be an issue here.

9 HEAVIER THAN AIR CO_2 PLUME

Modelling of the heavier than air CO_2 plume from the CO_2 removal stack was performed using AUSTOX and for a range of artificial meteorological conditions.

The results of this modelling indicate that the highest ground level concentrations occur under light winds and within several hundred metres of the stack. The predicted highest 3 minute concentration of 0.3% v/v occurred at a distance of 160 m under F class stability and a wind speed of 0.5 m s^{-1}. This is well below the exposure standard for CO_2 of 3.0% v/v for the short term exposure limit (STEL), (NOHSC, 1990), where a STEL is evaluated as a 15 minute average which should not be exceeded more than four times per day.

Therefore, ground level concentrations of CO_2 from the CO_2 removal stack will not pose a problem. However, as the CO_2 removal stack is adjacent to and lower than parts of the DRI plant structure, there may be the potential for the plume to impact on the building and cause high concentrations above the STEL. Therefore it is recommended that the effect of this plume on workers on this building be determined.

10 CONCLUSIONS

Using DISPMOD, the WA DEP coastal fumigation model, a one year data base constructed from air quality meteorological measurements collected in 1994 and 1995 and conservative assumptions, it is predicted that:

(a) the maximum hourly average, 9th hourly average, maximum 24 hour and annual average concentration of NO_2 from the steel complex and existing industries will be 228, 154, 49 and 7.1 $\mu g\ m^{-3}$ respectively. These are well below the air quality objectives of 320 $\mu g\ m^{-3}$ for an hourly average, 150 $\mu g\ m^{-3}$ for 24 hour average and 100 $\mu g\ m^{-3}$ for an annual average and indicates that NO_2 emissions will not be a problem;

(b) the emission of SO_2 from the steel complex are nearly negligible comprising a total of 0.45 $g\ s^{-1}$. Using DISPMOD this additional contribution to the existing source (the synthetic rutile plant) will increase the ground level concentrations by less than 1 $\mu g\ m^{-3}$. Therefore ground level concentrations which are already below the relevant SO_2 objectives will be essentially unchanged; and

(c) for particulates the maximum 15 minute concentration from the steel complex and existing sources will be 248 $\mu g\ m^{-3}$ occurring outside the industrial estate. This is well below the relevant objective of 1000 $\mu g\ m^{-3}$. For 24 hour and annual average concentrations, PM_{10} values of 23.9 and 5.0 $\mu g\ m^{-3}$ are predicted which again are well below the relevant objectives of 120 and 40 $\mu g\ m^{-3}$ respectively.

From the morning fumigation modelling, using the model of Deardorff and Willis (1982) the maximum one hourly concentration of NO_2 is predicted to be 140 $\mu g\ m^{-3}$. This is lower than the maximum concentrations predicted from DISPMOD and indicates that morning fumigation will not be a problem and that the dispersion processes modelled in DISPMOD are more critical in defining the size of plant emissions.

Using AUSTOX, a Gaussian puff model designed specifically for negatively and positively buoyant gas releases and a range of meteorological conditions, it is predicted that the maximum 3 minute concentrations of CO_2 from the heavier than air CO_2 removal stack plume will be 0.3% v/v occurring 160 m from the stack. This is well below the exposure standard of 3.0% v/v for the 15 minute short term exposure limit. Therefore ground level concentrations of CO_2 will not be a problem.

However, as the CO_2 stack is adjacent to and lower than part of the DRI plant structure, there may be the potential for the plume to impacts on the building and cause high concentrations above the occupational health limit. Therefore, it is recommended that the effect of this plume on workers on this building be determined.

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Tables

Stability Class	Frequency Occurrence (%)
A	2.5
B	5.8
C	17.2
D	45.7
E	11.9
F	16.9

Table 2.1 Annual frequency of occurrence of stability classes.

					Mass Flux			
Source	**Stack Height (m)**	**Emission Volume** $(m^3\ s^{-1})$	**Emission Temperature** $(^\circ C)$	**Stack Diameter (m)**	**NO_2** $(g\ s^{-1})$	**SO_2** $(g\ s^{-1})$	**Dust** $(g\ s^{-1})$	**CO_2** $(kg\ s^{-1})$
Pellet Plant								
Waste Gas (1)	29	222	160	3.76[2]	25.0[4]	negl	7.0	13.74
Waste Gas (2)	25	142	80	3.00[2]	19.6[4]	negl	5.5	11.63
Feed end dedust (3)	25	4.44	30	0.53[2]	negl	negl	0.2	negl
Feed end dedust (4)	25	390.4	50	4.98[2]	negl	negl	16.5	negl
HYL Plant								
CO_2 removal	75	3.77	45	0.49[2]	negl	negl	negl	5.70
Reformer flue (6)	40	71.9	180	2.14[2]	6.2	0.064	negl	6.97
Heater flue (8)	75	39.9	180	1.59[2]	3.42	0.39	negl	42.28
Dedusting System	20	6.17	30	0.63[2]	negl	negl	0.28	negl
Meltshop/CSP								
Meltshop (11)	30	500	130	5.64[2]	4.93	negl	4.1	19.95
Power Station								
F6FA Gas Turbine (each)	25[6]	475[7]	600[7]	4.0[6]	23.3[7]	negl[5]	0.62[5]	8.75[5]
TOTAL					129.1	0.45	35.4	126.52[8]

Notes:

1. All data from Siget Engineering spreadsheet, dated 2 March 1995 except where noted.
2. Scaled to give an exit velocity of 20 m s^{-1}.
3. NO_2 derived assuming 50% of NO_x is NO_2 .
4. Derived from exit concentrations of 250 mg m^{-3} (STP) of NO_x from Alan Tingay and Associates fax of 29 March 1995.
5. Signet Engineering fax of 22 March 1995.
6. Mission Energy fax of 28 March 1995.
7. Mission Energy fax of 4 April 1995.
8. Plant availability is anticipated to be approximately 330 days per year (Signet Engineering fax of 19 May 1995).

Table 4.1 Source characteristics for steel complex.

		Stack	
Parameter	**Units**	**Kiln C**	**Kiln D**
Stack Height	(m)	49	57
Exit Density	(kg m^{-3})	1.044	0.996
Exit Temperature	(°C)	65	81
Exit Volume	(m^3 s^{-1})	37.1	53.4
Stack Diameter	(m)	1.5	1.8
Source Strength SO_2	(g s^{-1})	55[1]	55[1]
Dust	(g s^{-1})	6.1[2]	8.1[2]

NOTES: 1. Licensed maximum. On average the SO_2 mass flux is typically 25% of this value.

2. Based on maximum measured dust concentration in exhaust. Average mass flux is expected to be lower.

Table 4.2 Source characteristics for the synthetic rutile plant.

Species	Area	Averaging Period	Standard[1] ($\mu g\ m^{-3}$)	Limit[1] ($\mu g\ m^{-3}$)
Sulphur Dioxide	A	1 hour	700	1400
		24 hour	200	365
		annual	60	80
	B	1 hour	500	1000
		24 hour	150	200
		annual	50	60
	C	1 hour	350	700
		24 hour	125	200
		annual	50	60
Particles	A,B,C	15 minute	-	1000
	A	24 hour	150	260
	B	24 hour	90	260
	C	24 hour	90	150

NOTES:
1. All values expressed at 0°C and 101.3 kPa.
2. Area A: the area of land which heavy industry is located
   Area B: the area surrounding industry, plus other outlying land zoned for industrial use
   Area C: land beyond areas A and B used predominantly for rural and residential purposes.

Table 5.1 SO_2 and total suspended particulate standards and limits for the Kwinana Policy Area. (after EPAWA, 1992).

Species	**Area**	**Averaging Period**	**Standard ($\mu g\ m^{-3}$)**	**Limit ($\mu g\ m^{-3}$)**
Sulphur Dioxide[1]	Industrial Estate	1 hour 24 hour annual	700 200 60	1400 365 80
	Residential	1 hour 24 hour annual	350 125 50	700 200 60
Particulate, PM_{50}[1]	Everywhere	15 minute	-	1000
	Industrial Estate	24 hour	150	260
	Residential	24 hour	90	150
Particulate PM_{10}[2]	Residential	24 hour annual	- -	120 40
Nitrogen Dioxide	Residential	1 hour[3] 24 hour[4] annual[5]	320 - -	- 150 100

Notes: 1. From WA EPA (1992), WA EPA (1989)
2. From NZAAQS (CASANZ, 1994)
3. From AEC/NHMRC (1986)
4. From WHO (1987)
5. From USEPA (1977)

Table 5.2 Proposed air quality guidelines.

Pollutant	Air Quality Objective	Anywhere		Outside Industrial Estate	
		Existing Sources ($\mu g\ m^{-3}$)	Cumulative ($\mu g\ m^{-3}$)	Existing Sources ($\mu g\ m^{-3}$)	Cumulative ($\mu g\ m^{-3}$)
SO_2	Maximum 1 hourly	501	501	480	480
	9th highest 1 hourly	291	291	220	220
	Maximum 24 hour	91.1	91.1	50	50
	Annual Average	11.0	11.0	7	7
NO_2	Maximum 1 hourly	negl	228	negl	228
	9th highest 1 hourly	negl	154	negl	154
	Maximum 24 hour	negl	49	negl	49
	Annual Average	negl	7.1	negl	7
Dust	Maximum 15 minute	132	248	125	248
	Maximum 24 hour	18.5	23.9	9	23.9
	Annual Average	2.4	5.0	2.0	5.0

Note: SO_2 concentrations have been predicted conservatively assuming that one kiln at the synthetic rutile plant is continuously in an upset condition.

Table 7.1 Maximum ground level concentrations predicted using DISPMOD from existing sources and the steel complex.

Down Wind Distance (km)	Concentration ($\mu g\ m^{-3}$) from			
	Gas Turbines	Pellet Plant	HYL Meltshop	Combined
1	56	63	21	140
2	49	62	21	132
5	48	61	20	129
8	45	60	20	125
10	42	58	20	120

Table 8.1 Maximum hourly ground level concentrations of NO_2 due to fumigation from the steel complex.

Figures

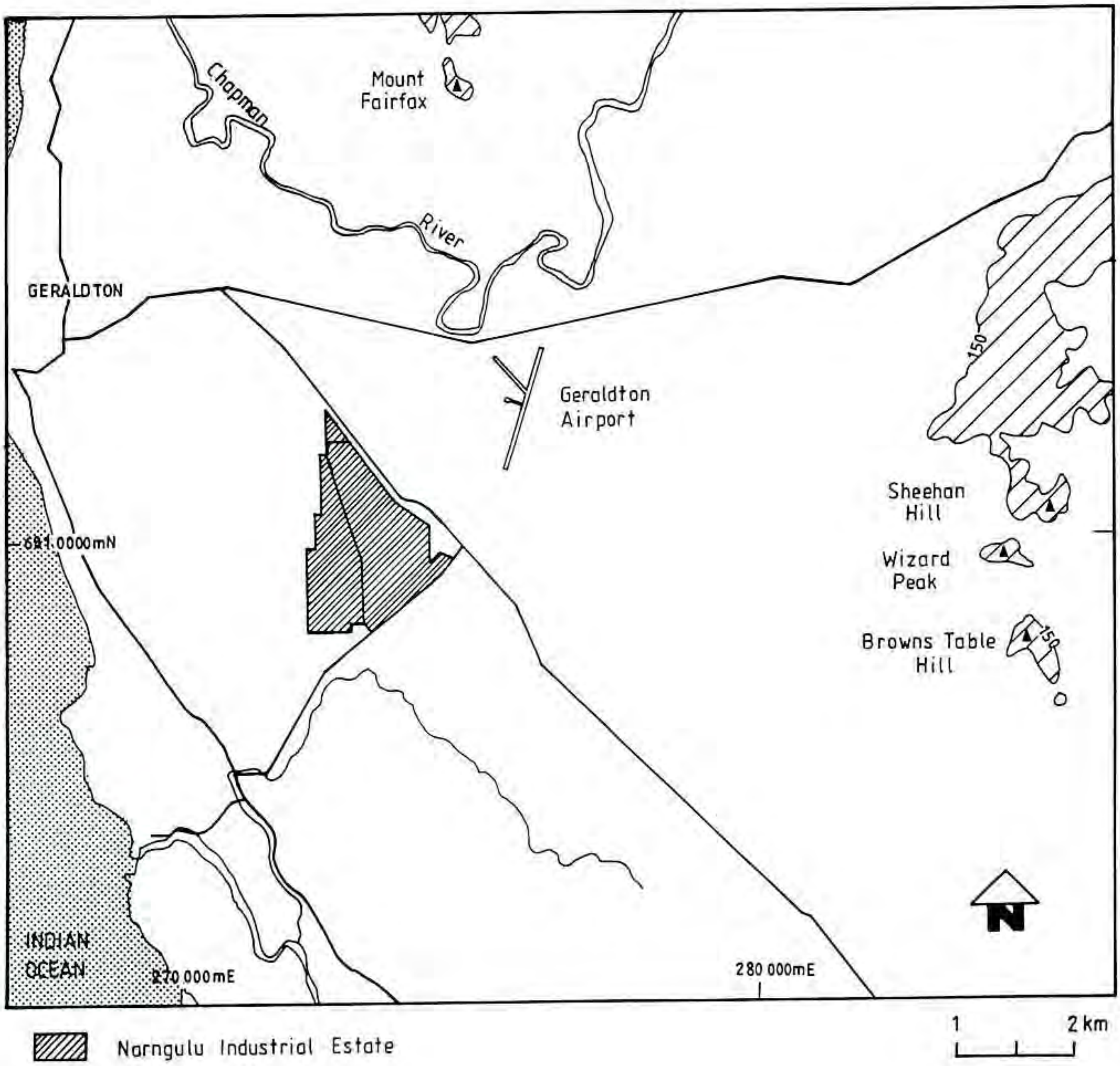

Figure 1.1 Location diagram of proposed steel complex at Narngulu.

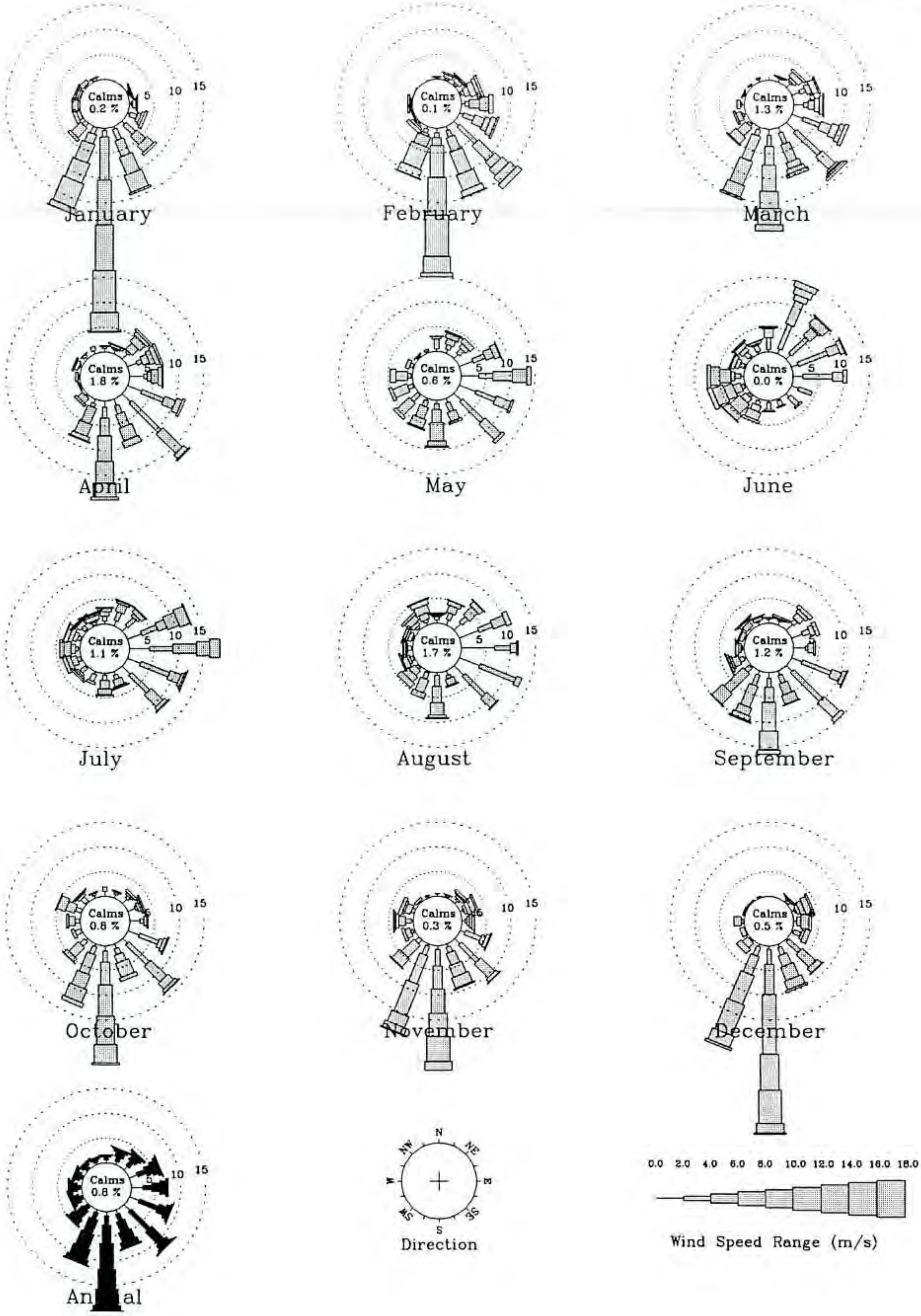

Figure 2.1 Annual and seasonal wind roses for Narngulu over the period 16 March 1994 to 15 March 1995.

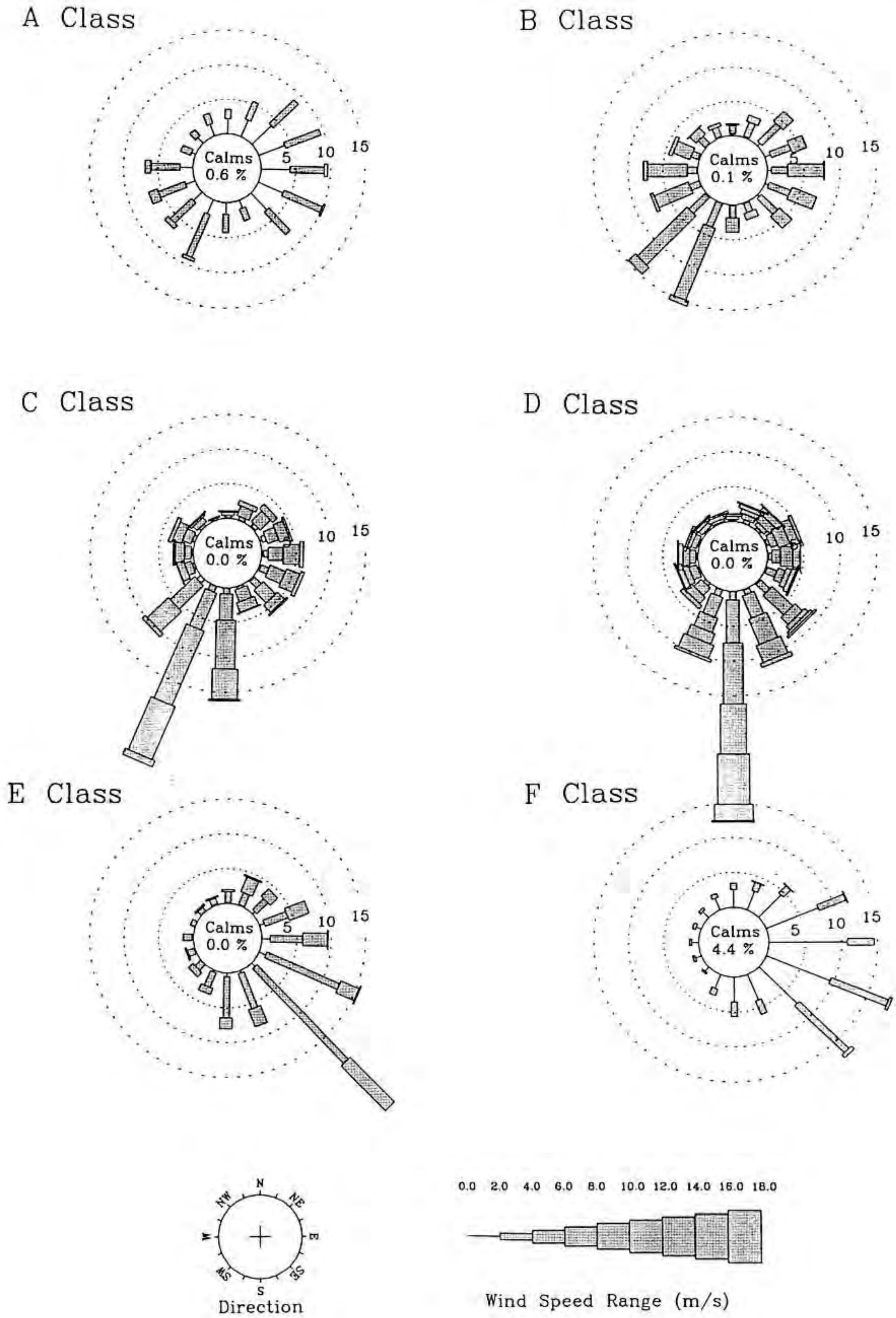

Figure 2.2 Annual wind roses for Pasquill Gifford stability classes A to F.

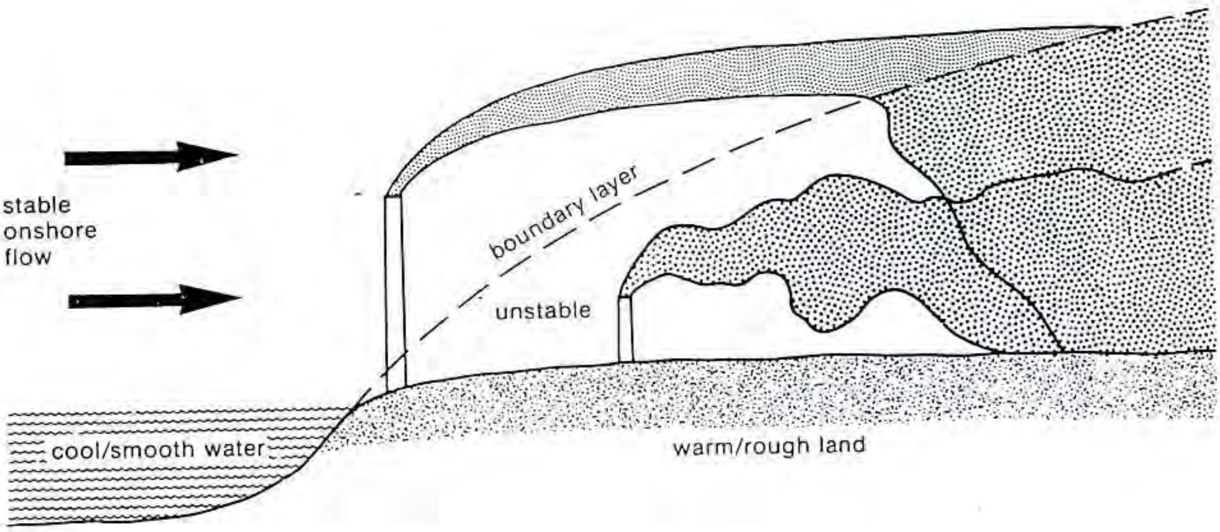

Figure 3.1 Dispersion processes which occur at coastal locations for onshore flows. The tall stacks emissions are undergoing fumigation due to the growing boundary layer whilst those from the smaller inland stack are trapped underneath the convective boundary layer (after Paparo, 1982).

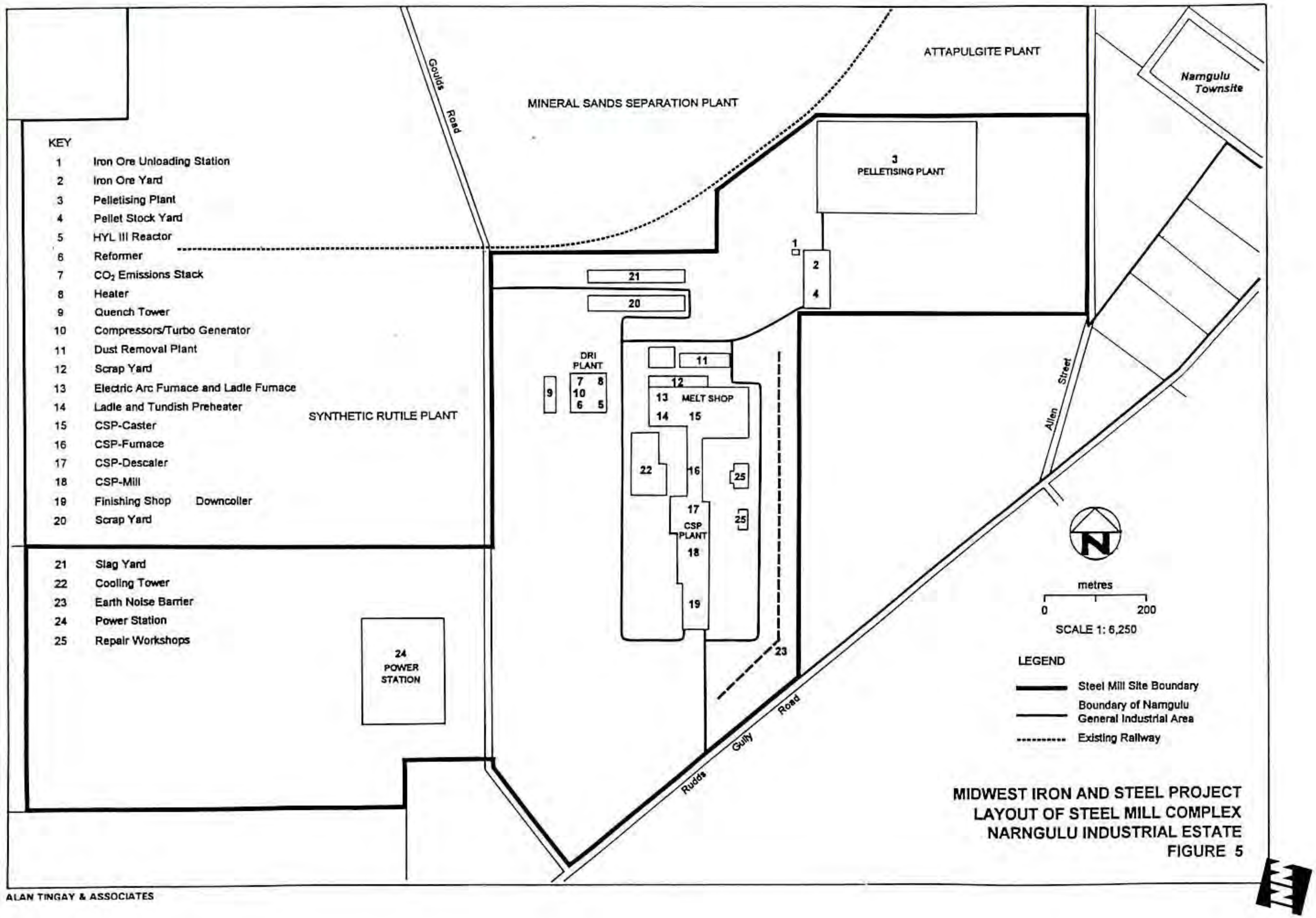

Figure 4.1 Proposed layout of the steel complex.

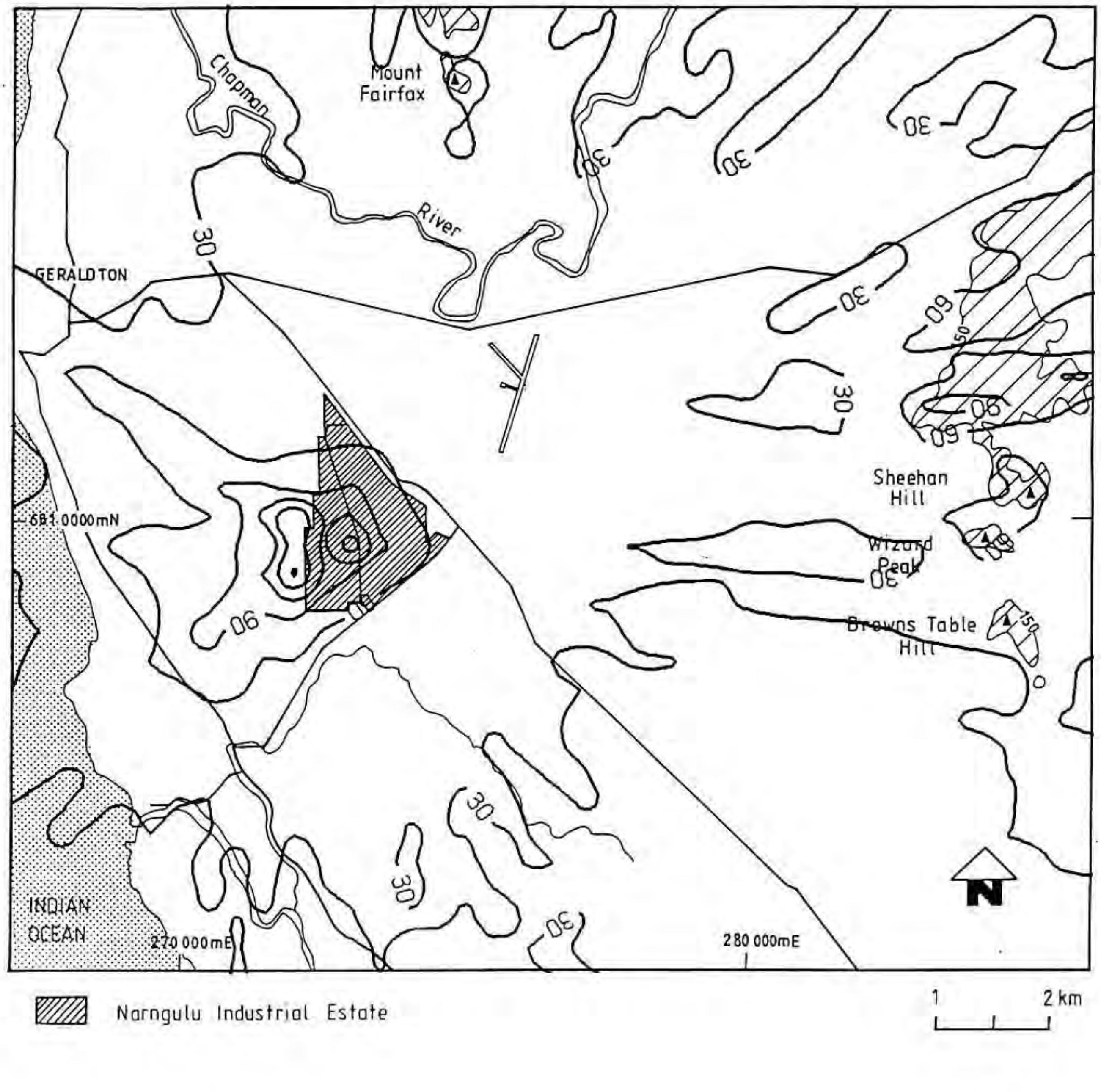

Figure 6.1 Predicted maximum one hourly average ground level concentration of SO_2 from the synthetic rutile plant operating under normal conditions with an onshore lapse rate of 0.001 °C m^{-1}.

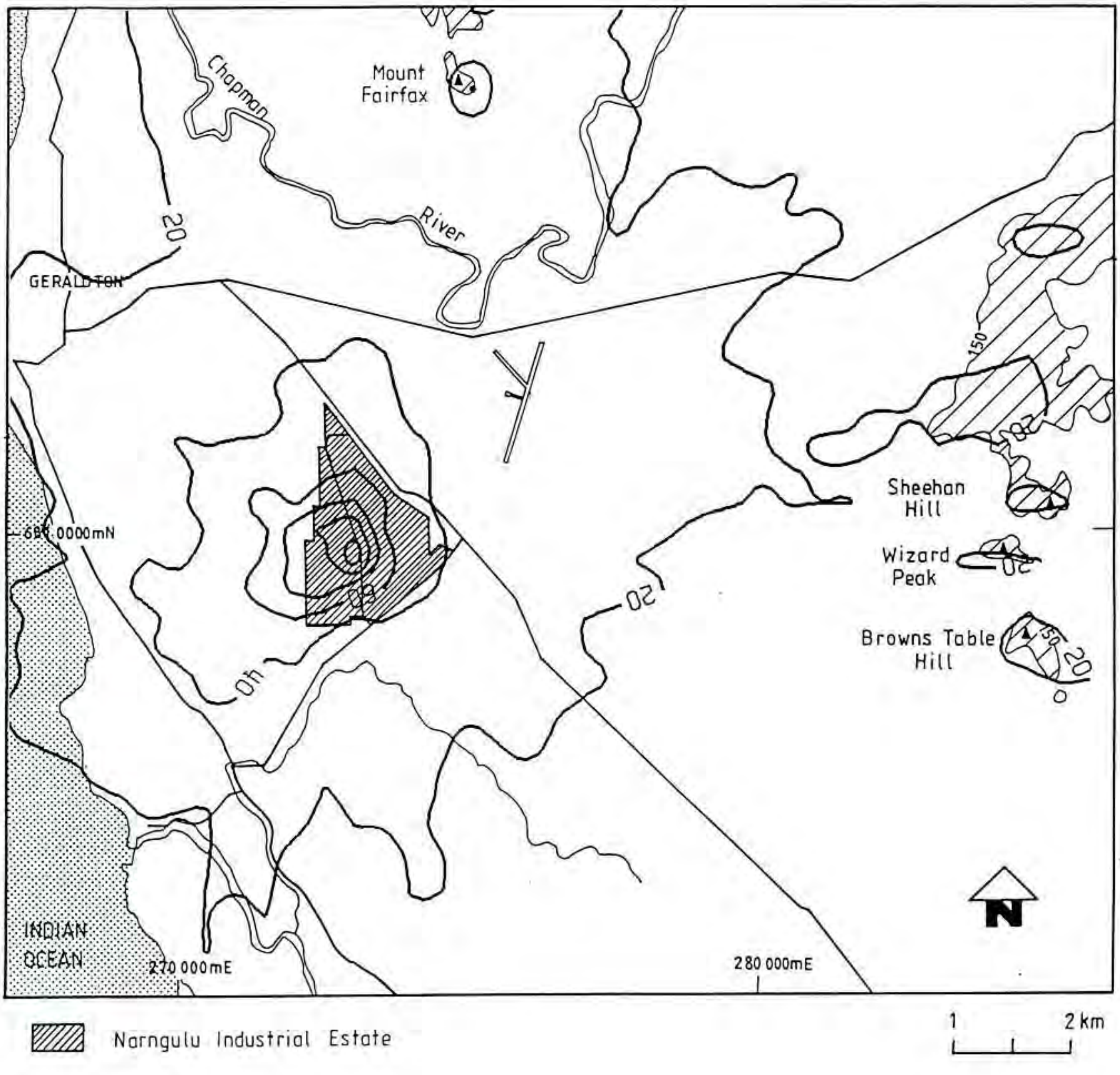

Figure 6.2 Predicted 9th highest one hour average ground level concentration of SO_2 from the synthetic rutile plant operating under normal conditions with an onshore lapse rate of $0.001\,^{\circ}C\ m^{-1}$.

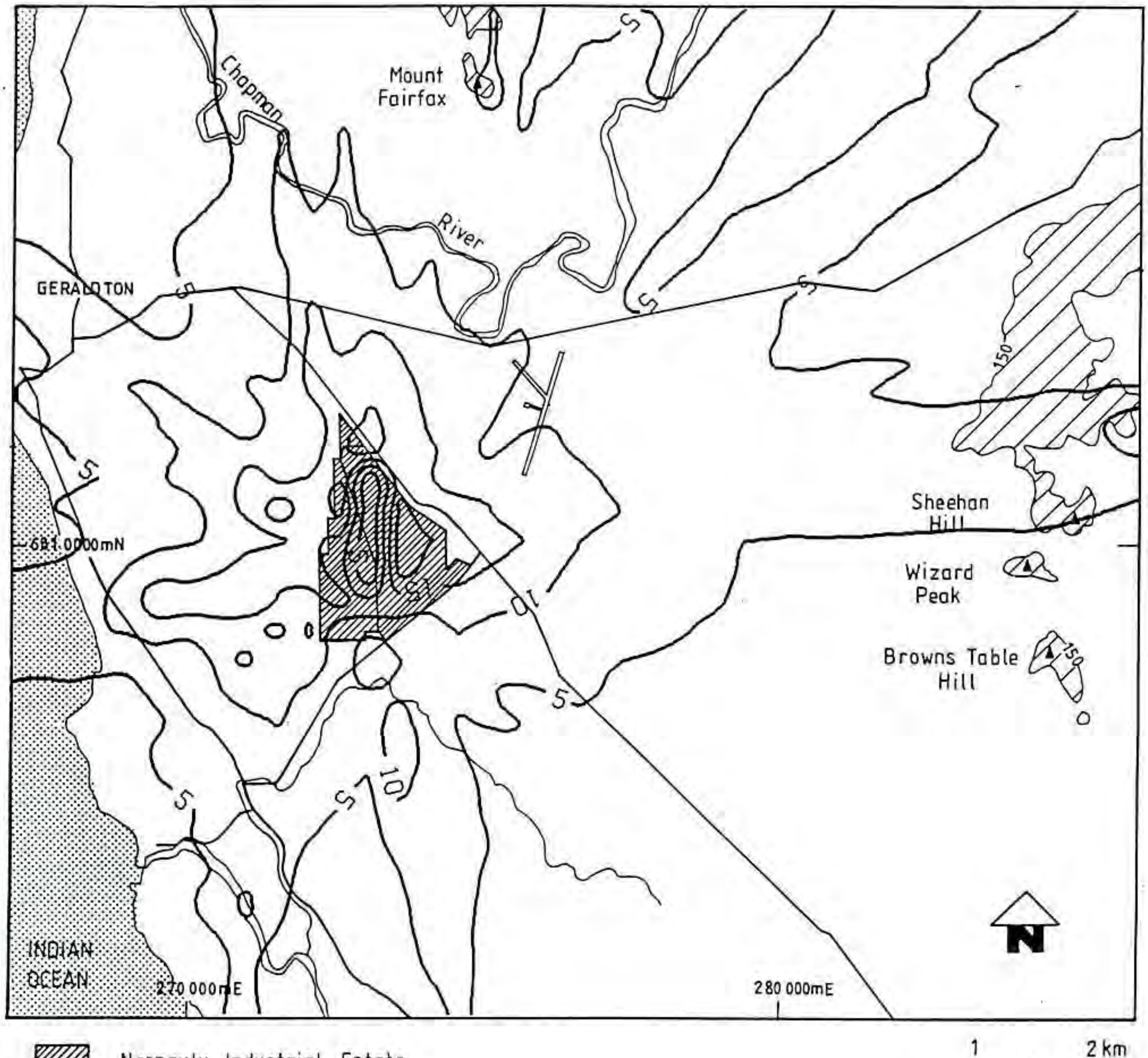

Figure 6.3 Predicted maximum 24 hour average ground level concentration of SO_2 from the synthetic rutile plant operating under normal conditions with an onshore lapse rate of 0.001°C m^{-1}.

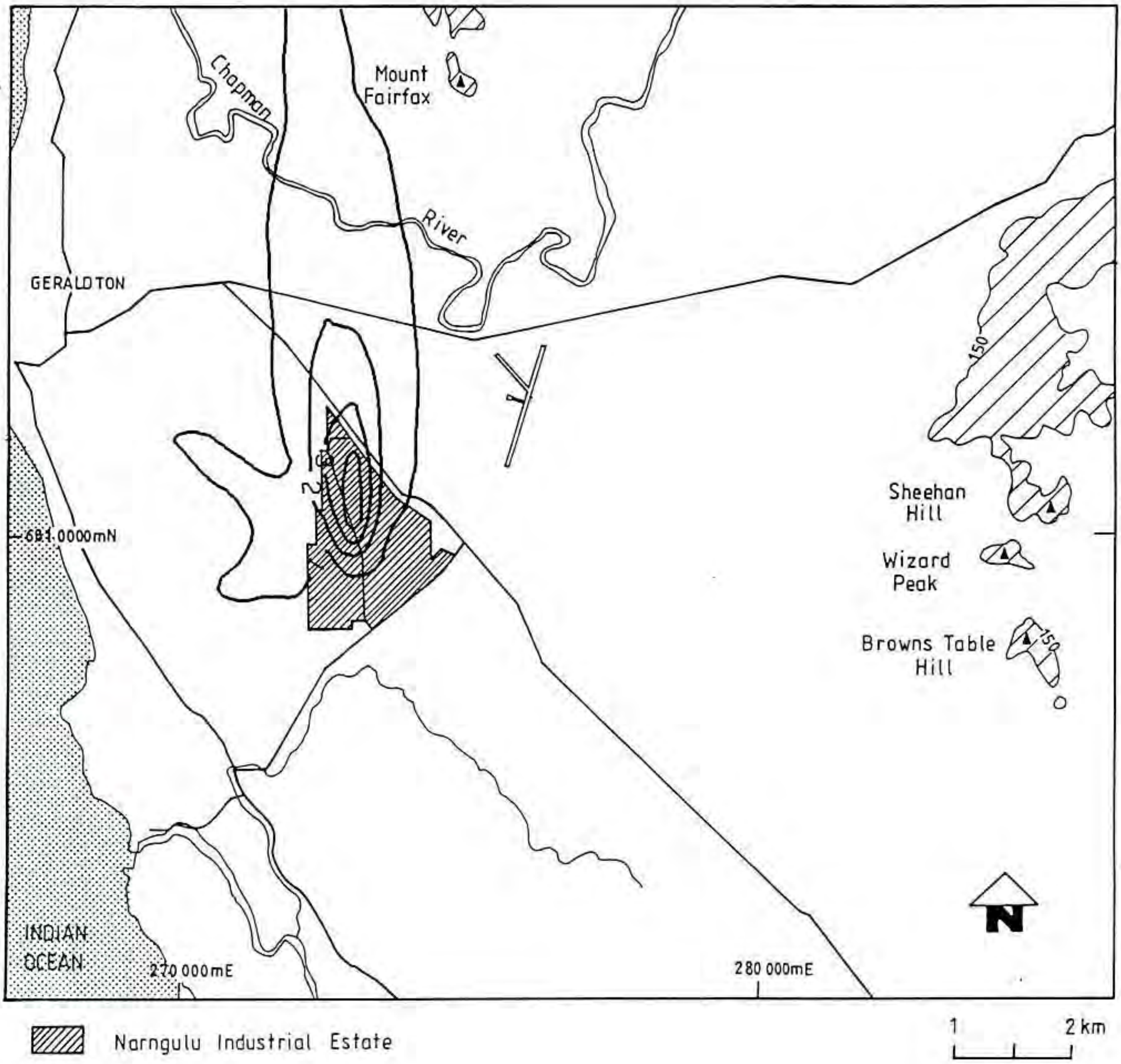

Figure 6.4 Predicted annual average ground level concentration of SO_2 from the synthetic rutile plant operating under normal conditions with an onshore lapse rate of 0.001 °C m^{-1}.

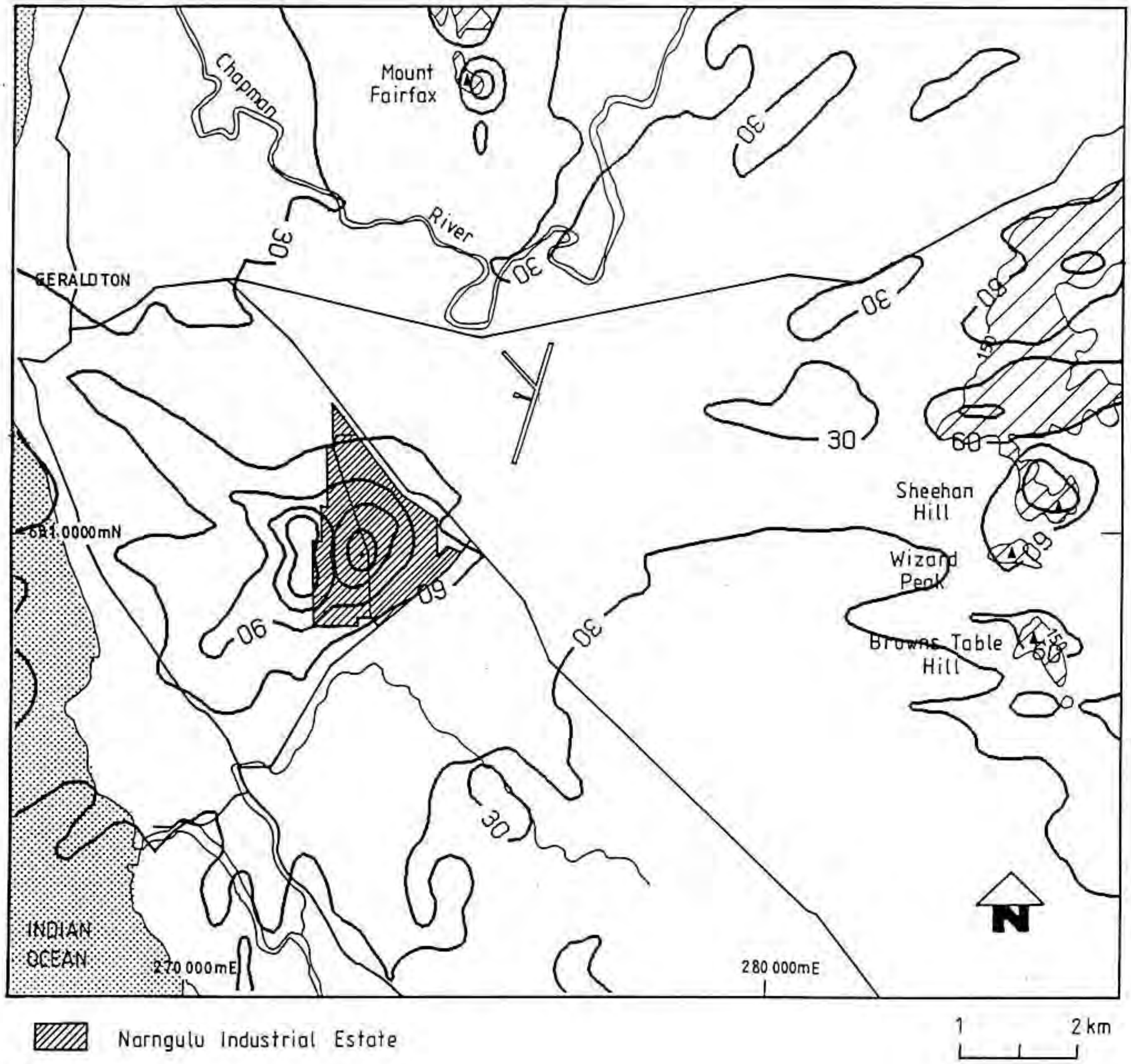

Figure 6.5 Predicted maximum one hourly average ground level concentration of SO_2 from the synthetic rutile plant operating under normal conditions with an onshore lapse rate of 0.01 °C m^{-1}.

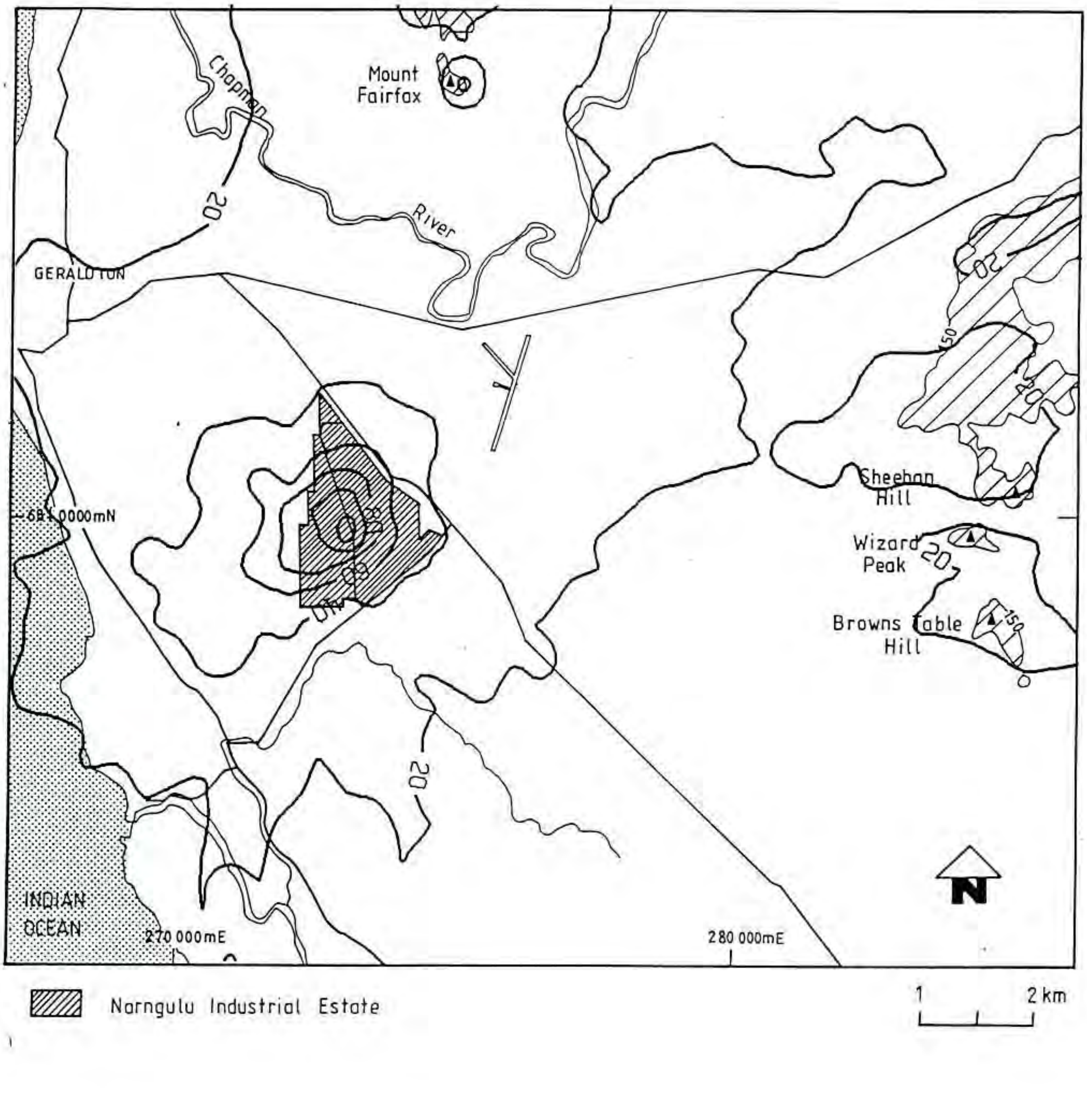

Figure 6.6 Predicted 9th highest one hour average ground level concentration of SO_2 from the synthetic rutile plant operating under normal conditions with an onshore lapse rate of 0.01 °C m^{-1}.

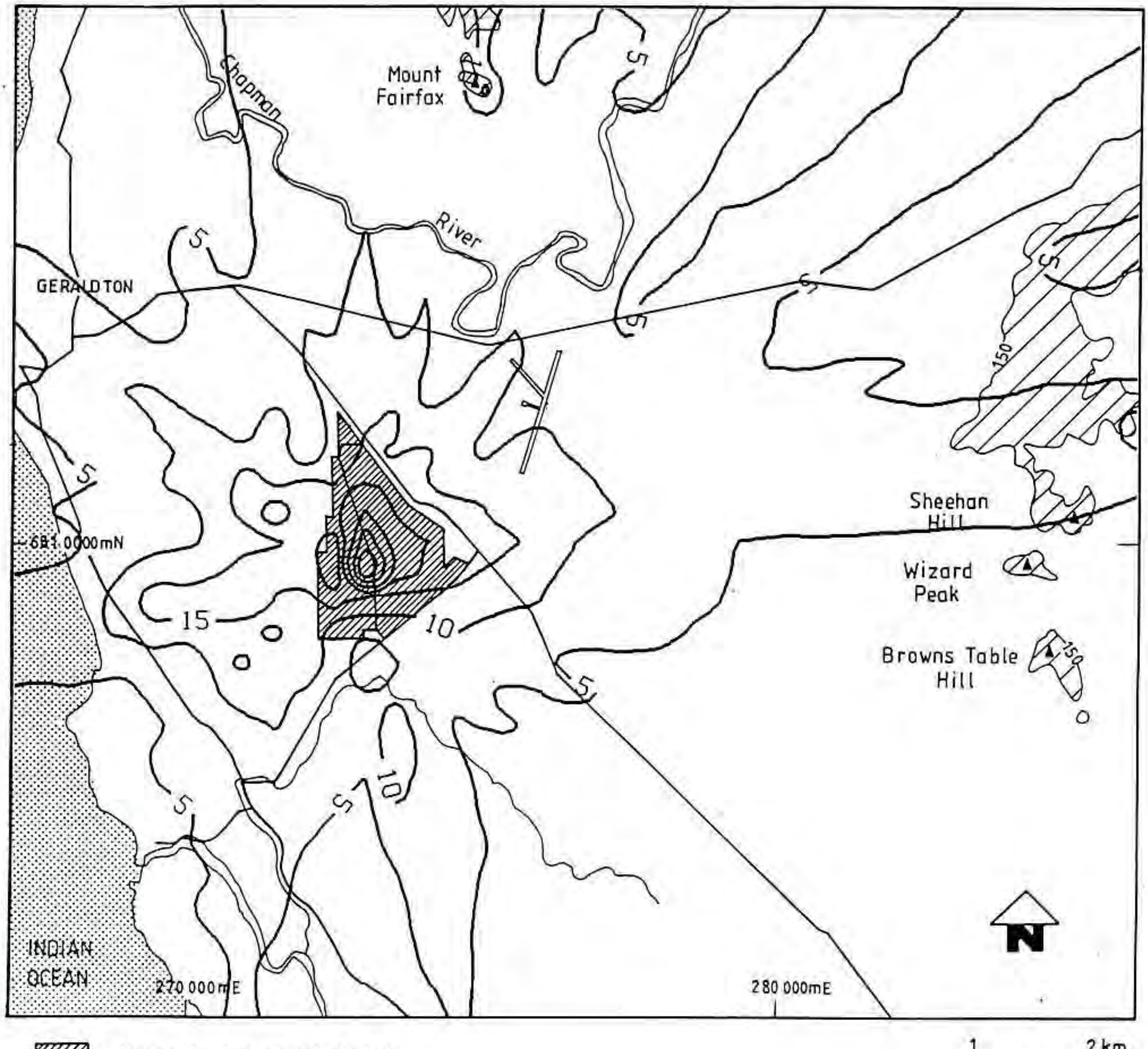

Figure 6.7 Predicted maximum 24 hour average ground level concentration of SO_2 from the synthetic rutile plant operating under normal conditions with an onshore lapse rate of 0.01 °C m^{-1}.

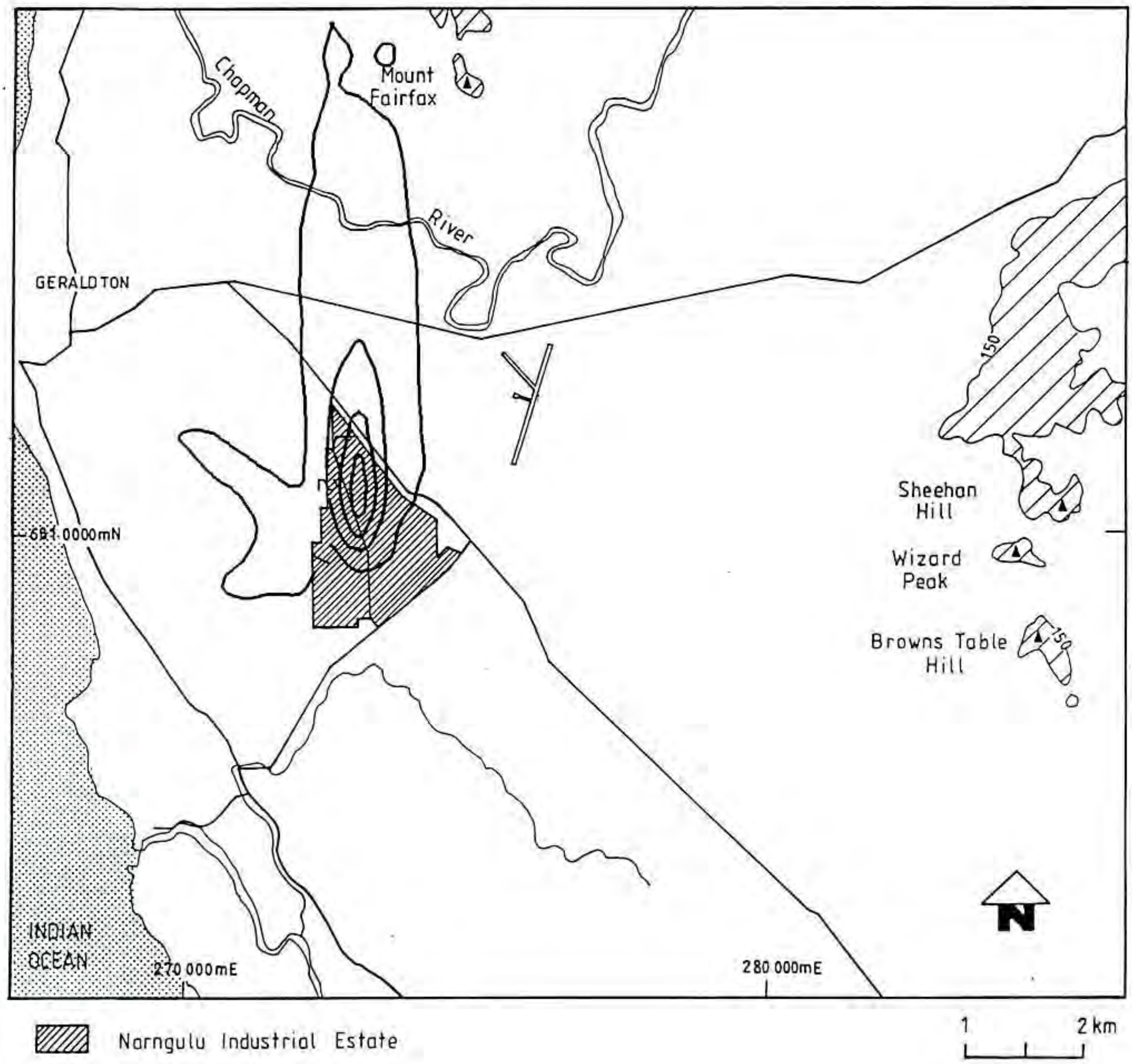

Figure 6.8 Predicted annual average ground level concentration of SO_2 from the synthetic rutile plant operating under normal conditions with an onshore lapse rate of 0.01 °C m^{-1}.

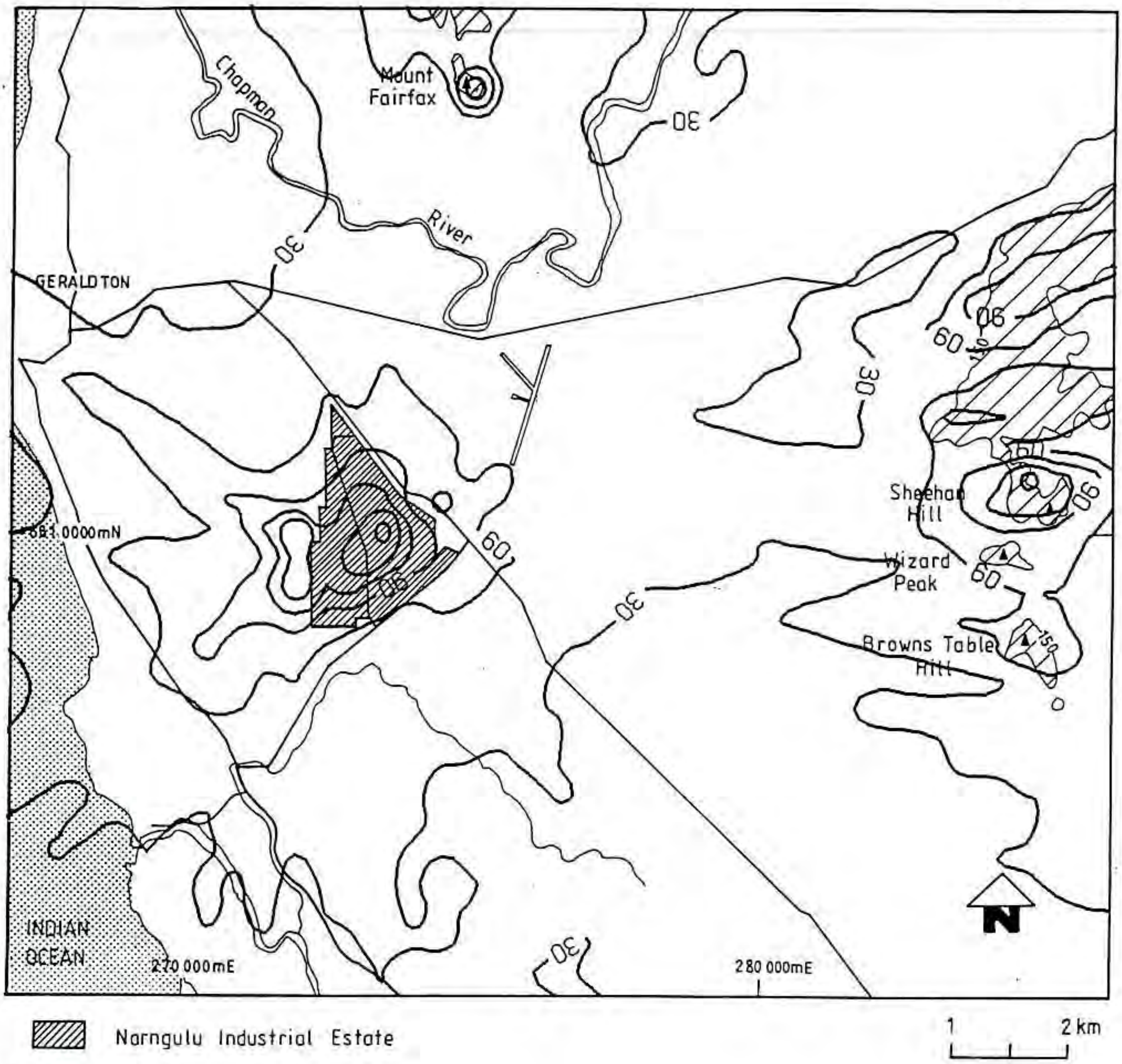

Figure 6.9 Predicted maximum one hourly average ground level concentration of SO_2 from the synthetic rutile plant operating under normal conditions with an onshore lapse rate of 0.02°C m^{-1}.

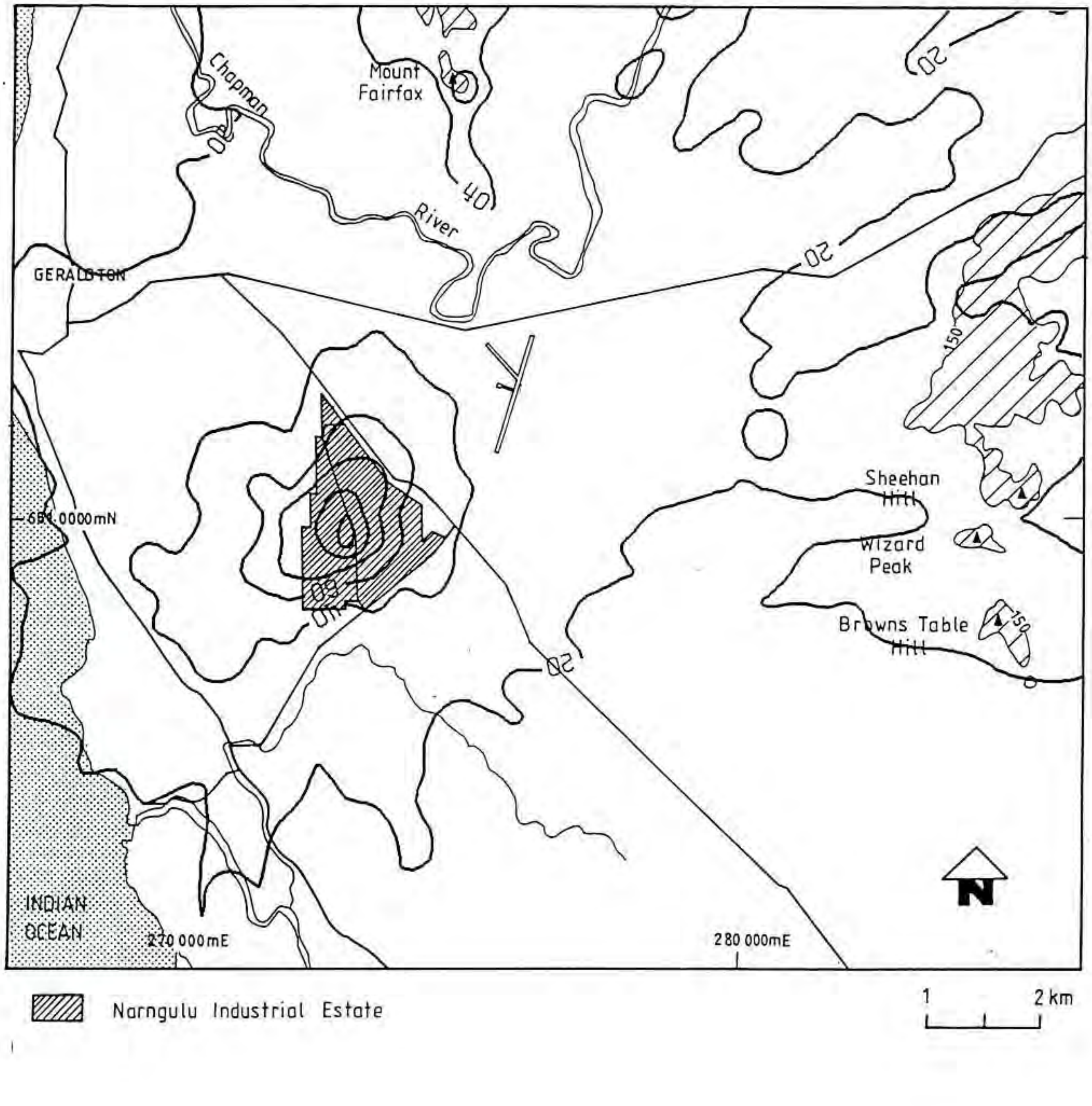

Figure 6.10 Predicted 9th highest one hour average ground level concentration of SO_2 from the synthetic rutile plant operating under normal conditions with an onshore lapse rate of 0.02°C m^{-1}.

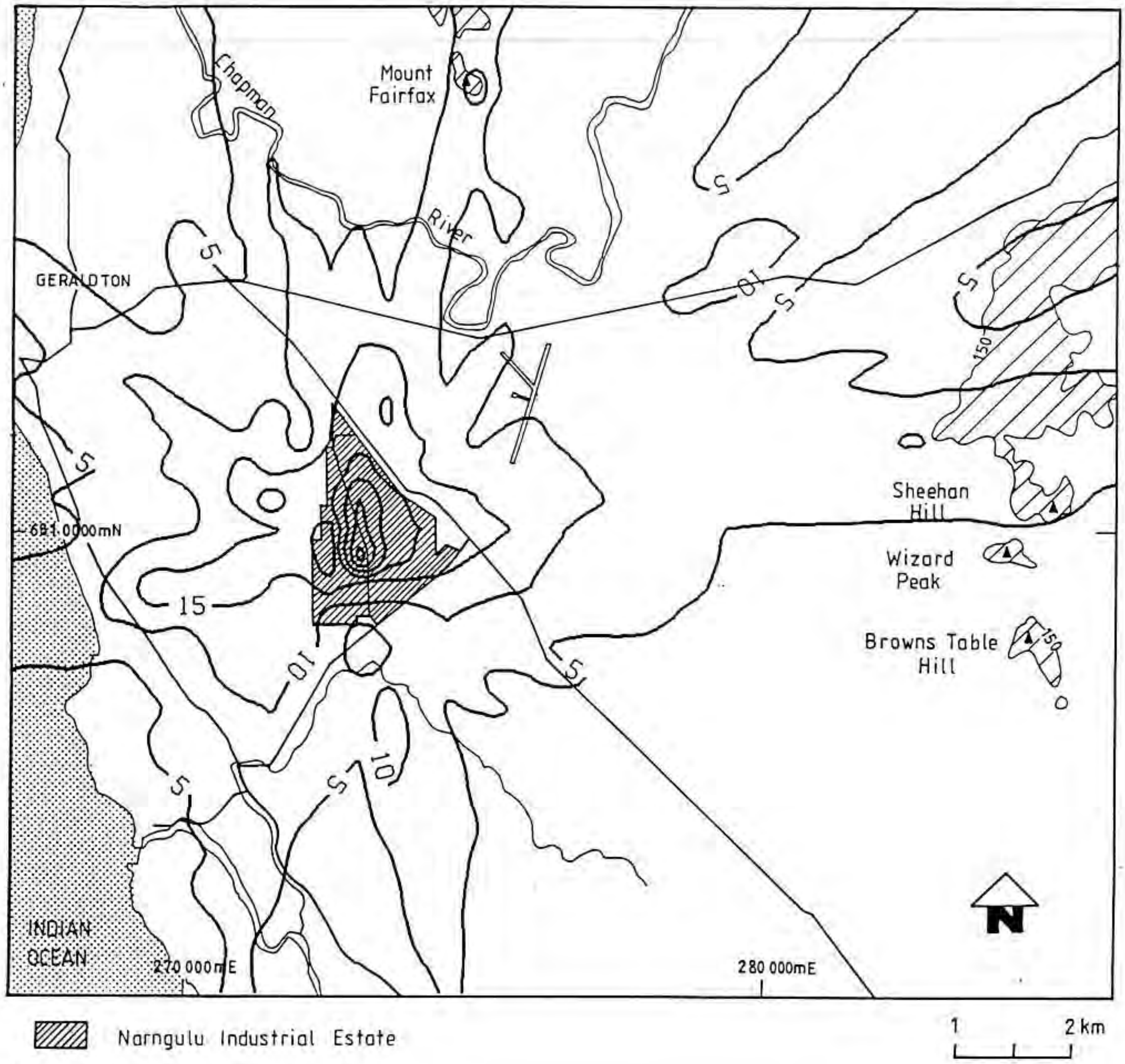

Figure 6.11 Predicted maximum 24 hour average ground level concentration of SO_2 from the synthetic rutile plant operating under normal conditions with an onshore lapse rate of 0.02°C m^{-1}.

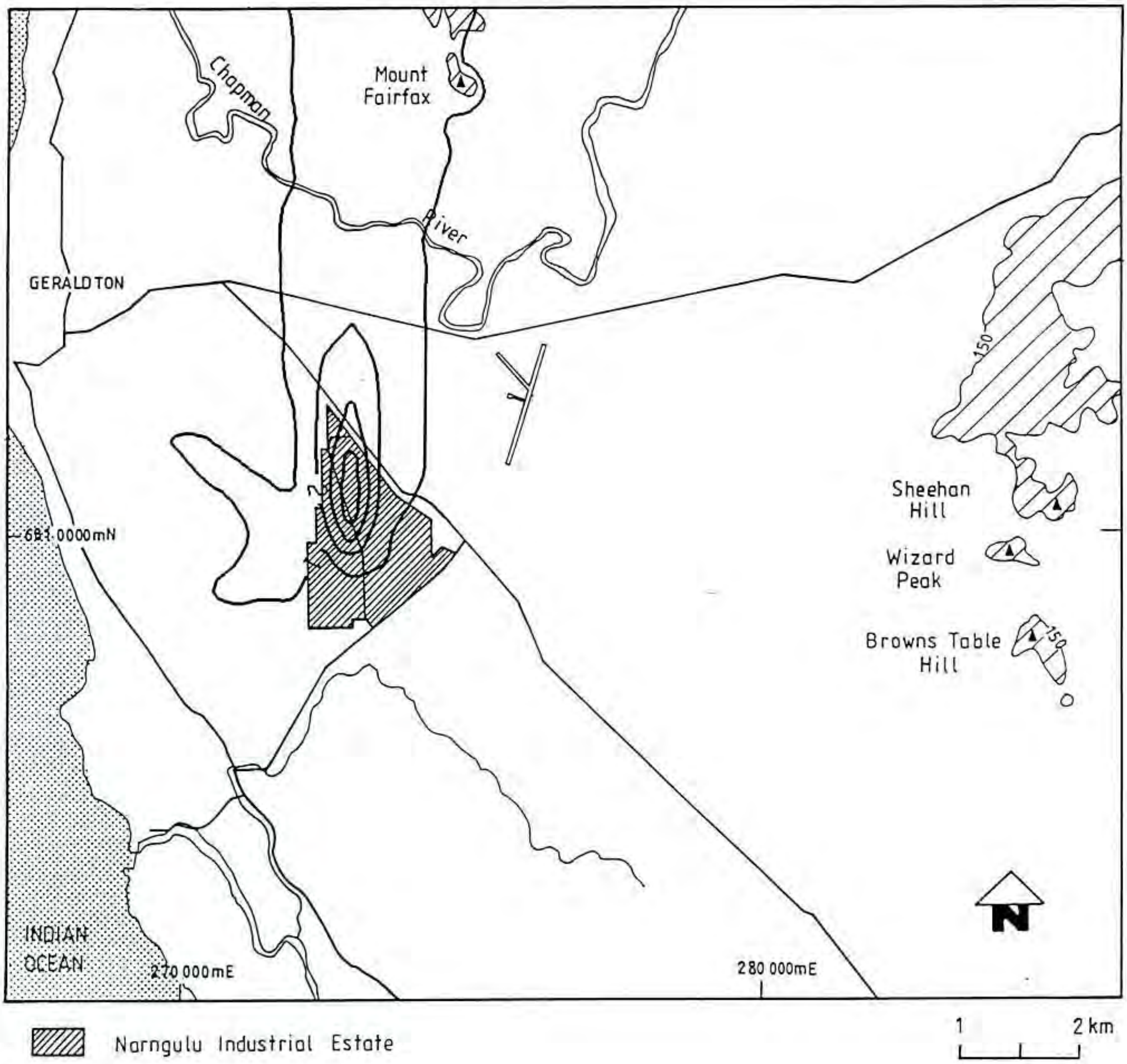

Figure 6.12 Predicted annual average ground level concentration of SO_2 from the synthetic rutile plant operating under normal conditions with an onshore lapse rate of $0.02°C\ m^{-1}$.

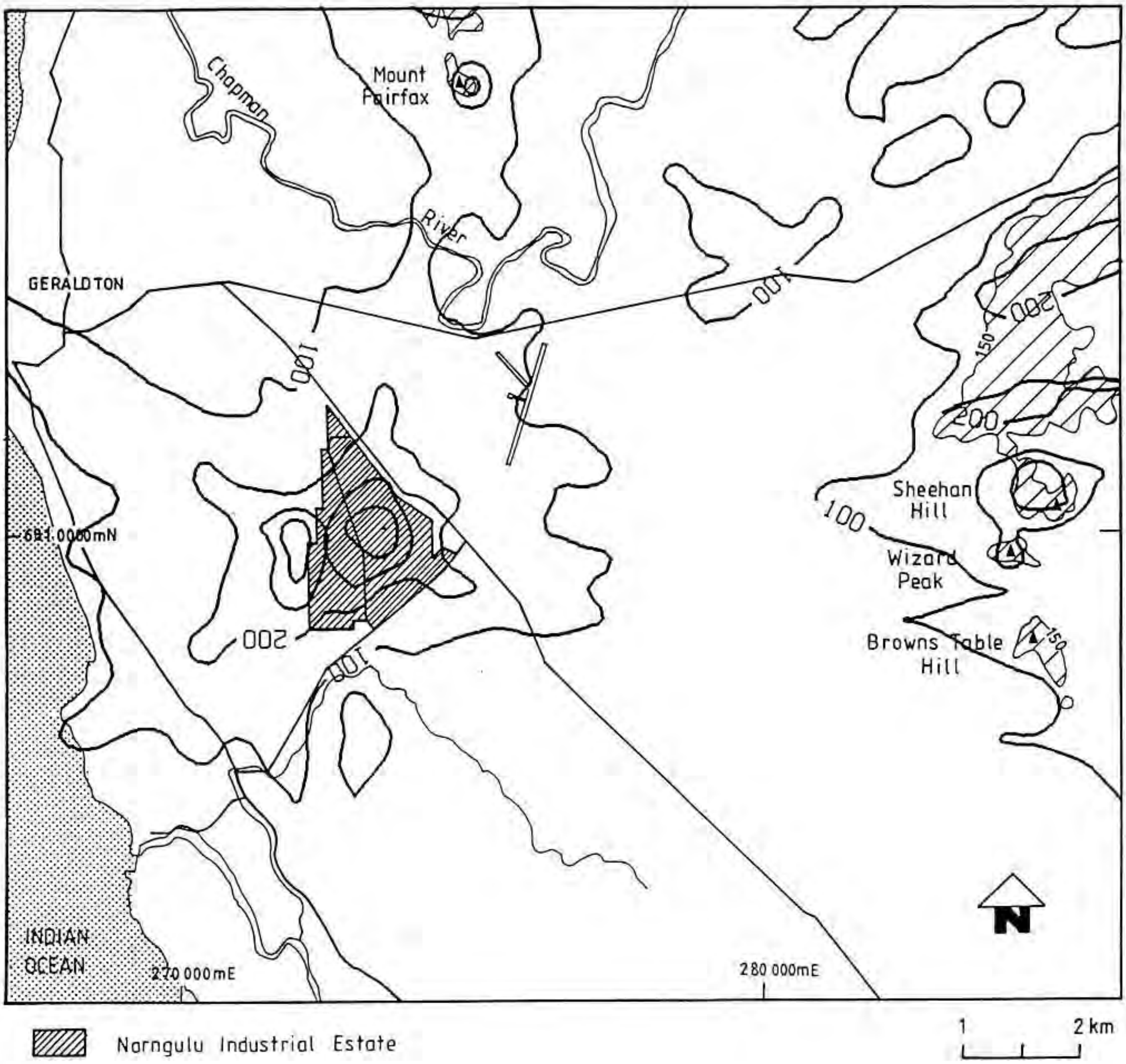

Figure 7.1 Predicted maximum one hourly average ground level concentration of SO_2 from the synthetic rutile plant.

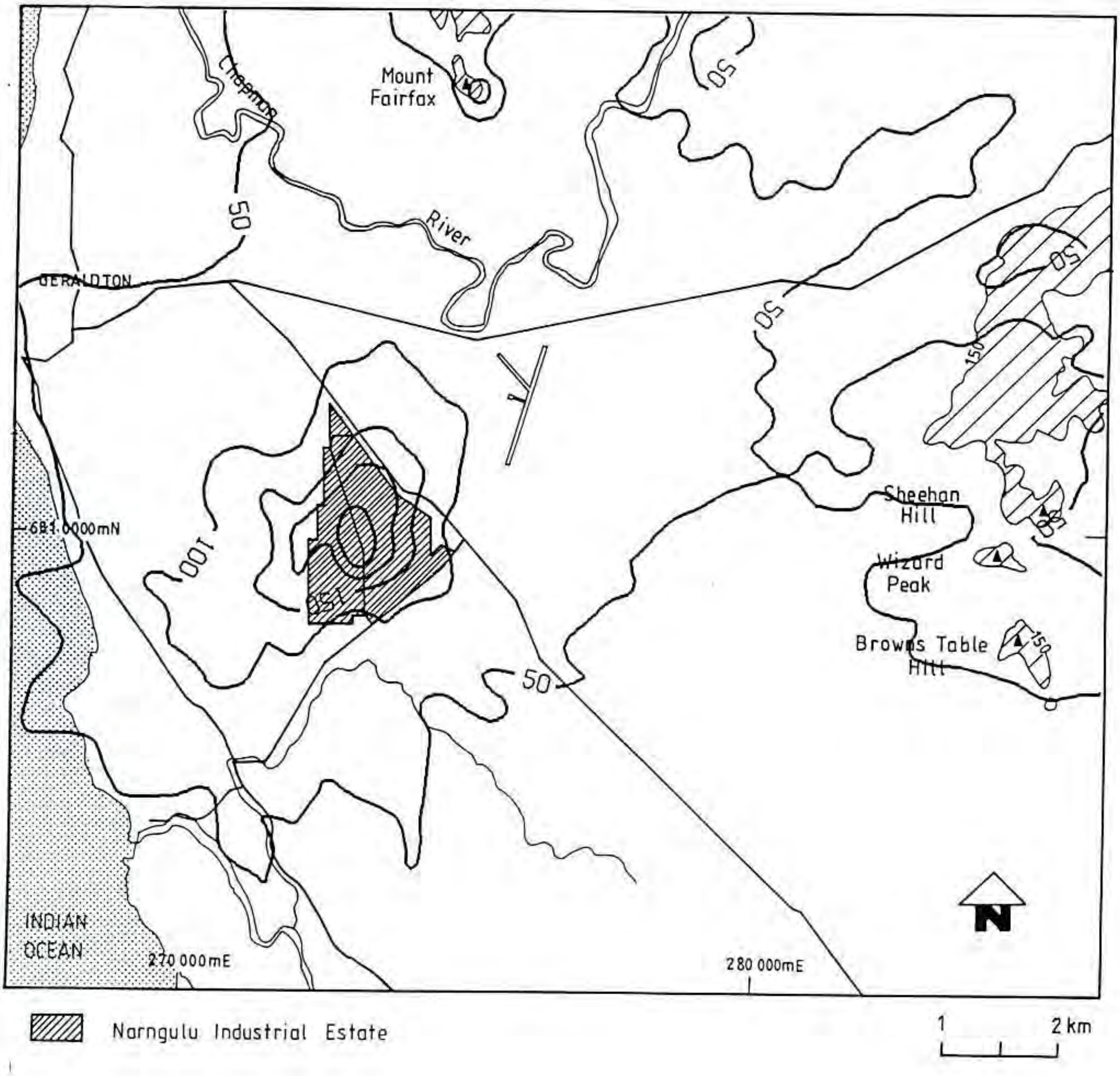

Figure 7.2 Predicted 9th highest one hourly average ground level concentration of SO_2 from the synthetic rutile plant.

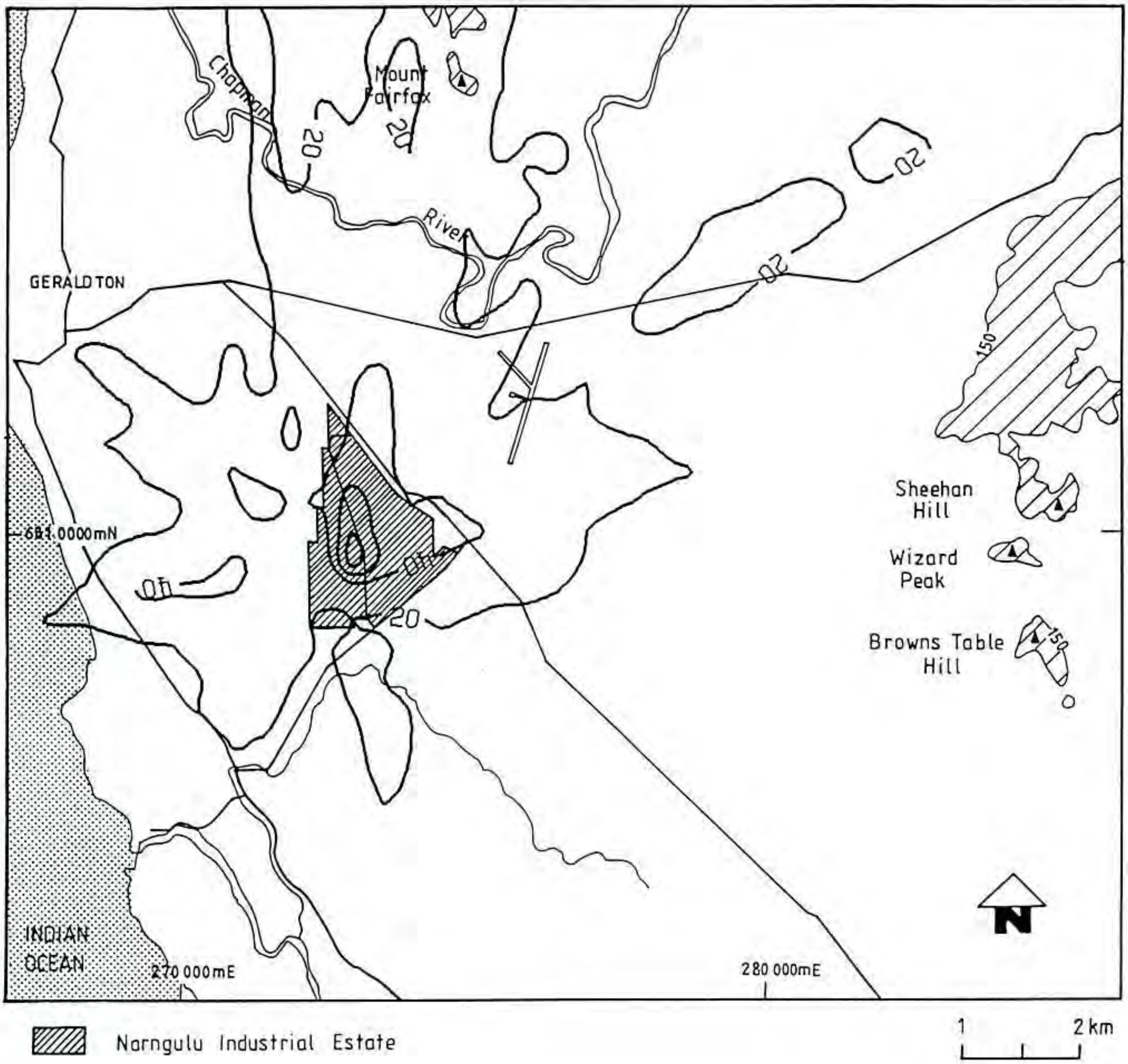

Figure 7.3 Predicted maximum 24 hour average ground level concentration of SO_2 from the synthetic rutile plant.

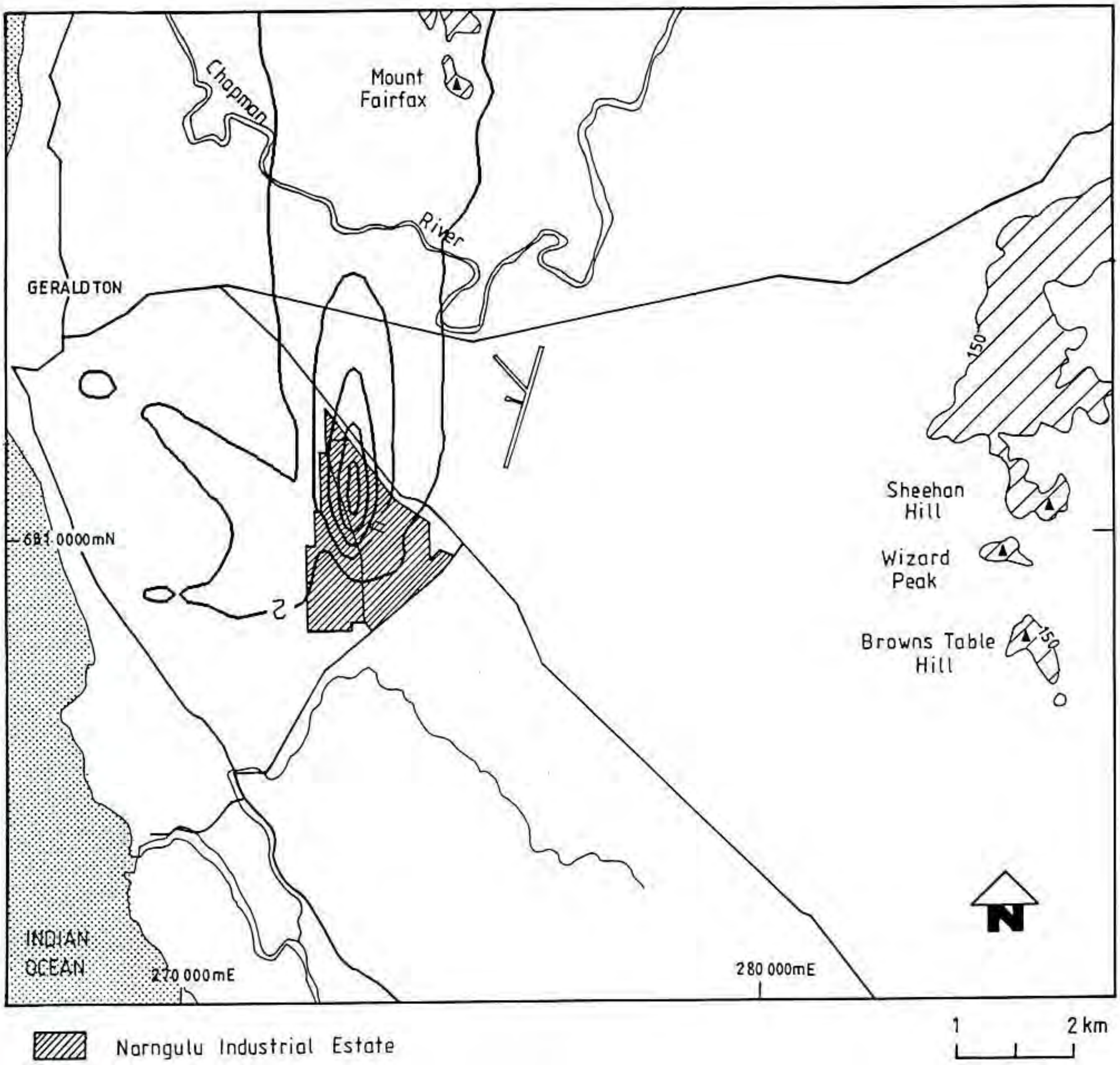

Figure 7.4 Predicted annual average ground level concentration of SO_2 from the synthetic rutile plant.

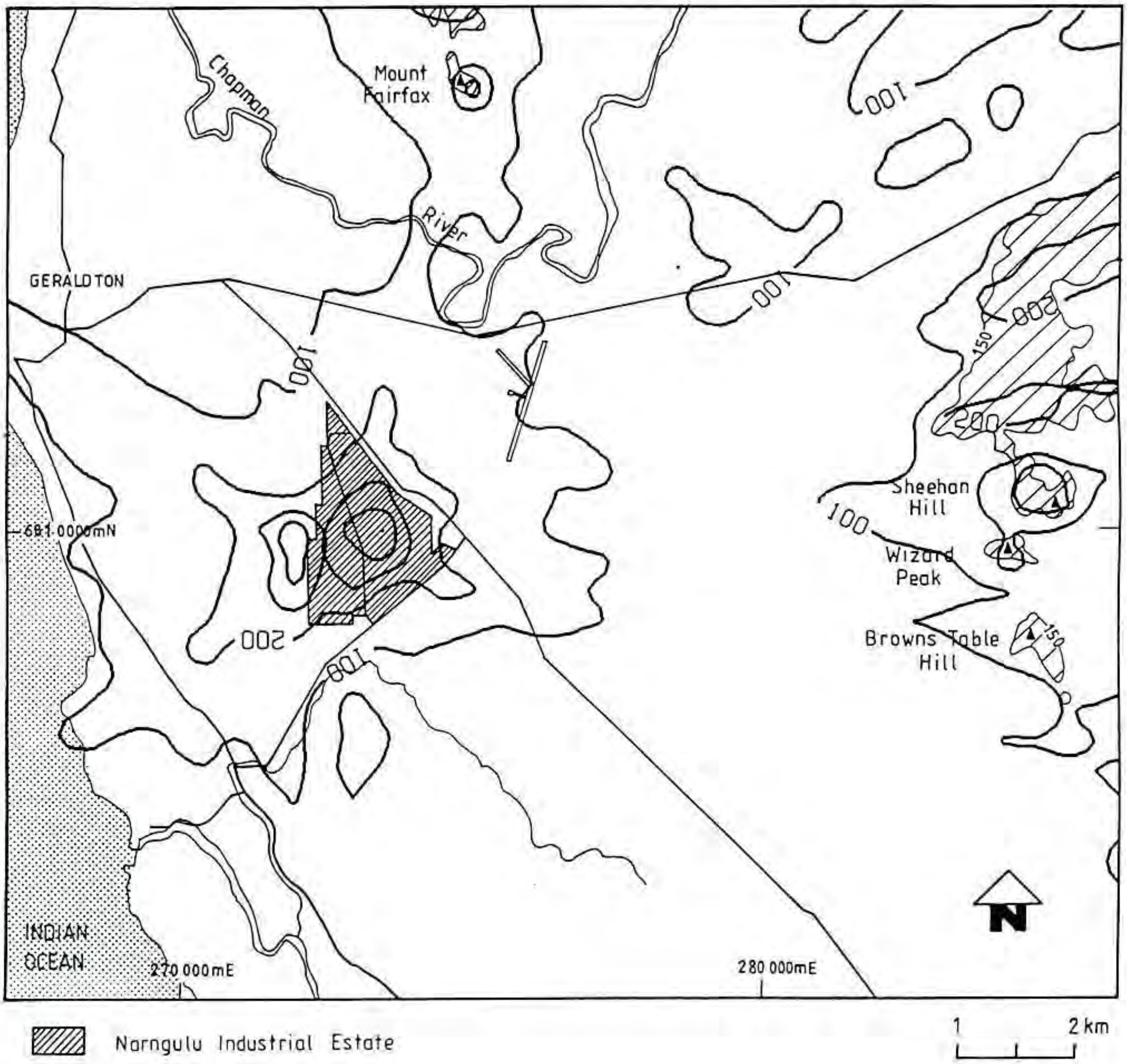

Figure 7.5 Predicted maximum one hourly average ground level concentration of SO_2 from the synthetic rutile plant and steel complex.

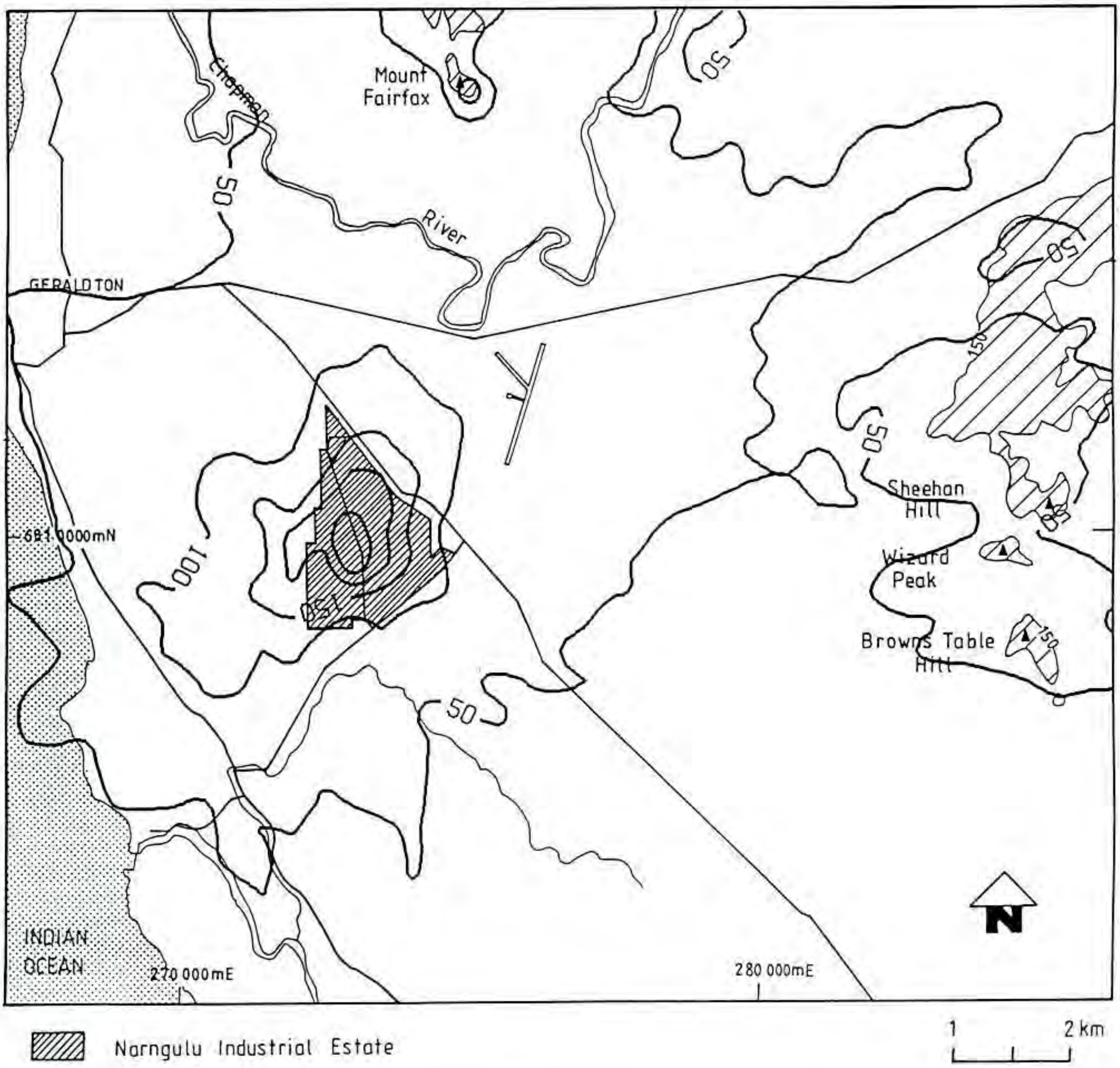

Figure 7.6 Predicted 9th highest one average ground level concentration of SO_2 from the synthetic rutile plant and steel complex.

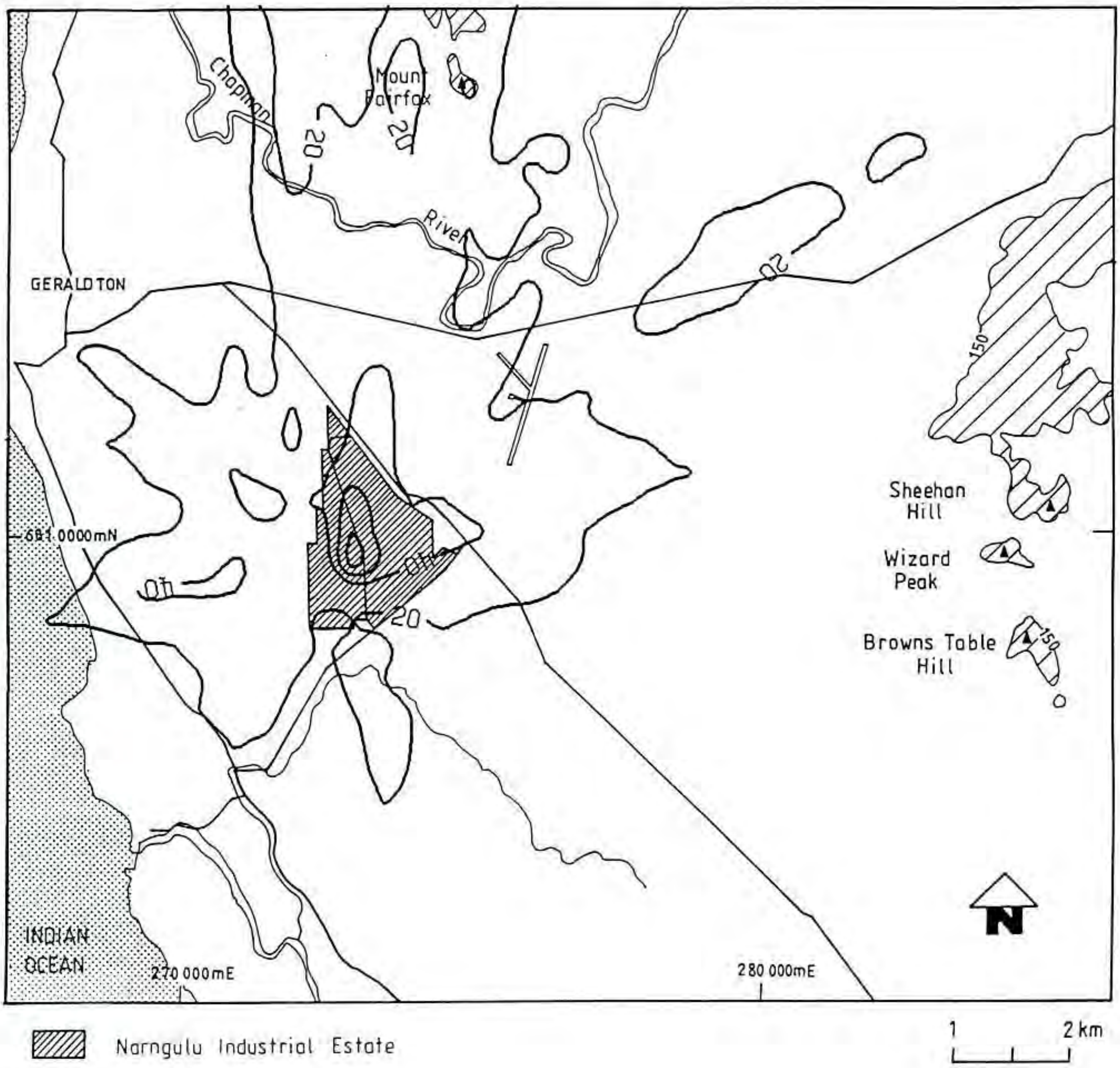

Figure 7.7 Predicted maximum 24 hour average ground level concentration of SO_2 from the synthetic rutile plant and steel complex.

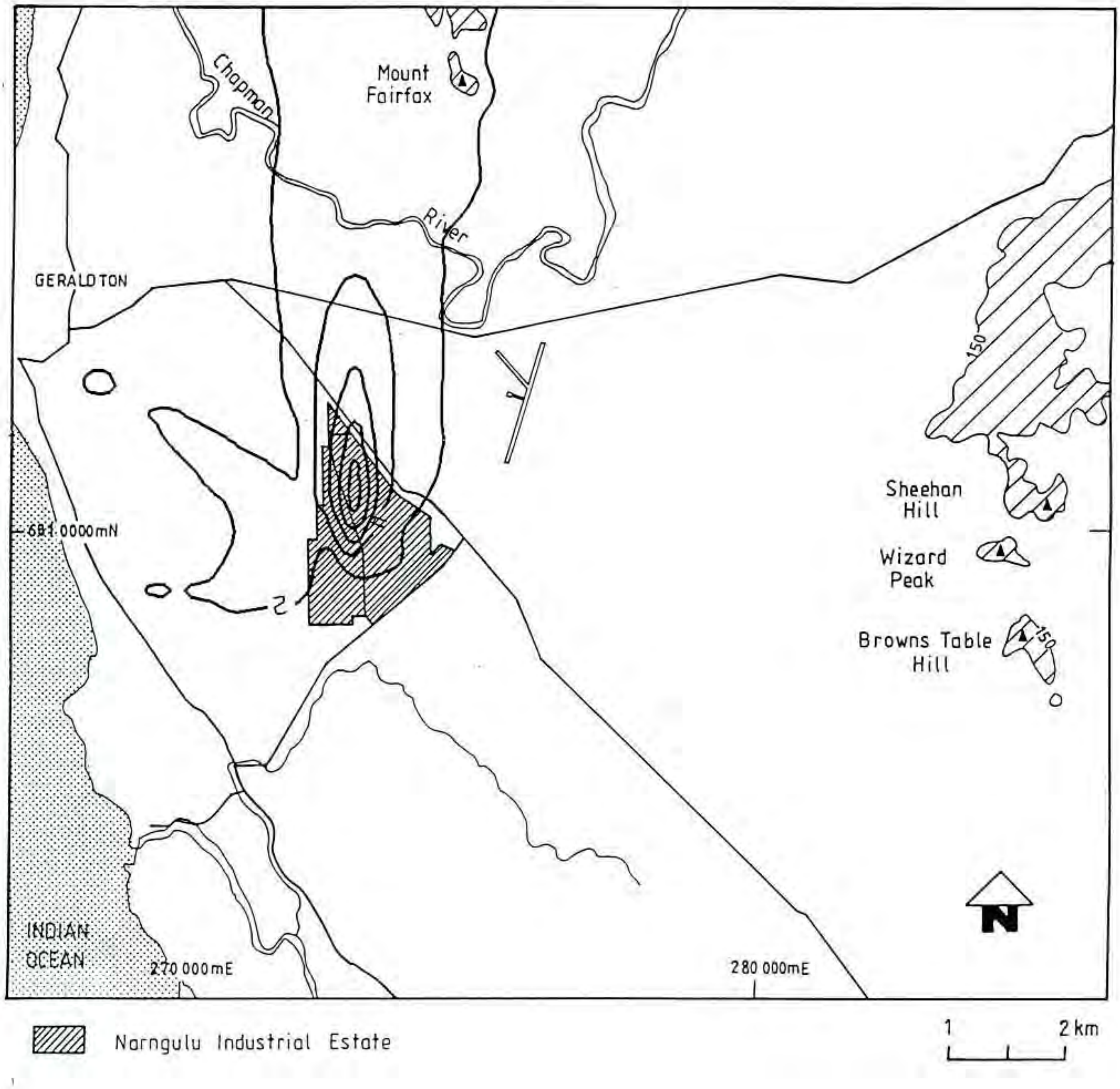

Figure 7.8 Predicted annual average ground level concentration of SO_2 from the synthetic rutile plant and steel complex.

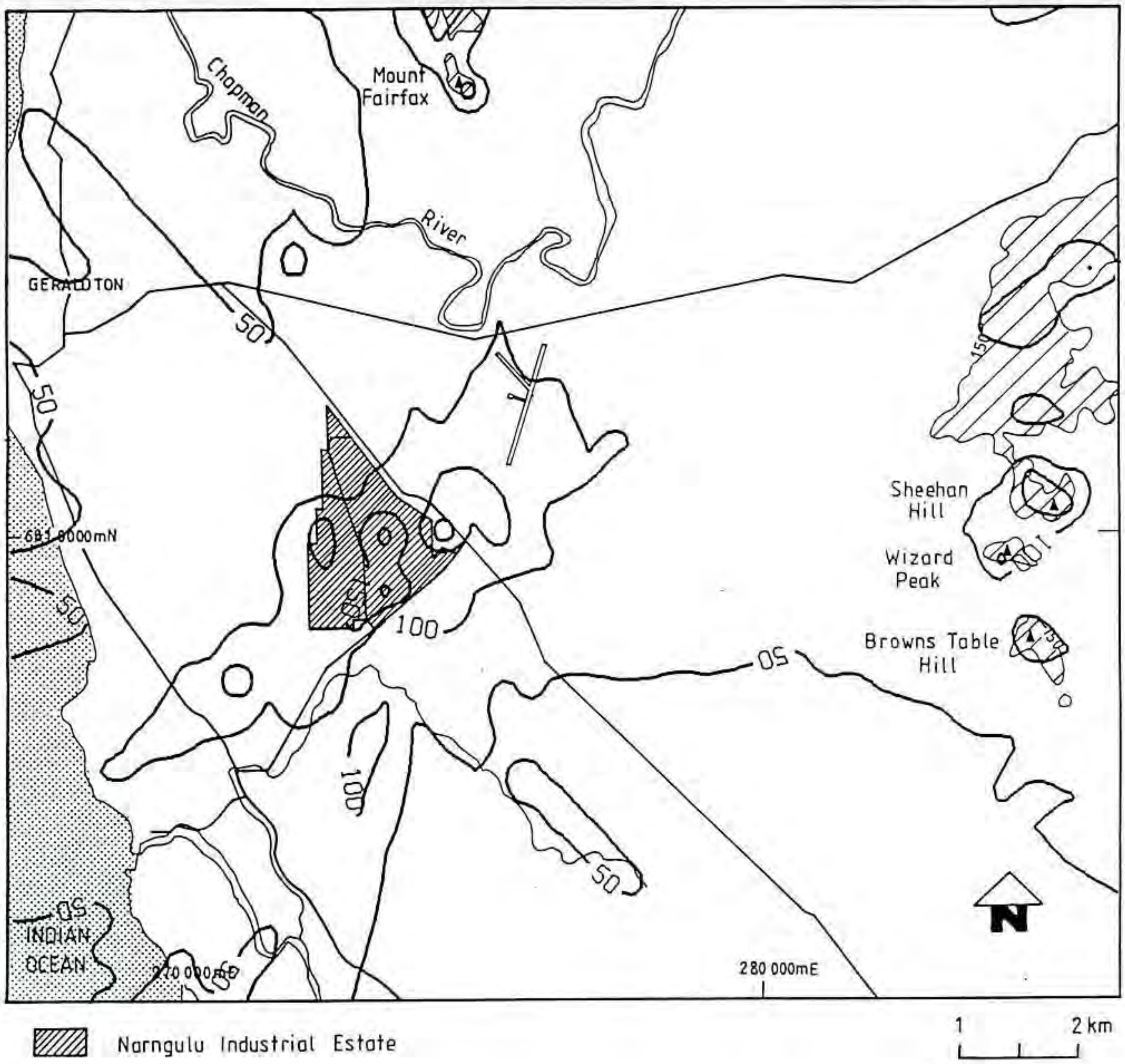

Figure 7.9 Predicted maximum one hourly average ground level concentration of NO_2 from the steel complex.

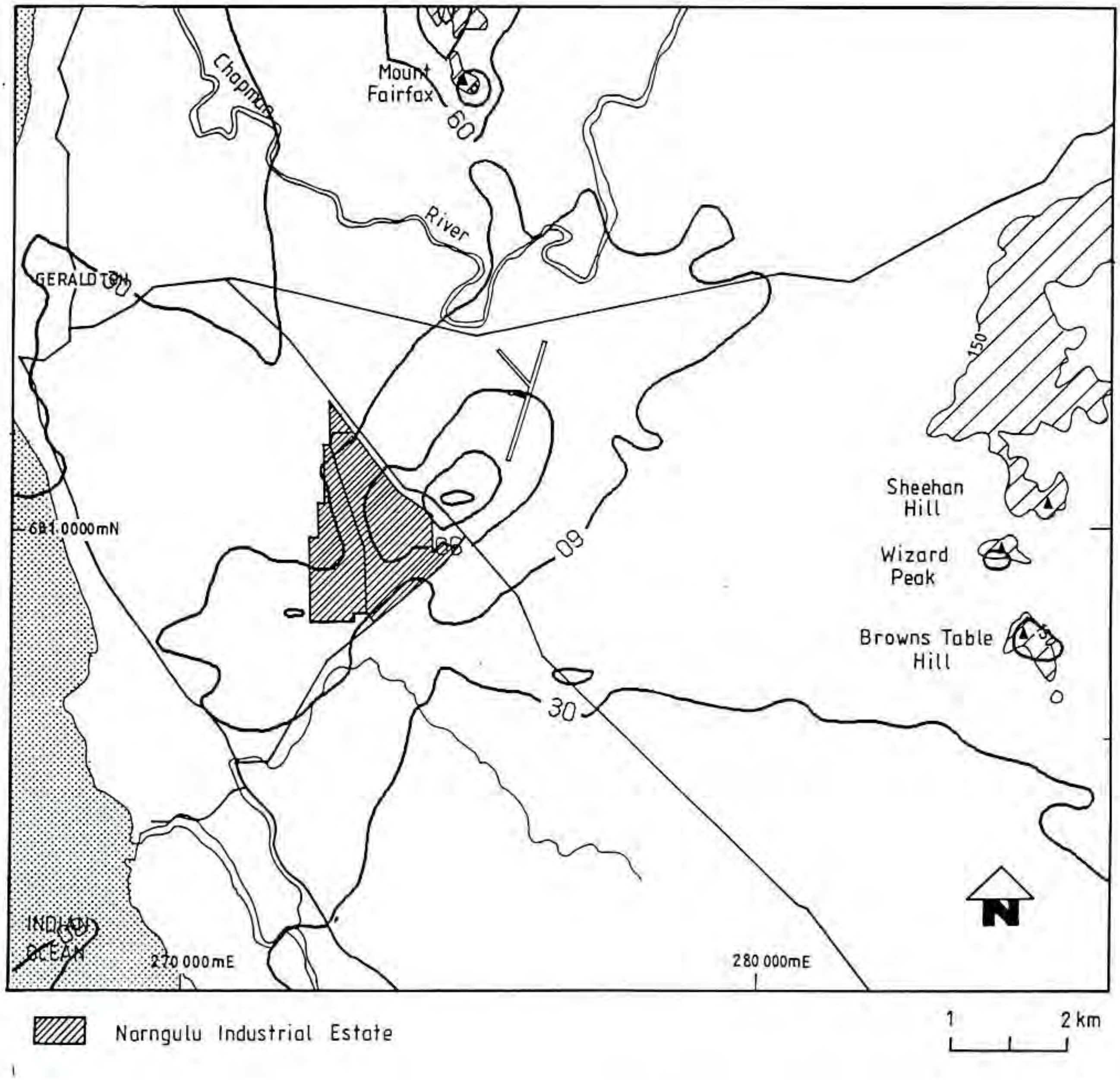

Figure 7.10 Predicted 9th highest one hour average ground level concentration of NO_2 from the steel complex.

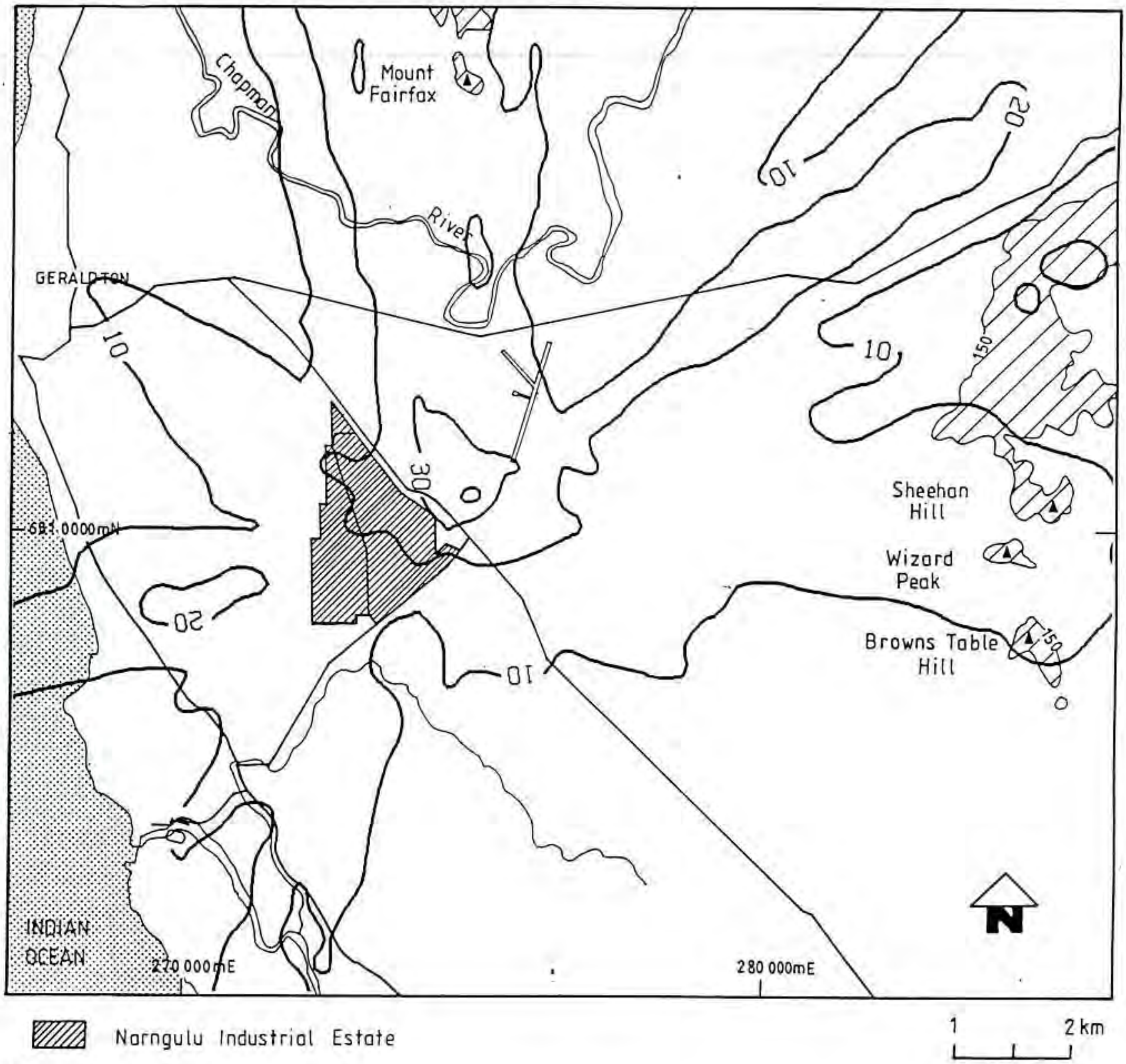

Figure 7.11 Predicted maximum 24 hour average ground level concentration of NO_2 from the steel complex.

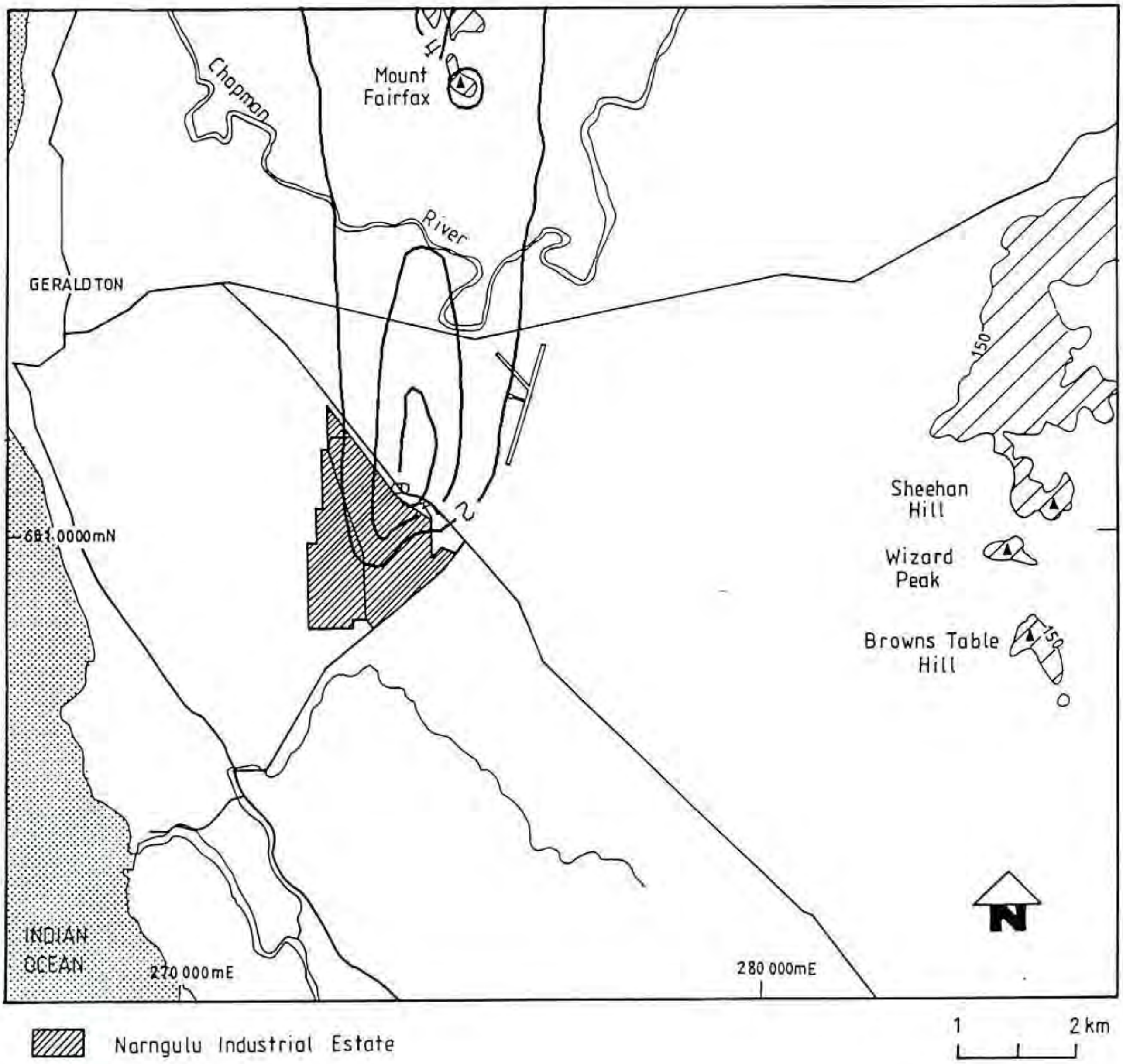

Figure 7.12 Predicted annual average ground level concentration of NO_2 from the steel complex.

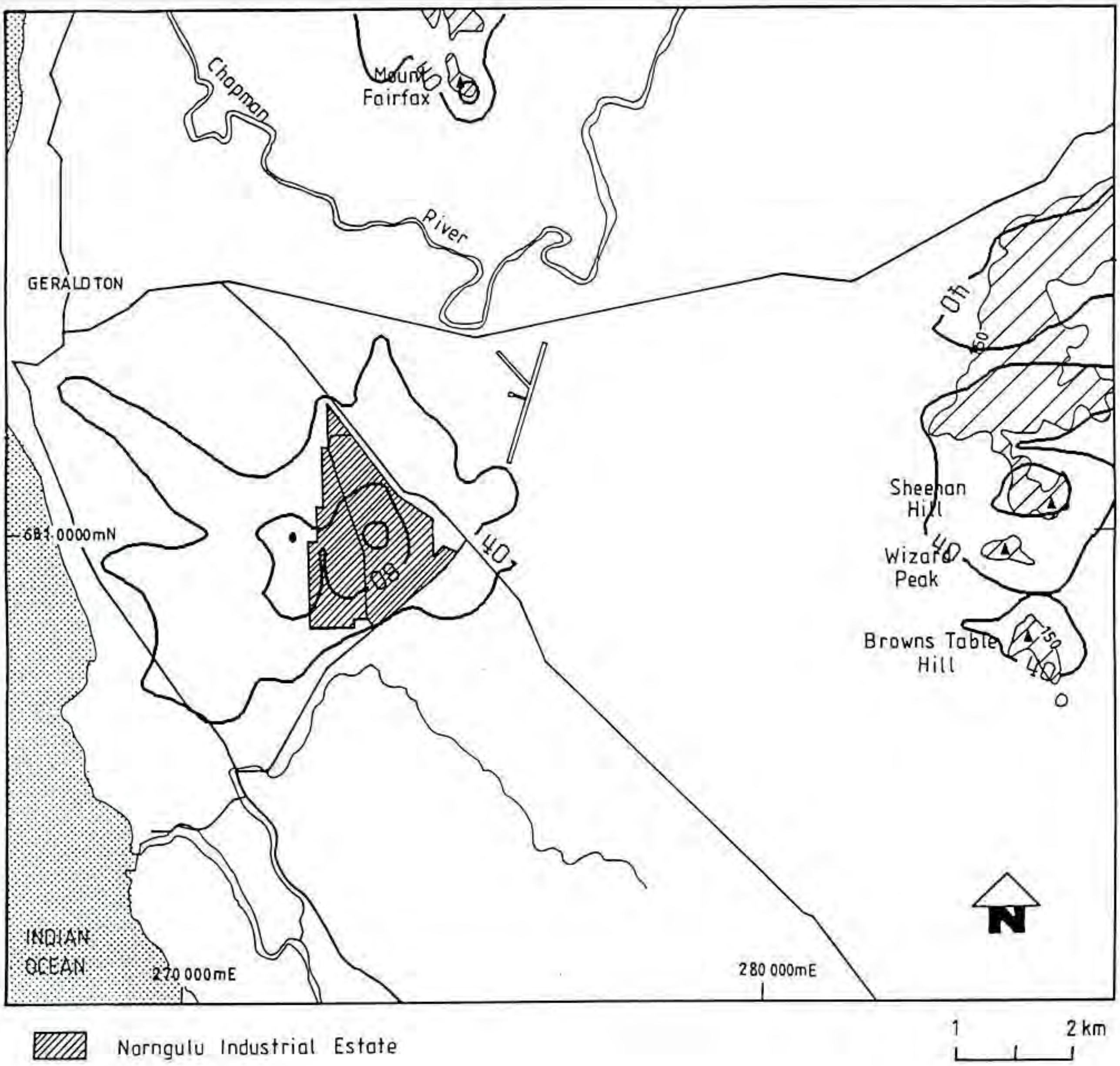

Figure 7.13 Predicted maximum 15 minute average ground level concentration of particulate (PM_{10}) from the synthetic rutile plant.

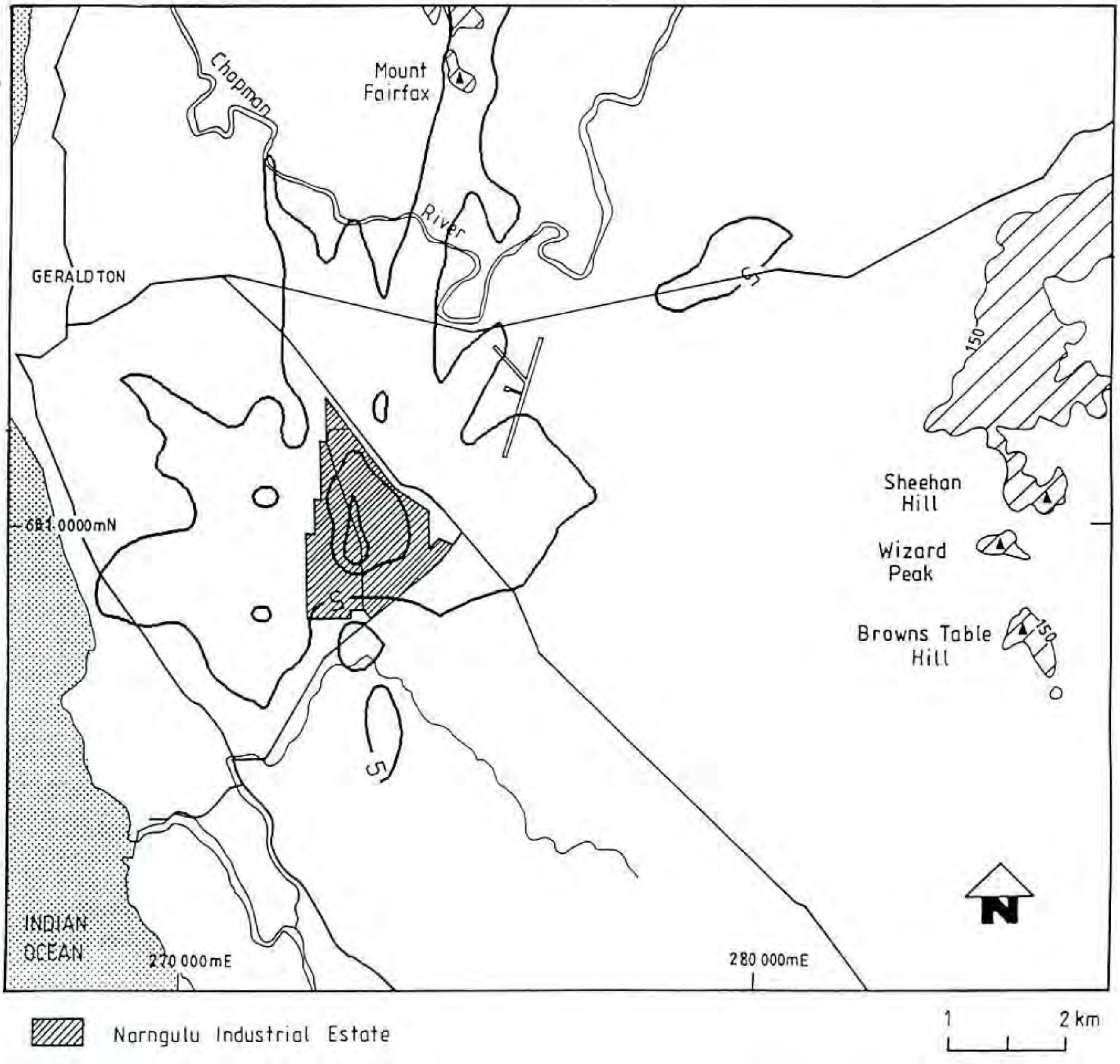

Figure 7.14 Predicted maximum 24 hour average ground level concentration of particulate (PM_{10}) from the synthetic rutile plant.

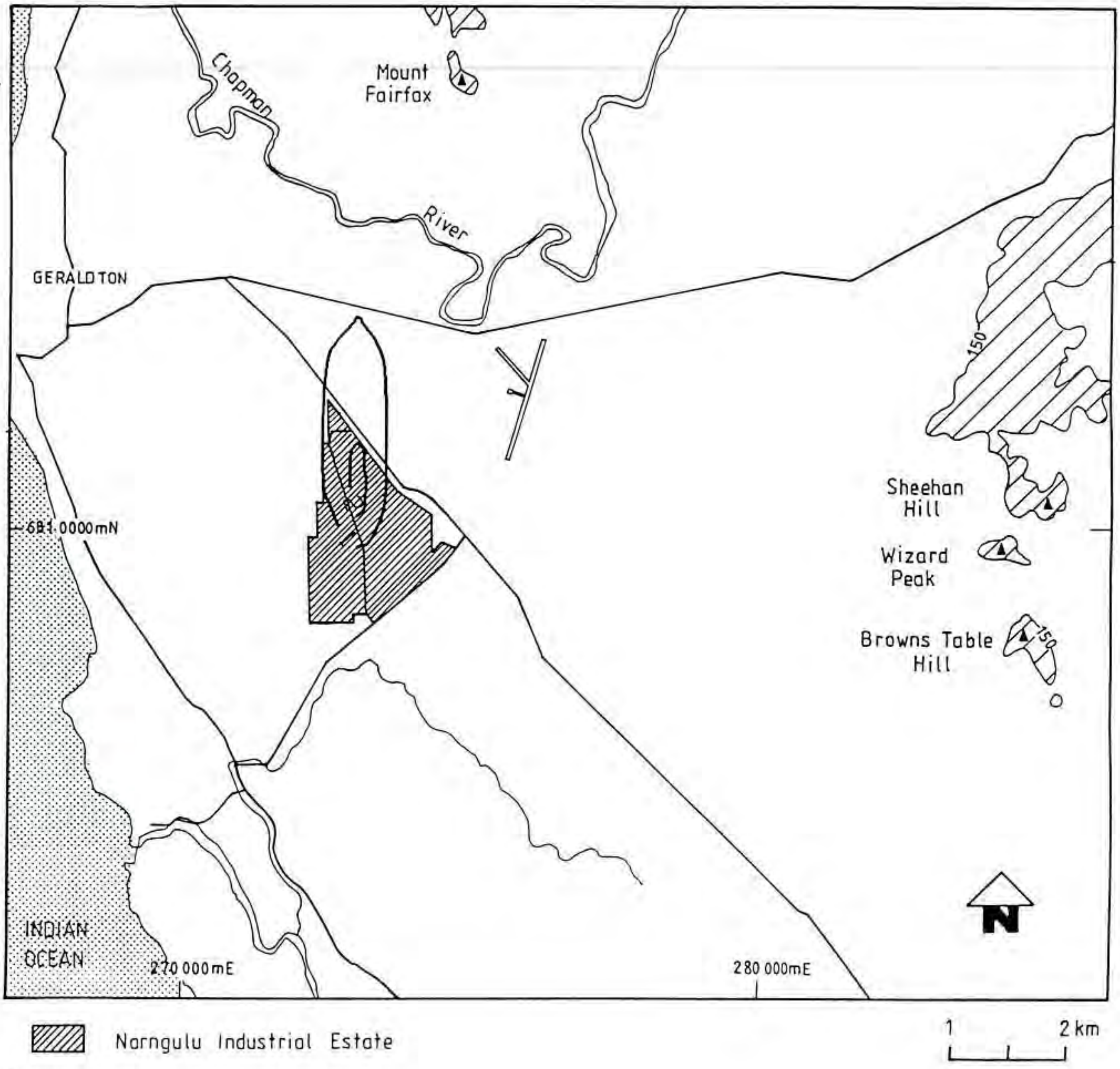

Figure 7.15 Predicted annual average ground level concentration of particulate (PM_{10}) from the synthetic rutile plant.

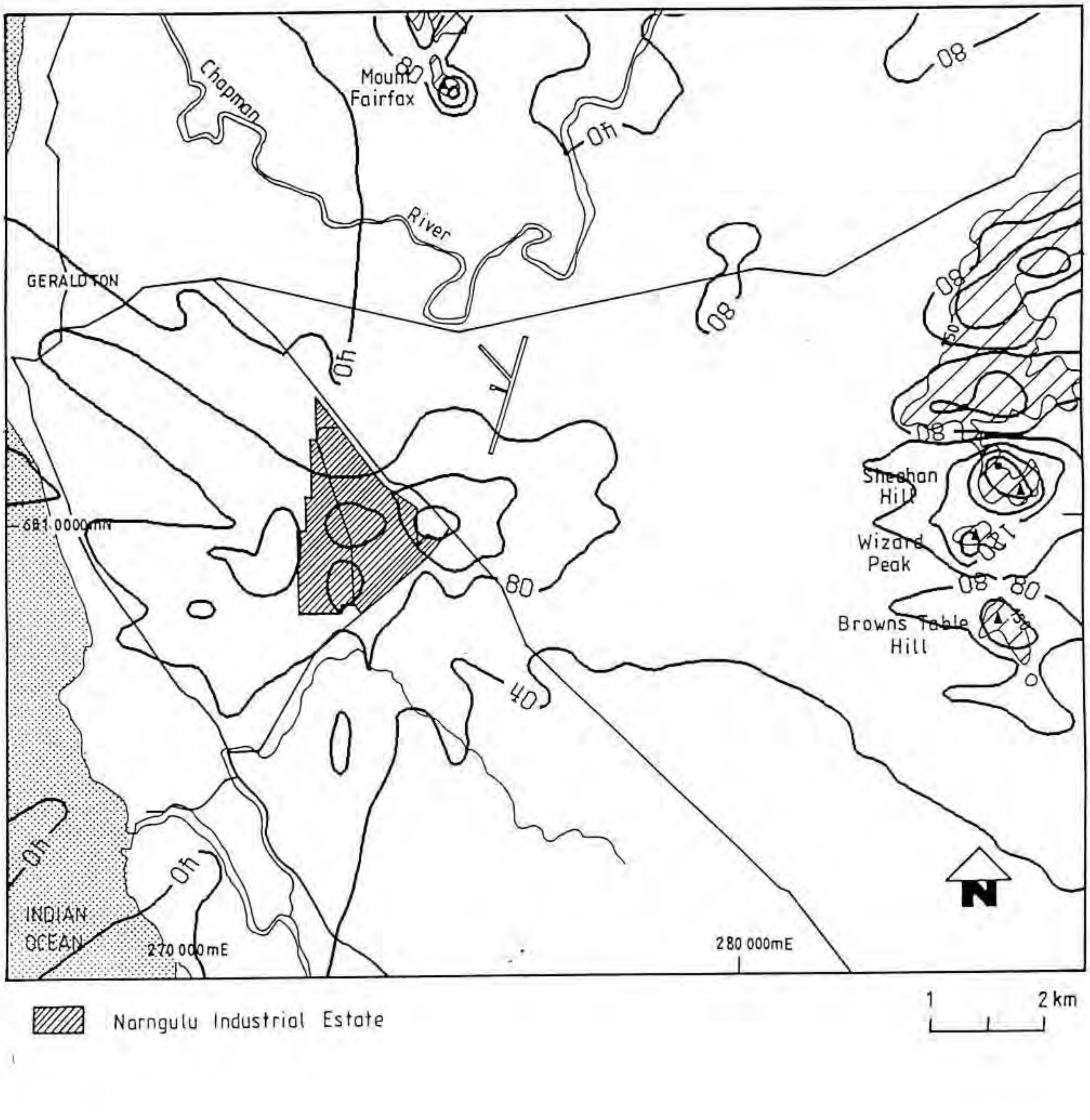

Figure 7.16 Predicted maximum 15 minute average ground level concentration of particulate (PM_{10}) from the synthetic rutile plant and steel complex.

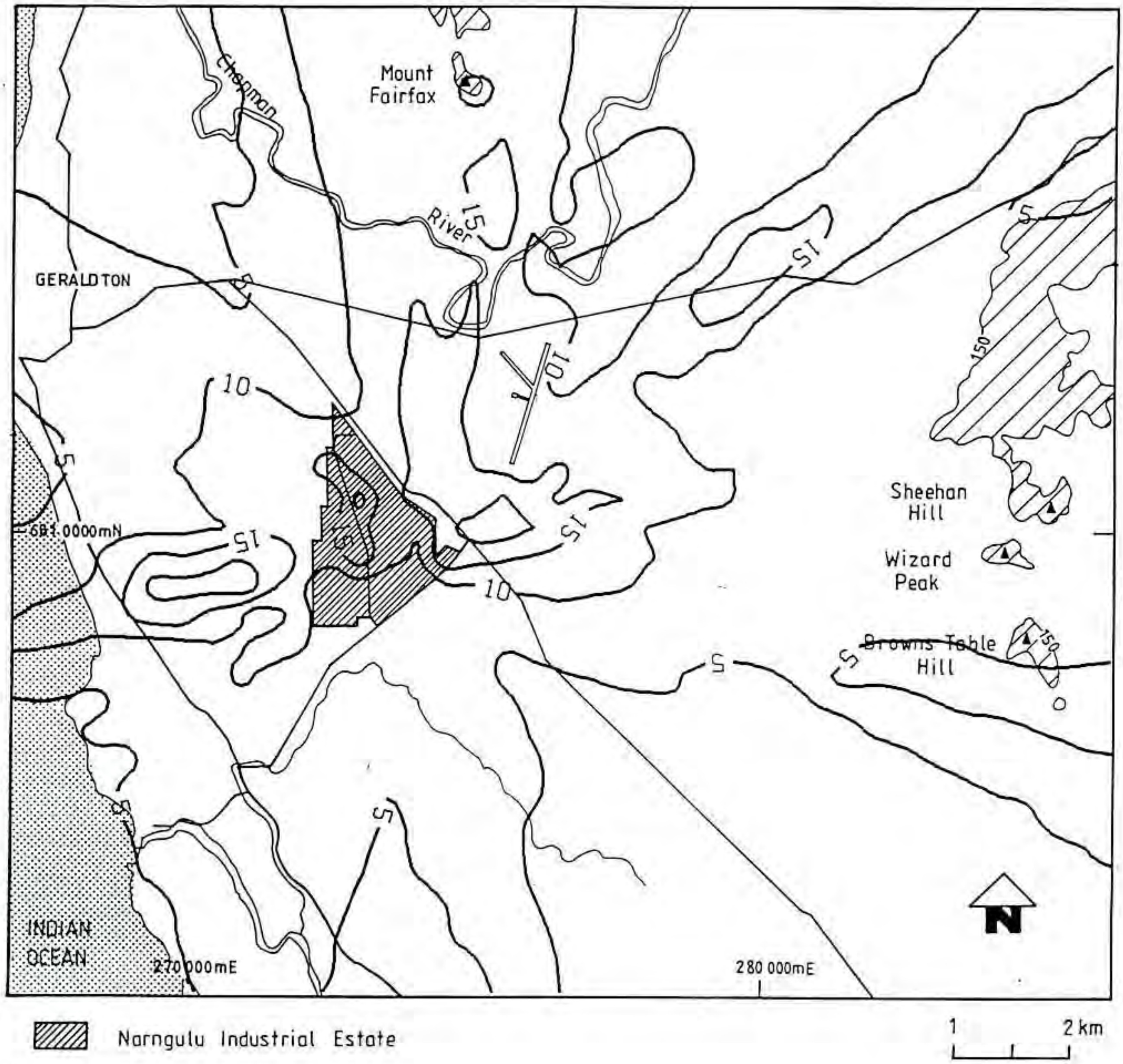

Figure 7.17 Predicted maximum 24 hour average ground level concentration of particulate (PM_{10}) from the synthetic rutile plant and steel complex.

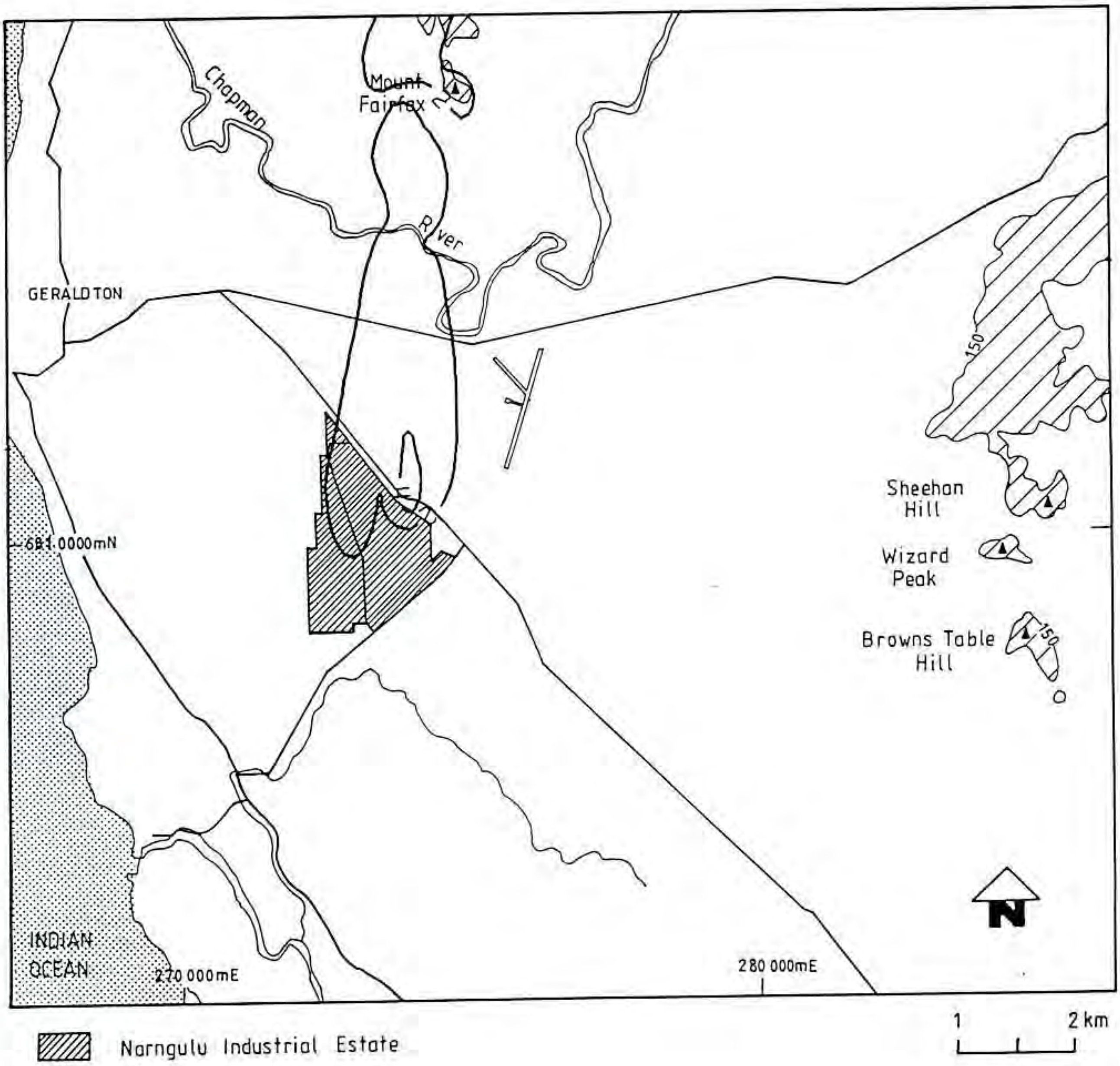

Figure 7.18 Predicted annual average ground level concentration of particulate (PM_{10}) from the synthetic rutile plant and steel complex.

Appendix A

Examples of a command and control file used in a typical DISPMOD run

Run time: Thu Apr 20 14:12:01 WST

```
DISPMOD>Enter the name of the control file: narn4.ctl
DISPMOD>Enter the name of the output file:  narn.out
DISPMOD>Do you want to use stability classes (Y/N <N>): N
DISPMOD>Do you want only centre-line concentrations (Y/N <N>): N
DISPMOD>Use fixed sea breeze depth of 1500 m? (Y/N <N>):  Y
DISPMOD> Choose an option for onshore flow lapse rate:
1 fixed value  2 Manins/Physick  3 Rye     1
DISPMOD> Apply standard seasonal lapse rate variation? (Y/N <N>):  Y
DISPMOD> Enter fixed onshore Gamma (G0): 0.02
DISPMOD>Use measured sigma theta? (Y/N <N>): N
DISPMOD>Do you want to reduced Sigma Theta at height in TIBLs (Y/N <N>):  N
DISPMOD>Do you want mixing into TIBLS to be sharper than SGPHI (Y/N <N>): Y
        Enter new constant SGPHI for TIBLS   1.0
DISPMOD> If met data is to be averaged, do you want to compare variance
due to direction meander to calculated variance and
select the greater? (Y/N <N>): N
DISPMOD> Do you want to get info to screen/log on events
with timestep conc. exceeding a nominated value?  N
DISPMOD>Do you want AUSPLUME plume penetration (Y/N <N>):  N
        Include terrain effects (y/n)  :  Y
        Enter terrain file receptor grid : narn.ter
DISPMOD>Enter the name of the WML file (no extension for database) narn9495.dis
        (RETURN TO END RUN):  16 394  23718  16175
```

```
Mutiple tall stacks North Location #4
  267000. 6802000.  500. 39 35 0.3610 -28.7 157.0   3.0  .083  .047  0.25
 160394 150395 0010 2400  3  1 77  1.9  2.3
  8 0.00 0350. 0500. 0700. 1000. 1
  1  1  1  1  1  1  1  1
  1  2  3  4  5  6  7  8
  0          ! NUMBER OF STACKS THAT ARE NOT BEING USED
WASTE GAS 1     29.0 3.76 273970 6809670 1.00  0.5200   0.025   222.   0.815 1  25  70  23
WASTE GAS 2     25.0 3.00 274015 6809765 1.00  0.5200   0.020   142.   1.000 1  25  70  23
REFORMER  6     40.0 2.17 273333 6809280 1.00  0.5000   0.006    72.   0.779 1  92  10  23
HEATER    8     75.0 1.29 273377 6809330 1.00  0.5000   0.004    40.   1.292 1  92  10  23
MELTSHOP        30.0 5.64 273583 6809400 1.00  0.5000   0.005   500.   0.876 1  30  80  23
GAS T.    1     25.0 4.00 273050 6808710 1.00  0.3700   0.023   475.   0.397 1  12  20  22
GAS T.    2     25.0 4.00 273050 6808750 1.00  0.3700   0.023   475.   0.397 1  12  20  22
GAS T.    3     25.0 4.00 273050 6808790 1.00  0.3700   0.023   475.   0.397 1  12  20  22
0

TITLE
(A)
XREF,YREF,GINT,NUMX,NUMY,DTSL,ALAT,CSTDIR,ZLSB,SGTHSB,SGPHSB,TIBPEN
(2F9.1,F6.1,2I3,F7.4,3F6.1,3F6.0)
IDS,IMS,IYS,IDF,IMF,IYF,IT1,IT2,IAV,IDATAV,IY1
(2(1X,3I2),2I5,3I3)
**** NOTE - IAV    = MODEL TIME STEP IN MULTIPLES OF 10 MINUTES (EG. 3 = 30 MIN
                     TIMESTEP.
          - IDATAV = INPUT MET DATA AVERAGING TIME IN MULTIPLES OF 10 MINUTES
                     (EG. 3 = 30 MIN INPUT DATA)
**** NOTE - IAV CANNOT BE LESS THAN IDATAV AND IDATAV MUST BE GREATER THAN 0
NUMSCE,QMIN,ALEV1,ALEV2,ALEV3,ALEV4,I
(I3,F5.1,4F6.0,I2)
**** NOTE - POLPOT MODE IS NOW FOR MULTIPLE SOURCES WITH FIXED EMISSIONS.
READ IN THE NUMBER OF STACKS PER SOURCE GROUP
KSCE(I),I=1,NUMSCE
(22I3)
READ IN THE STACK NUMBERS IN THE ORDER OF USE (.IE SOURCE GROUPING)
(ISTNUM(I),I=1,ISTTOT
READ IN THE NUMBER OF STACKS NOT TO BE USED
NSNTUS
READ IN STACK INFORMATION DATA
C STKHGT - HEIGHT OF STACK
C STKDIA - DIAMETER OF STACK
C STKX   - LATITUDE OF STACK AMG COORDS
C STKY   - LONGITUDE OF STACK AMG COORDS
C TEMSL  - SLOPE OF THE TEMPERATURE LOSS EQUATION FOR STACK
C TEMIN  - INTERCEPT OF THE TEMPERATURE LOSS EQUATION FOR STACK
C TEMSL AND TEMIN ARE USED TO AMKE ALLOWANCE FOR THE TEMPERATURE LOSS OF
C          FLUE GASES IN THE STACK WHEN GAS TEMPERATURES ARE MEASURED AT
C          THE BASE OF THE STACK
C DCOAST - ARRAY DISTANCE (METRES) FROM THE COAST OF EACH SOURCE GROUP
C Q      - SOURCE STRENGTH (KG/S)
C STKVOL - SOURCE VOLUME (M**3/S) AT STACK TEMP (IE. GAS FLOW RATE)
C STKRHO - EMISSION DENSITY (KG/M**3) AT STACK TEMP
C IBUILD - BUILDING EFFECTS FOR THIS SOURCE (1=YES, 0=NO)
C HBSTK  - HEIGHT OF BUILDING
C WBSTK  - WIDTH OF BUILDING
STKHGT(K),STKDIA(K),STKX(K),STKY(K),DCOAST(K),Q(K),STKVOL(K),STKRHO(K),
IBUILD(K),HBSTK(K),WBSTK(K)
(14X,F5.1,F5.2,F7.0,F8.0,F5.2,F4.0,F6.0,3F8.0,I2,2F4.0)
*** NOTE- WITH BUILDING EFFECTS IT IS ASSUMED THAT THE LAST SOURCE IN THE
          SOURCE GROUP HAS THE BUILDING DIMENSIONS. THIS LAST SOURCE ALSO
          CONTAINS THE LOGICAL (IBUILD) WHICH DETERMINE WHETHER BUILDING
          EFFECTS ARE TO BE USED.
```