FEED FLEXIBILITY PROJECT

PUBLIC ENVIRONMENTAL REVIEW

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FEED FLEXIBILITY PROJECT
PUBLIC ENVIRONMENTAL REVIEW

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

The Public Environmental Review (PER) for the feed flexibility project at Kwinana Refinery has been prepared by BP Refinery (Kwinana) Pty Ltd in accordance with Western Australian Government procedures. The PER will be available for comment for eight weeks, beginning on Wednesday, 6 February 1991 and finishing on Wednesday, 3 April 1991.

Comments from government agencies and from the public will assist the EPA in preparing an assessment review, in which it will make a recommendation to Government.

WHY WRITE A SUBMISSION?

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

All submissions received will be acknowledged.

DEVELOPING A SUBMISSION

You may agree or disagree, or comment on, the general issues discussed in the PER or with specific proposals. It helps if you give reasons for your conclusions, supported by relevant data.

You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the PER:

- 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

It will be easier to analyse your submission if you keep in mind the following points:

- 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.
- Please indicate whether your submission can be quoted, in part or in full, by the EPA in its assessment report.

Copies of the PER can be obtained from BP Refinery (Kwinana) Pty Ltd, Mason Road, Kwinana, at a cost of $10.00 plus packaging and postage.

Remember to include:

- name
- address
- date.

The closing date for submission is Wednesday, 3 April 1991.

Submissions should be addressed to:

The Chairman
Environmental Protection Authority
1 Mount Street
Perth WA 6000
Attention: Dr B Kennedy

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SUMMARY

BP Refinery (Kwinana) Pty Ltd proposes to construct several new units at the Kwinana Refinery which will enable processing of more high sulphur crude oil feedstocks. A number of smaller modifications are also proposed to increase the recovery of saleable products and reduce emissions from the Refinery.

Worldwide stocks of low sulphur crude are decreasing and refineries are re-equipping to process the more plentiful high sulphur (Middle Eastern) crudes. As low sulphur crude production declines its price will rise and the price differential between low and high sulphur crudes will increase. If Kwinana Refinery is to remain competitive against product imports it must re-equip to process high sulphur crudes. At present high sulphur crudes account for about one third of the throughput at the Refinery, and the proposed Feed Flexibility Project modifications will allow this to progressively increase to two thirds of throughput.

While low sulphur crude production is declining, the demand for low sulphur oil products is increasing. Also the demand for fuel oil has declined markedly in recent years. Thus, there is a need for increased sulphur removal and increased conversion of fuel oil into products such as gasoline. The shift to process high sulphur crudes has been underway for several years at BP Refinery Kwinana, and is expected to continue for at least the next decade. The proposed Feed Flexibility Project is part of an ongoing program to equip the Refinery to meet changes in crude oil supply, product demand and environmental standards.

BP Refinery Kwinana employs 525 full-time employees directly. Between 50 and 250 contractors are onsite at most times of the year, dependent on workload and a much larger number of West Australians are employed indirectly in service industries. Annual throughput is presently some 4.5 million tonnes worth approximately $500-600 million with crude imports from Western Australia, Southeast Asia, and the Middle East. The key products are propane, butane, motor spirit (petrol), Jet, kerosene, diesel oil, marine diesel, fuel oil, lubricating oils and bitumen. These products leave the Refinery by pipeline, tankships and road tankers for Western Australia, the Eastern States, Northern Territory and overseas export. BP Refinery Kwinana is the source of most of the transport fuels and lubricating oil base stocks consumed in WA, as it supplies about 81% and 90% of these markets respectively.

The specific objectives of the proposed Feed Flexibility Project are to:

- process more high sulphur crude and reduce dependence on low sulphur crude,
- meet gasoline and diesel fuel product quality specifications
- increase production of LPG
- provide security of employment for personnel employed by BP Refinery Kwinana

- meet community expectations for sulphur dioxide emissions

- reduce odorous air emissions

- reduce particulate air emissions

- improve the quality of wastewater discharged to Cockburn Sound

The proposed Feed Flexibility Project would require expenditure in excess of $50 million, and provide construction and plant supply contracts in Australia and, in particular Western Australia. As BP Refinery Kwinana will endeavour to maximise the Western Australian and Australian content in plant construction, only specialised equipment items not produced in Australia are expected to be sourced from overseas. The proposed development would provide security of supply of petroleum products for the WA market at a competitive price.

The proposed development would provide substantial environmental benefits, particularly in the quality of the Refinery's atmospheric emissions and wastewater discharge.

At present particulate emissions from the Residue Cracking Unit exceed the NH&MRC guideline of 250 mg/m^3. Particulate emission controls proposed for the Residue Cracking Unit would reduce emissions to well below 250 mg/m^3. Another major environmental improvement would be the reduction in odorous air emissions from storage of gasoline components.

The proposed Feed Flexibility Project would significantly improve the quality of the Refinery's wastewater. Phenolic emissions would be reduced from about 200 kg/day to 50 kg/day, ammonia nitrogen from 300 kg/day to 100 kg/day and sulphides from 75 kg/day to 30 kg/day.

The specific modifications to the Refinery proposed in the Feed Flexibility Project are as follows:

- To remove sulphur from diesel fuel components a new Hydrofiner of 1800 tonnes/day will be constructed to operate in parallel with the existing 900 tonnes/day Hydrofiner.

- Modifications to Propane Production Unit No.1 will reduce spent caustic disposal.

- A new Sour Water Stripper will be built to reduce sulphide and ammonia emissions to Cockburn Sound.

- A new Sulphur Recovery Unit will be constructed to operate in parallel with the existing Sulphur Recovery Unit to minimise sulphur emissions to atmosphere.

- To reduce phenolic emissions to Cockburn Sound a new Catalytic Cracked Spirit Minalk Unit will be constructed.

- A new Straight Run Gasoline Minalk Unit will reduce the emission of mercaptan odours from storage of gasoline components.

- Particulate emission controls will be installed on the Residue Cracking Unit to reduce particulate emissions to well below 250 mg/m^3.

- Minor modifications will be made to improve the efficiency of LPG recovery and capacity of the Residue Cracker Gas Recovery Unit and Propane Production Unit No.2.

- Minor modifications will be made to the feed injection and catalyst disengagement sections inside the Residue Cracking Unit reactor to reduce the formation of coke.

The Feed Flexibility Project will provide the Refinery with the flexibility to import and economically process greater quantities of crudes from the Middle East region as opposed to relying on the rapidly diminishing and more expensive low sulphur Australian and South East Asian crudes. The overall effect will be a small reduction in the Refinery's annual throughput due to the replacement of low sulphur crudes with high sulphur Middle East crudes. However, with the higher conversion and recovery rates achievable, the product balance will remain essentially the same with only marginal reductions in the production of fuel oil.

As the Middle East crudes contain higher levels of sulphur the modifications have been designed to ensure there is minimal effect on the environment and that the Refinery not only remains within its operating licences and agreements, but also makes significant steps to reduce the Refinery's liquid and odorous emissions.

The current schedule for the Project indicates that the particulate emission controls for the Residue Cracking Unit, and modifications to the Residue Cracker Gas Recovery Unit and Propane Production Unit No.2 would be commissioned during the last quarter 1991 and the first quarter 1992. The other modifications and new units would be commissioned between second and third quarters 1992.

After completion of the proposed Feed Flexibility Project there would be significant reductions in odorous air emissions and particulate emissions. Particulate emission controls proposed for the Residue Cracking Unit would result in at least a two thirds reduction in particulate emissions to atmosphere from the Refinery. The new Straight Run Gasoline Minalk Unit will eliminate the odorous mercaptans from Straight Run Gasoline before it is sent to storage.

There would be no increase in sulphur dioxide or hydrocarbon emissions as a result of the Project. Small increases in nitrogen oxides (3%) and carbon dioxide (6%) emissions are expected due to an increase in fuel gas consumption as a result of the new Hydrofiner furnace and increased coke combustion in the Residue Cracking Unit catalyst regenerators. Modelling results show that under normal operating conditions sulphur dioxide and particulate concentrations in the receiving environment comply with the proposed Draft Environmental Protection Policy standards and limits for sulphur dioxide and dust in the Kwinana region.

Significant reductions in phenolic, sulphide and ammonia discharges to Cockburn Sound would result from the proposed Project. The amount of copper discharged to the Sound would also be reduced due to the replacement of the Copper Chloride sweeteners with the Straight Run Gasoline Minalk Unit. Other components in Refinery wastewater are expected to remain unchanged. There will be a small increase in seawater usage (from 430 to 435 ML/day) for cooling associated with the new Hydrofiner. No increase in freshwater usage will result from the proposed modifications.

There will be no impacts on groundwater quality resulting from the proposed Feed Flexibility Project.

The main changes in the amount of solid waste that would be generated by the Refinery following the proposed modifications are:

- an increase in the amount of Desulphuriser (Hydrofiner) catalyst and Residue Cracking Unit catalyst for disposal. It is envisaged that an alternative to onsite disposal will be found for these catalysts.

- an increase in the amount of Sulphur Recovery Unit catalyst for disposal. This will be disposed of onsite.

- an increase in the amount of pyrophoric scale for disposal, this will be disposed of onsite.

All solid waste would be disposed of in accordance with the statutory requirements of the Health Department of WA and be to the satisfaction of the EPA.

Given both the considerable distance between the Refinery and the nearest residential area, and the existing general background noise levels emanating from the Kwinana Industrial Area, noise generated during construction and normal plant operations would not affect neighbouring residential areas. BP Refinery Kwinana will design and operate the plant so as to control noise generation and noise levels at the boundary of the Refinery at all times to the satisfaction of the Environmental Protection Authority.

The proposed Feed Flexibility Project modifications do not introduce any type of risk or hazard not already present in the Refinery. The modifications will not result in any increase in the inventory of hazardous material stored onsite. The proposed modifications will comply with all relevant legislation and will be subject to the stringent six stage BP Safety Review procedure, including a HAZOP study. The Hazard Management Process applied to the proposed Project will be consistent with guidelines established by the Safety Coordinator, Explosives and Dangerous Goods Division, Department of Mines.

The principles for management and monitoring of the emissions and hazards associated with the Feed Flexibility Project are summarised as follows:

- Emissions are controlled at the Refinery by a combination of pollution control equipment, operating techniques and choice of crude feedstock. The Feed Flexibility Project will significantly improve the quality of wastewater discharged to Cockburn Sound, and reduce atmospheric emissions of particulates and odorous mercaptans. The proposed Project will also significantly reduce the likelihood of high sulphur dioxide emissions as a second Sulphur Recovery Unit will be constructed. At all times Refinery operations are programmed so as to comply with all regulatory requirements and minimise impacts on the environment.

- During routine and non-routine shutdowns and startups everything possible will be done to minimise any impacts on the environment. Refinery throughputs will be adjusted, as quickly as is practicable, in order to meet EPA licence conditions.

- A monitoring programme involving regular sampling and testing of all wastewater discharges, sulphur dioxide and particulate emissions, groundwater quality, solid waste quality and noise levels is in place at the Refinery. All monitoring results are reported to the relevant regulatory authority.

- An audit of the Hazard Management Process; carried out in accordance with guidelines agreed with the Safety Coordinator, Department of Mines; will be completed prior to commissioning and made available to the Department of Mines.

An extensive set of management commitments have been made by BP Refinery Kwinana, encompassing shutdown procedures, safety features, hazard management, operational philosophies and monitoring. BP Refinery Kwinana is committed to ensuring that the Refinery complies with all statutory requirements and minimises impacts on the surrounding communities and the environment.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE PROJECT

BP Refinery (Kwinana) Pty Ltd proposes to construct several new units at the Kwinana Refinery which will enable processing of more high sulphur crude oils (feed), thus increasing feed flexibility. These units are a new Hydrofiner Unit, new Straight Run Gasoline Minalk Unit, new Catalytic Cracked Spirit Minalk Unit and a new Sulphur Recovery Unit. A number of smaller modifications are also proposed to increase the recovery of saleable products and reduce emissions from the Refinery. The proposed development would enable:

- processing of more high sulphur crude oil feedstocks and increased recovery of Liquid Petroleum Gas (LPG).

- a significant reduction in the environmental impact of present Refinery operations by reducing emissions to atmosphere and improving the quality of wastewater discharged to Cockburn Sound.

The proposed Feed Flexibility Project is part of an ongoing program to equip the Refinery to meet changes in crude oil supply, product demand and environmental standards.

While OPEC (Middle Eastern) crude oil production is increasing the production of non-OPEC crude oil is declining rapidly worldwide (Figure 1.1). In Australia this decline is even more dramatic with the Australian Institute of Petroleum estimating that by the year 2000, crude demand in Australia will be 800 000 barrels/day, while crude production will fall to 200 000 barrels/day. In general non-OPEC crude has a lower sulphur content than OPEC crudes.

Since the 1970's the feedstock to the Kwinana Refinery has been predominantly low sulphur Australian and Indonesian crude, and the plant has been configured accordingly. If Kwinana Refinery is to remain competitive against product imports it must re-equip to process high sulphur Middle Eastern crudes. As low sulphur crude production declines its price will rise, and the price differential between low and high sulphur crudes will increase.

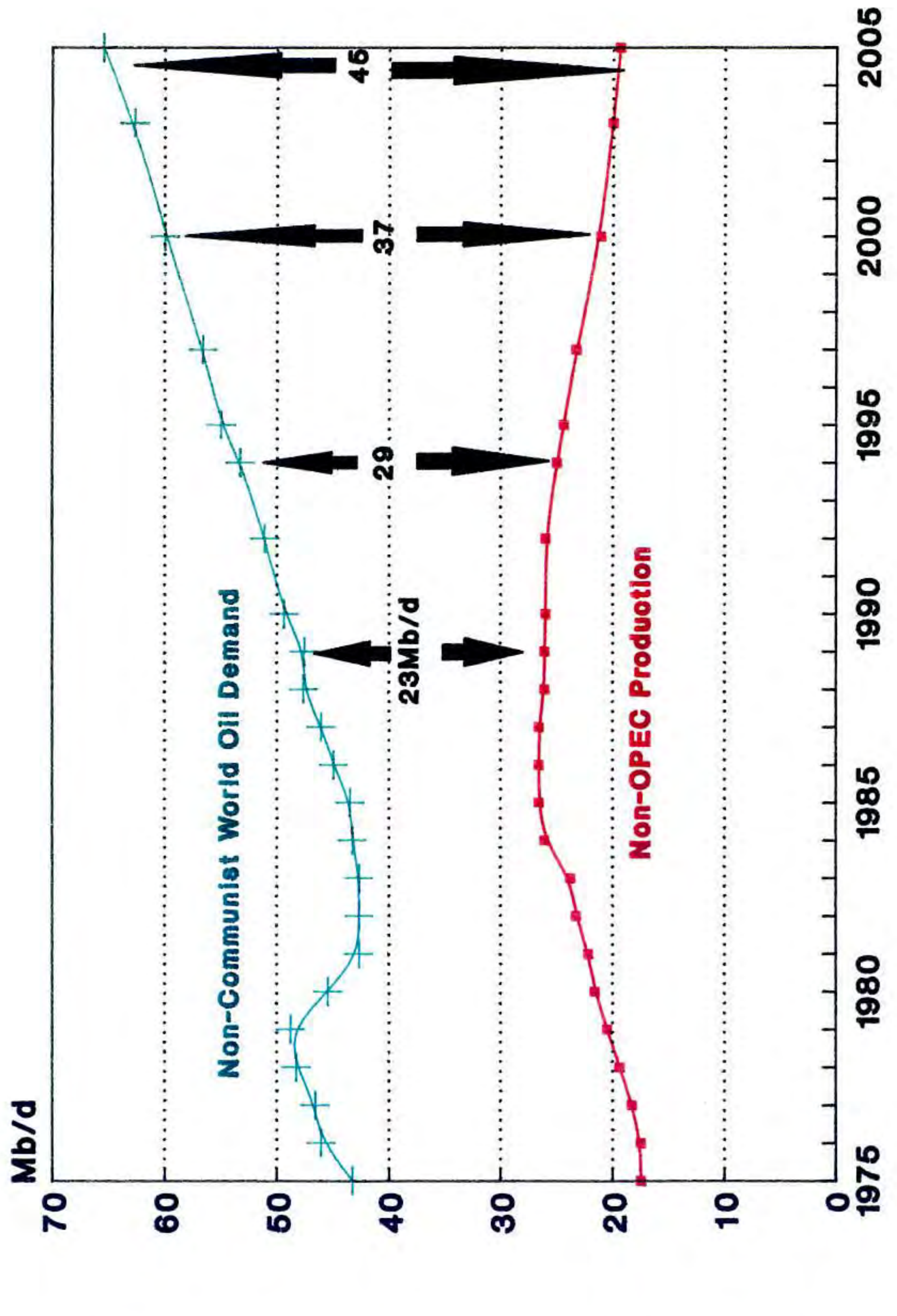


Figure 1.1: OPEC and Non-OPEC Projected Oil Production

Modifications must be made to a number of Refinery processes so that increased sulphur in the crude oil can be removed or converted to a form which meets product quality specifications.

The modifications to the Refinery processes will be made to ensure that there is minimal effect on, or where possible, positive benefits for the environment.

This chapter provides background information relevant to the proposed development as follows:

- background to the project, including company history and activities, location and description of BP Refinery Kwinana operations, and the proposed development (Section 1.1),

- timing of the proposal (Section 1.2),

- scope and structure of this report (Section 1.3),

- the approval process, including statutory approvals and the environmental approval process (Section 1.4).

1.1.1 Company History and Existing Activities.

In 1952 site clearance and initial construction of the Kwinana Refinery was commenced. The Refinery was commissioned in 1955 and was the first industry established in the Kwinana Industrial Area. The design throughput of the Refinery was 3,000,000 tonnes of crude per year. The principal products were motor spirit, aviation gasoline, kerosene, diesel, fuel oil and bitumen. The original Refinery consisted of a three berth jetty, a Tank Farm with seventy tanks, two atmospheric Crude Distillation Units, a Vacuum Unit, a Catalytic Reformer, a Catalytic Cracker, Hydrofiner, Bitumen Unit, Steam Generation Plant and cooling water and effluent treatment facilities.

In 1959 a second Catalytic Reformer and additional tankage was added and in 1963 the Lubricating Oil Plant was build to manufacture 100,000 tonnes of lubricating oils per year. A year later a Propane Deasphalting Unit was added to the Lubricating Oil Plant and the first Propane Production Unit was erected to separate and purify propane and butane for LPG.

The Catalytic Cracking Unit was modernised in 1978 to increase the capacity and improve the conversion for motor gasoline and diesel oil production. In addition a second Propane Production Unit (PPU2), associated with the Catalytic Cracker, was built. In 1981 a new Alkylation Unit was commissioned for conversion of butane gas to aviation gasoline/gasoline components.

In 1982 & 1983 Kwinana's Steam Generation Area and Catalytic Reformer No.2 were modernised to improve energy efficiency and plant control. A Merox Sweetening plant was also built to sweeten the Jet produced from the Crude Distillation Units.

In 1985 work commenced on upgrading the Catalytic Cracker to a Residue Cracking Unit to allow the conversion of fuel oil to motor gasoline and diesel oil products. This project involved conversion of the existing Catalytic Cracker. The project was commissioned in 1987. At the same time upgrading of the Crude Distillation Unit No.2 commenced in order to match the feedstock required for the Residue Cracker, improve the energy efficiency and increase the processing capability and efficiency of the Unit. The original Catalytic Reformer (CR1) was decommissioned in 1985.

The Catalytic Polymerisation Unit was built in 1987 together with an upgrade of the recovery facilities to increase the the production of propane and butane from the refinery gas streams. This project enabled part of the Refinery fuel gas to be converted to high quality motor gasoline and allowed the Refinery greater use of West Australian natural gas. Connection to natural gas had taken place in 1986 in order to reduce the burning of fuel oil and reduce the refinery's impact on air pollution in the area.

A refinery-wide control system designed with the latest digital communications technology was installed during 1988 and 1989. This project involved the replacement of the six existing dispersed control rooms by one central control room, replacing the existing pneumatic and analogue instrumentation with digital control equipment and installation of a computer for process optimisation, data handling and management information generation. The project was completed in 1989.

In 1988 the Bitumen Emulsions Plant was commissioned to supply the expanding spray bitumen market and construction of the Sulphur Recovery Unit was commenced. This Unit was designed to recover sulphur from refinery fuel gas streams which was previously emitted to the atmosphere as sulphur dioxide (SO_2). This project was completed in 1989 and has significantly reduced sulphur dioxide concentrations in the Kwinana area.

The major refinery processes at Kwinana Refinery are:

. atmospheric and vacuum distillation
. catalytic cracking
. alkylation
. polymerisation
. desulphurisation
. catalytic reforming
. solvent extraction

The major products are:

. propane
. butane
. motor spirit (petrol)
. Jet
. kerosene
. diesel oil
. marine diesel
. fuel oil
. lubricating oils
. bitumen

These products leave the Refinery by pipeline, tankships and road tankers for Western Australia, the Eastern States, Northern Territory and also for overseas export.

Kwinana Refinery is built on a wholly owned site occupying an area of 280 hectares and operates on a twenty four hours a day basis throughout the year. The location and layout of the Refinery is shown in Figure 1.2. The estimated replacement value of Kwinana Refinery today is in excess of $1,000 million. The refinery employs 525 full time employees directly. Between fifty and two hundred and fifty contractors are onsite at most times of the year dependent on the work load and a much larger number of West Australians are employed indirectly in service industries. The annual throughput is presently some four and a half million tonnes worth approximately $500-600 million with crude imports from Western Australia, South East Asia and the Middle East.

Kwinana Refinery is a key refinery within the BP group of companies which together employ some 120,000 people worldwide. The formal reporting structure is through the BP Oil business stream which has a Head Office in Melbourne. The refinery is a Division of the Manufacturing & Supply Department of BP Oil Australasia which in turn is a part of the BP Oil worldwide business stream. BP Refinery (Kwinana) Pty Ltd is incorporated in Western Australia and is a wholly owned subsidary of BP Australia Holdings Ltd.

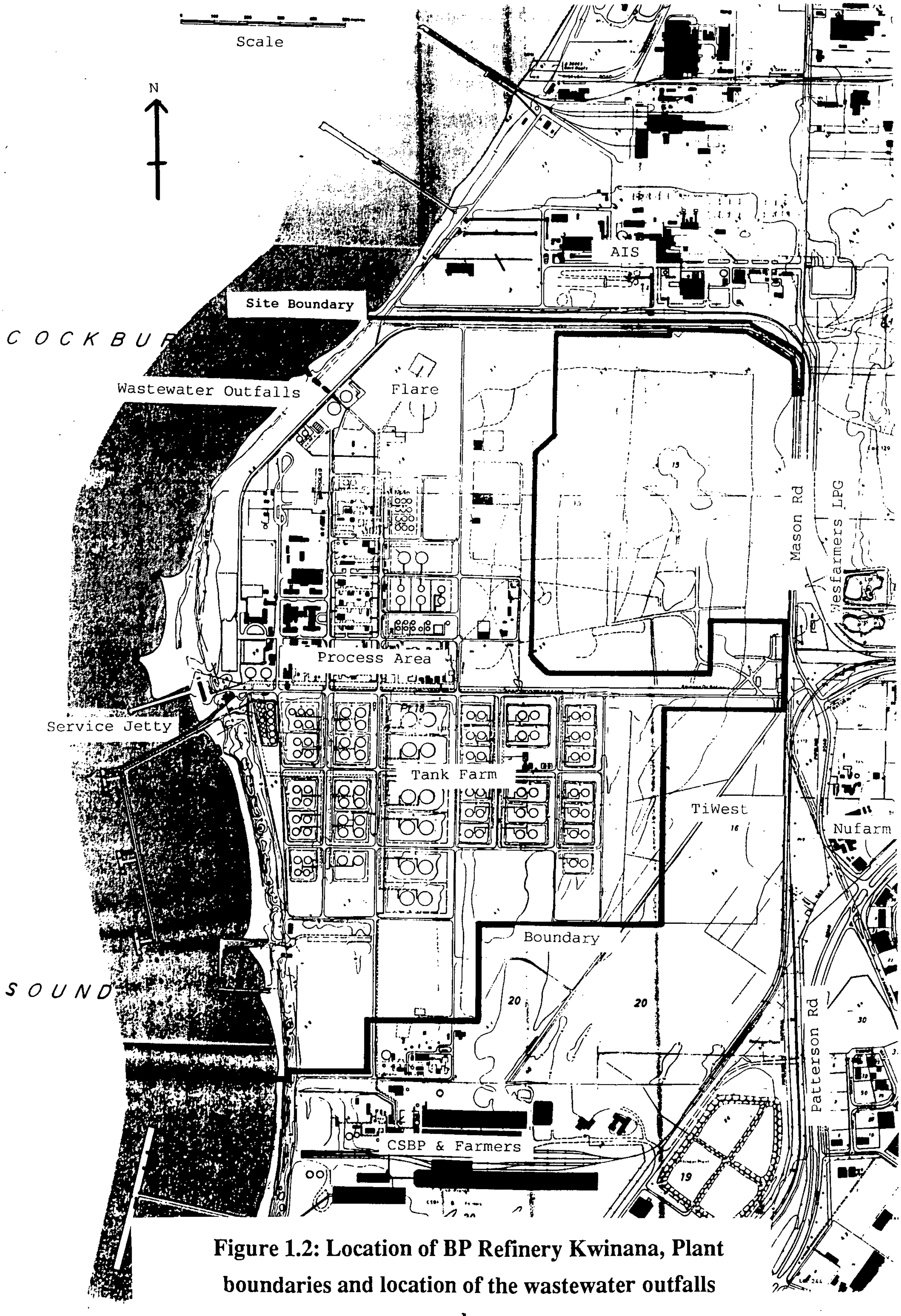


Figure 1.2: Location of BP Refinery Kwinana, Plant boundaries and location of the wastewater outfalls are shown.

1.1.2 The Proposed Development

The proposed development would enable the Refinery to process a wider range of crude oil feedstocks while at the same time reduce emissions to the atmosphere and improve the quality of wastewater discharged to Cockburn Sound.

Worldwide, stocks of low sulphur crude are decreasing and refineries will have to re-equip to process the more plentiful high sulphur crudes. Meanwhile the demand is increasing for low sulphur oil products. Thus, there is a need for increased sulphur removal and increased conversion of fuel oil into products such as gasoline. The shift to process high sulphur crudes has been underway for several years and is expected to continue for a least the next 10 years. At BP Refinery Kwinana, the first feed flexibility project commenced in 1985 with the construction of a Residue Cracking Unit followed by a Sulphur Recovery Unit. The current proposal represents another move towards increased flexibility and it is expected that further projects will be proposed in the future.

In general terms the objectives of the proposed Project are to allow processing of higher sulphur crudes at the Refinery and reduce emissions to atmosphere and Cockburn Sound. Specific objectives are presented in Section 2.2

The specific modifications to the Refinery proposed in this development are as follows:-

- To remove sulphur from diesel fuel components a new Hydrofiner Unit of 1800 tonnes per day (TPD) will be constructed to operate in parallel with the existing 900 TPD hydrofiner. The sulphur will be converted to hydrogen sulphide which will be routed to a new Sulphur Recovery Unit.

- Modifications to Propane Production Unit No.1 will reduce spent caustic disposal. At present Propane Production Unit No.1 removes hydrogen sulphide and mercaptans from liquified petroleum gas (LPG) by washing with caustic soda (NaOH). This generates odorous spent caustic. The modifications include an amine unit to remove the hydrogen sulphide and route it to the Sulphur Recovery Unit. The mercaptans will then be removed by a new LPG Merox Extraction Unit. Merox (derived from mercaptan oxidation) is a licensed Universal Oil Products Ltd extraction process for conversion of odorous mercaptan sulphur to non-odorous disulphide. In an LPG Merox, the caustic is regenerated and reused many times over. The net effect of these modifications will be to reduce spent caustic disposal by 31% of the Refinery total.

- A new Refinery Sour Water Stripper will be built to reduce sulphide and ammonia emissions to Cockburn Sound. Various refinery processes produce water containing sulphides and ammonia (sour water). The Refinery has two sour water strippers that remove the sulphides and ammonia, but they are relatively inefficient and produce wet offgas which contains hydrogen sulphide and ammonia gas. The offgas is incinerated in furnaces. The new Sour Water Stripper will be a state-of-the-art unit, producing high quality wastewater and a dry overhead gas. At least part of the stripped wastewater will be reused to reduce fresh water usage. The offgas will be routed to the new Sulphur Recovery Unit.

- A new Sulphur Recovery Unit will be constructed to operate in parallel with the existing Sulphur Recovery Unit to minimise sulphur emissions to atmosphere. This Unit will have a special two stage muffle furnace which will enable it to convert ammonia to nitrogen gas. The second Sulphur Recovery Unit will be capable of producing 35 tonnes per day of liquid sulphur. This is more than sufficient to handle the increased hydrogen sulphide gas input derived from the new Hydrofiner, Propane Production Unit No.1 treatment facilities and the new Sour Water Stripper combined.

  It will also provide additional security in the event that the existing Sulphur Recovery Unit shuts down. At present if the Sulphur Recovery Unit shuts down due to equipment failure, the options are to allow a major increase in sulphur dioxide emissions or to shut down various process units.

  The risk of accidents and environmental incidents is minimised by avoiding process unit shutdowns and startups. As long as either one of the Sulphur Plants is operational it will be possible to control sulphur dioxide emissions to within acceptable limits by reducing throughputs rather than shutting units down.

- A new Straight Run Gasoline Minalk (Minimum Alkalinity) Unit will reduce the emission of mercaptan odours from gasoline component tankage. This process uses dilute caustic soda to convert odorous mercaptans to disulphides (sweetening). It replaces the antiquated and inefficient copper chloride sweeteners, which will be shut down. This reduces the risk of copper salts being present in Refinery wastewater.

- To reduce phenolic emissions to Cockburn Sound a new Catalytic Cracked Spirit Minalk Unit will be constructed. As with the Straight Run Gasoline Minalk, this will sweeten (convert mercaptans to non-odorous disulphides) a gasoline component. It will replace the existing Catalytic Cracked Spirit Merox Unit, which is the major source of phenolic material in spent caustic.

The Minalk uses such dilute caustic that it does not extract the phenol from the Catalytic Cracked Spirit. The phenol remains as a harmless minor component of gasoline. The Catalytic Cracked Spirit Minalk will produce 85% less spent caustic than the existing Catalytic Cracked Spirit Merox and reduce the Refinery total spent caustic production by 6%.

- Particulate emission controls for the Residue Cracking Unit. The Residue Cracking Unit has two regenerators R1 and R2 which burn coke from a silica-alumina based catalyst. Catalyst is recovered from the regenerators' flue gas by cyclones. R1 has two-stage internal cyclones which reduce the concentration of catalyst in its flue gas to less than 250mg/m^3. R2 operates at too high a temperature for internal cyclones and has single-stage external cyclones. These reduce R2 particulate emissions to about 600 mg/m^3. It is proposed to install secondary recovery equipment on R2 to reduce the particulate emissions to well below 250mg/m^3.

- Minor modifications to improve the efficiency and capacity of the Residue Cracker Gas Recovery Unit and Propane Production Unit No.2. The Gas Recovery Unit separates Catalytic Cracked Spirit, LPG and refinery fuel gas from the Residue Cracking Unit products.

  The equipment is inefficient at recovering valuable LPG from fuel gas. The modifications to these units will provide extra capacity, improve recovery of LPG and improve product quality.

- Minor modifications to the feed injection and catalyst disengagement sections inside the Residue Cracking Unit reactor to reduce the formation of coke.

Overall Refinery production levels will not change significantly as a result of the proposed project as increased throughput is not an objective. However, the relative production levels of different products will change slightly. These changes are discussed in Section 3.4.

The modifications proposed in this project will result in a significant reduction in the environmental impact of present Refinery operations. Particulate emissions to the atmosphere will be reduced to well below acceptable limits. The second Sulphur Recovery Unit will provide a backup for the existing unit, thus reducing the necessity to increase SO_2 emissions above permissible levels, for safety reasons, in the advent of plant shutdowns. SO_2 emissions under normal operating conditions will remain at present levels. Odours will be reduced from gasoline component tankage.

The Refinery discharges wastewater and salt cooling water into Cockburn Sound. Ecological studies (Le Provost et al 1990) have shown that the wastewater has only localised impacts on the environment. However, the concentration of several substances is higher than desirable and BP Refinery Kwinana is making the changes necessary to improve wastewater quality. The Feed Flexibility Project will result in a significant reduction in ammonia, sulphide and phenolic loadings to Cockburn Sound.

1.2 TIMING OF THE PROPOSAL

The current schedule for the project indicates that the particulate emission controls for the Residue Cracking Unit, and modifications to the Residue Cracker Gas Recovery Unit and Propane Production Unit No.2 would be commissioned during the last quarter 1991 and the first quarter 1992. The other modifications and new units would be commissioned between the second and third quarters 1992.

1.3 SCOPE AND STRUCTURE OF THE PER

A proposal for the Feed Flexibility Project was referred to the Environmental Protection Authority (EPA) which determined that the project required assessment under Part IV of the Environmental Protection Act, 1986. The level of assessment set by the EPA was a Public Environmental Review (PER) and guidelines for its preparation were issued. The PER has been prepared according to the guidelines issued by the EPA; the guidelines are presented in Appendix A.

The objective of the PER is to provide details of the proposal so that interested parties may have the opportunity to comment on it during the public review component of the assessment process.

The scope of the PER is restricted to the potential environmental impacts associated with the construction and operation of the new units and modifications to existing units that were described in Section 1.1.2. The PER describes the means by which these potential environmental impacts would be managed. Elements of the environment are considered in terms of the Refinery site itself, the Kwinana Industrial Area (KIA) and neighbouring residential areas.

The impacts of existing Refinery operations are not specifically addressed in this PER including the following:

- Wastewater disposal impacts

  BP Refinery Kwinana has plans to substantially upgrade the wastewater treatment facilities at the Refinery. The environmental impacts of wastewater disposal will be considered as part of the modernisation plan which will be referred to the EPA for assessment. BP Refinery Kwinana has made a commitment that the modernisation plan will be submitted to the EPA within two years of the issue of Works Approval for the Feed Flexibility Project.

- Solid waste disposal impacts

  A solid waste minimisation and management programme will be prepared and made available to the EPA. Recycling and re-use options for solid waste are being actively investigated at the present time.

- Groundwater quality

  The proposed Feed Flexibility Project will not impact on groundwater quality.

- Risks and hazards

  Risks and hazards are not a direct issue with the proposed Feed Flexibility Project modifications. The modifications do not embody any new process technology and in essence simply increase the efficiency of present processing techniques. However, BP Refinery Kwinana have made a number of commitments relating to risks and hazards (see Chapter 7).

The PER is structured as follows:

- Chapter 1 presents a background to the proposal and the PER, details of the proponent, the proposed schedule and the approval process for the project.

- Chapter 2 discusses the project justification, including business and environmental objectives, the benefits and consequences of not proceeding with the project, and the alternatives considered.

- Chapter 3 describes existing Refinery plant and processes, proposed new plant and processes, materials usage and production, transport and handling, waste products and disposal, plant safety and contingency planning, and site facilities and works.

- Chapter 4 addresses land use and related issues, including local and regional land use, visibility and visual impact, occupational health and safety, and risks and hazards.
- Chapter 5 evaluates potential environmental impacts of the project, and social impacts.
- Chapter 6 describes the proposed programme of controls and safeguards to minimise environmental impacts.
- Chapter 7 summarises all commitments made in relation to environmental management and monitoring.
- Chapter 8 conclusions.

1.4 APPROVAL PROCESSES

1.4.1 Statutory Approvals and Responsible Authorities

In addition to obtaining approval under the Environmental Protection Act, 1986 the Feed Flexibility Project would have to satisfy the licensing and other requirements of a wide range of decision making authorities. The legislation that applies to the project includes the following:

- The Town Planning and Development Act, 1928 (as amended) empowers the Town of Kwinana to control development under provisions of its Town Planning Scheme. Application will be made to the Kwinana Town Council for development approval ('Application for approval to commence development') and separate building approvals.
- The Industrial Lands (Kwinana) Agreement Act, 1964 (as amended) administered by the Industrial Lands Development Authority, controls the disposition of certain lands at Kwinana (including the Refinery) for industrial purposes.
- The Local Government Act, 1960 (as amended) provides authority to the Town of Kwinana with respect to local planning and zoning regulations.
- The Metropolitan Region Town Planning Scheme Act, 1959 (as amended) provides the Department of Planning and Urban Development with regional planning powers to control development. An application for development approval will be submitted via the Kwinana Town Council.

- The Occupational Health, Safety and Welfare Act, 1988 provides regulations to ensure the good health and safety of both employees and the general public.

- The Health Act, 1911 (as amended) authorises the Kwinana Town Council to control 'offensive trades'.

- The Dangerous Goods (Road Transport) Regulations, 1983 are administered by the Department of Mines, which is responsible for reviewing the design and operation of vehicles and transport of the product.

- The Explosives and Dangerous Goods Act, 1961 (as amended), administered by the Department of Mines, regulates the on-site storage of flammable materials and dangerous goods.

- The Metropolitan Water Authority Act, 1984 covers the conditions for supply of scheme water to the Refinery and the Rights in Water and Irrigation Act, 1914 (as amended) covers actions that may affect groundwater supplies.

- The Fremantle Port Authority Act, 1902 (as amended) controls shipping movements in the inner and outer Fremantle harbours.

- The Oil Refinery Industry (Anglo-Iranian Oil Company Limited) Act, 1952 (as amended) an agreement relating to the establishment and working of an oil refinery in Western Australia.

- The Poisons Act, 1964 (as amended) regulates and controls the possession, sale and use of poisons and other substances, and constitutes a Poison Advisory Committee.

1.4.2 Environmental Approval Process

The environmental assessment process is designed to provide information to the EPA and the public about proposed developments which have the potential to cause significant environmental effects. In Western Australia the environmental approval process is formalised by the Environmental Protection Act, 1986 which was proclaimed in February 1987. The environmental approval process is illustrated in Figure 1.3.

Public Environmental Reviews are public documents and, as such, are subject to a public review period of eight weeks, during which time submissions from the public and government departments will be sought by the EPA. The submissions assist the EPA in assessing the proposal and in formulating advice to the Minister for the Environment. During the review the EPA will liaise with the proponent if further information is required. The EPA will recommend to the Minister for Environment that the proposal is:

- environmentally acceptable,
- acceptable subject to certain conditions, or
- environmentally unacceptable.

The Minister will publish the EPA's recommendations in a report which is available to the public. Interested parties can lodge an appeal against the content of, and recommendations in, the EPA's assessment report within 14 days of its release.

Development approval for the project lies with the Department of Planning & Urban Development, and the Kwinana Town Council, and their evaluation is made in concert with the environmental approval process.

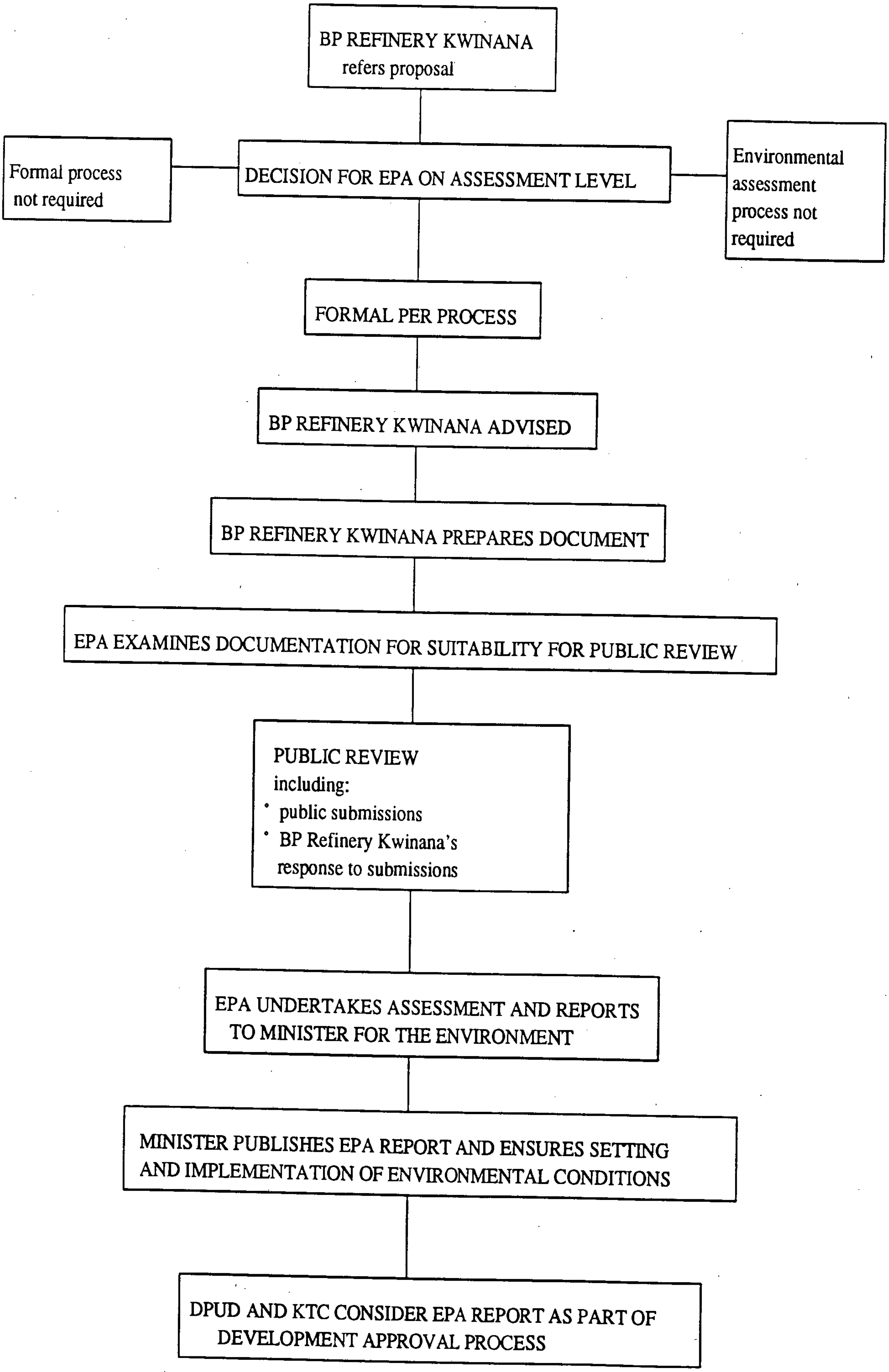


Figure 1.3: APPROVAL PROCESS

CHAPTER 2

PROJECT JUSTIFICATION

2.1 INTRODUCTION

This chapter includes:

- project objectives, including business and environmental objectives (Section 2.2),
- economic and environmental benefits (Section 2.3),
- alternatives considered, including the consequences of not proceeding with the proposed development (Section 2.4).

2.2 PROJECT OBJECTIVES

2.2.1 Business Objectives

BP Refinery Kwinana is the source of most of the transport fuels and lubricating oil base stocks consumed in WA, it supplies about 81% and 90% of these markets respectively. The Refinery plays a significant role in holding down supply costs in WA and ensuring continuity of supply. The Refinery is also a cost-effective exporter of selected products to S.E. Asia and Eastern Australia. About 25% of refinery throughput is exported as value-added products. To maintain the Refinery's competitive position it will be necessary to re-equip the plant to process high sulphur crudes. As low sulphur crudes increase in price, the increasing price differential between low sulphur and high sulphur crudes will mean that continued reliance on low sulphur crudes would erode the competitiveness of the Refinery and affect Australia's balance of payments.

The Company's main business objective is to preserve the long-term economic viability of Kwinana Refinery as a complex oil refinery manufacturing a complete range of fuels, lubricating oils and bitumen products. Its specific objectives are to:

- process more high sulphur crude and reduce dependence on low sulphur crude,

- meet gasoline and diesel fuel product quality specifications,

- increase production of LPG,

- provide security of employment for personnel directly employed by BP Kwinana Refinery.

2.2.2 Environmental Objectives

In summary, the environmental objectives are to:

- meet community expectations for sulphur dioxide emissions,

- reduce odorous air emissions,

- reduce particulate air emissions,

- improve the quality of wastewater discharged to Cockburn Sound.

2.3 PROJECT BENEFITS

2.3.1 Economic Benefits

The proposed development would result in a number of benefits to the local community, Western Australia and Australia:

- the proposed development would require expenditure in excess of $50 Million, and would provide construction and plant supply contracts in Australia and, in particular Western Australia. BP Refinery Kwinana will endeavour to maximise the Western Australian and Australian content in plant construction, only specialised equipment items not produced in Australia are expected to be sourced from overseas,

- ensure or provide security of supply of petroleum products for the WA market at a competitive price.

- generate a reduction in elemental sulphur imports to WA of 12 000 tonnes/year, worth $1.2 Million.

2.3.2 Environmental Benefits

The proposed development would provide substantial environmental benefits, particularly in the quality of the Refinery's wastewater discharge and air emissions.

At present particulate emissions from the Residue Cracking Unit exceed the National Health and Medical Research Council guideline of 250 mg/m^3. Particulate emission controls proposed for the Residue Cracking Unit would reduce emissions to well below 250 mg/m^3. Another major environmental improvement would be the reduction in odorous air emissions from gasoline component tankage. Under certain meteorological conditions odours from this source are detectable outside the Refinery boundary. The new Straight Run Gasoline Minalk Unit will eliminate the odorous mercaptans in the straight run gasoline before it is sent to tankage.

The Refinery's wastewater (oil and once through salt cooling water) undergoes primary separation to remove undissolved oil and any solid matter before it is discharged to Cockburn Sound. The existing standard of wastewater treatment, although considered acceptable at the time the Refinery was built in the early 1950's, falls short of international standards and of current community expectations.

The proposed development would significantly improve the quality of the Refinery's wastewater. Phenolic emissions would be reduced from about 200 kg/day to 50 kg/day, ammonia nitrogen from 300 kg/day to 100 kg/day, and sulphides from 75 kg/day to 30 kg/day.

These improvements are described in greater detail in relevant sections of this document.

2.4 EVALUATION OF ALTERNATIVES

2.4.1 Consequences of Not Proceeding

The consequences of not proceeding with the proposed development are both economic and environmental.

- Economic Consequences

The economic consequences of not proceeding with the proposed development are as follows:

- The long-term economic viability of BP Refinery Kwinana as a complex and integrated oil refinery would not be preserved, and refining operations at Kwinana may cease as a consequence.

- The potential benefits of increased employment - both direct and indirect during the construction phase - would be lost.

- Importing petroleum products would adversely affect the West Australian and Australian economy.

- Environmental Consequences

The environmental consequences of not proceeding are as follows:

- The projected reductions in emissions would not be achieved.

- Other long-term environmental projects may be jeopardised as a result of reduced profitability.

2.4.2 Alternatives

The alternative to this proposal is to continue current operations at the Refinery. This is not preferred for both economic and environmental reasons.

No alternative cost-effective technologies to those proposed are available to process high sulphur crudes.

CHAPTER 3

PROJECT DESCRIPTION

3.1 INTRODUCTION

This chapter describes the existing plant and the proposed development as follows:-

- existing site development and process activities (Section 3.2),

- the proposed development including a description of new plant and processes (Section 3.3),

- materials usage, production, source and supply of other raw materials, water usage, energy supply and consumption, and transport and handling (Section 3.4),

- waste discharges, including gaseous emissions, liquid effluents, solid wastes and noise (Section 3.5),

- plant safety and contingency planning, including staff training, medical facilities, emergency response and fire fighting (Section 3.6),

- site facilities and works, including construction facilities, buildings and structures, amenities, paving and road works, road access, car parking, water supply, drainage systems and wastewater treatment (Section 3.7).

3.2 EXISTING SITE DEVELOPMENT & PROCESS ACTIVITIES

The existing site development and process activities are described in the following sections. The environmental discharges from the existing plant are described in Section 3.5

Figure 3.1 shows a simplified process flow diagram of existing Refinery operations, and a plan of the existing plant layout is provided in Figure 3.2.

BP Refinery Kwinana was built in 1952-55 to process high sulphur Middle Eastern crudes. In the 1960's more Australian and Indonesian low sulphur crudes became available, and by the 1970's these formed the bulk of the Refinery feedstock. The Refinery configuration was modified to process these low sulphur crudes. During the late 1980's the Refinery has been progressively upgraded to process more high sulphur Middle Eastern crude. The Refinery is currently configured to process about one third of throughput as high sulphur crude.

3.2.1 Crude Distillation Units (CDU1 & CDU2)

These two units (see Figure 3.2) have a combined annual throughput up to 5,500,000 t of crude oil. In a typical crude unit the oil is heated to about 400°C, before passing to the fractionating columns where about half vaporises. As the vapours rise in the columns, they become steadily cooler, the less-volatile components progressively condensing to liquids. The remaining vapours that reach the top are separately condensed. For cooling purposes part is returned to the column as reflux, the remainder being split in a further column into fuel gas, liquefied petroleum gas (LPG) and a liquid component of gasoline. This liquid (light gasoline) and four less-volatile liquid streams (naphtha, kerosene, light and heavy gas oils), together with the unvaporised residue of the crude, form feedstocks for other processing units, or are blended into finished products. On Crude Distillation Unit No.1 the combined LPG and gasoline stream is contacted with caustic solution to remove hydrogen sulphide and some mercaptan sulphide prior to being split into fuel gas, LPG and gasoline.

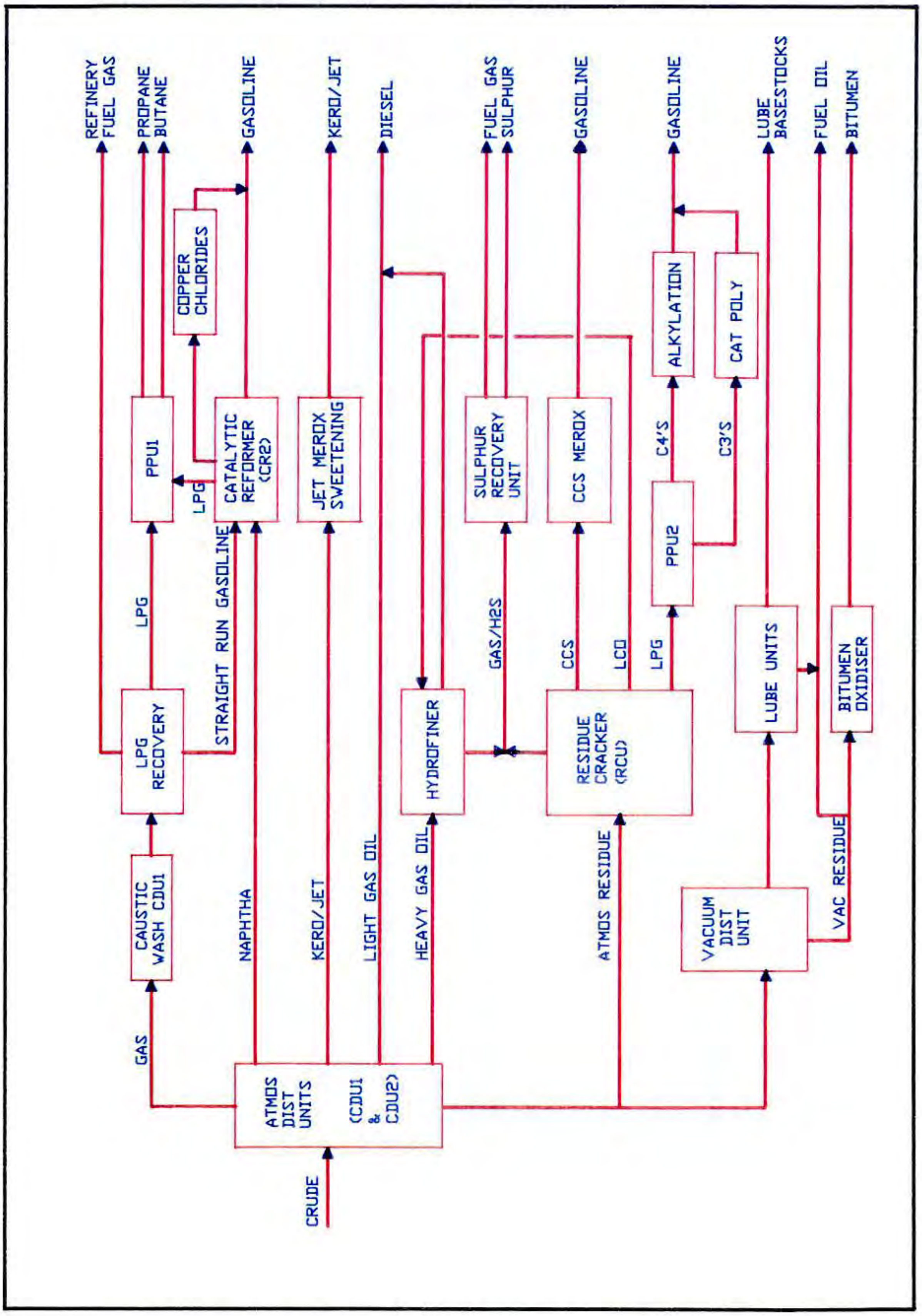


Figure 3.1 Simplified Flow Diagram
Refinery Process (Existing)

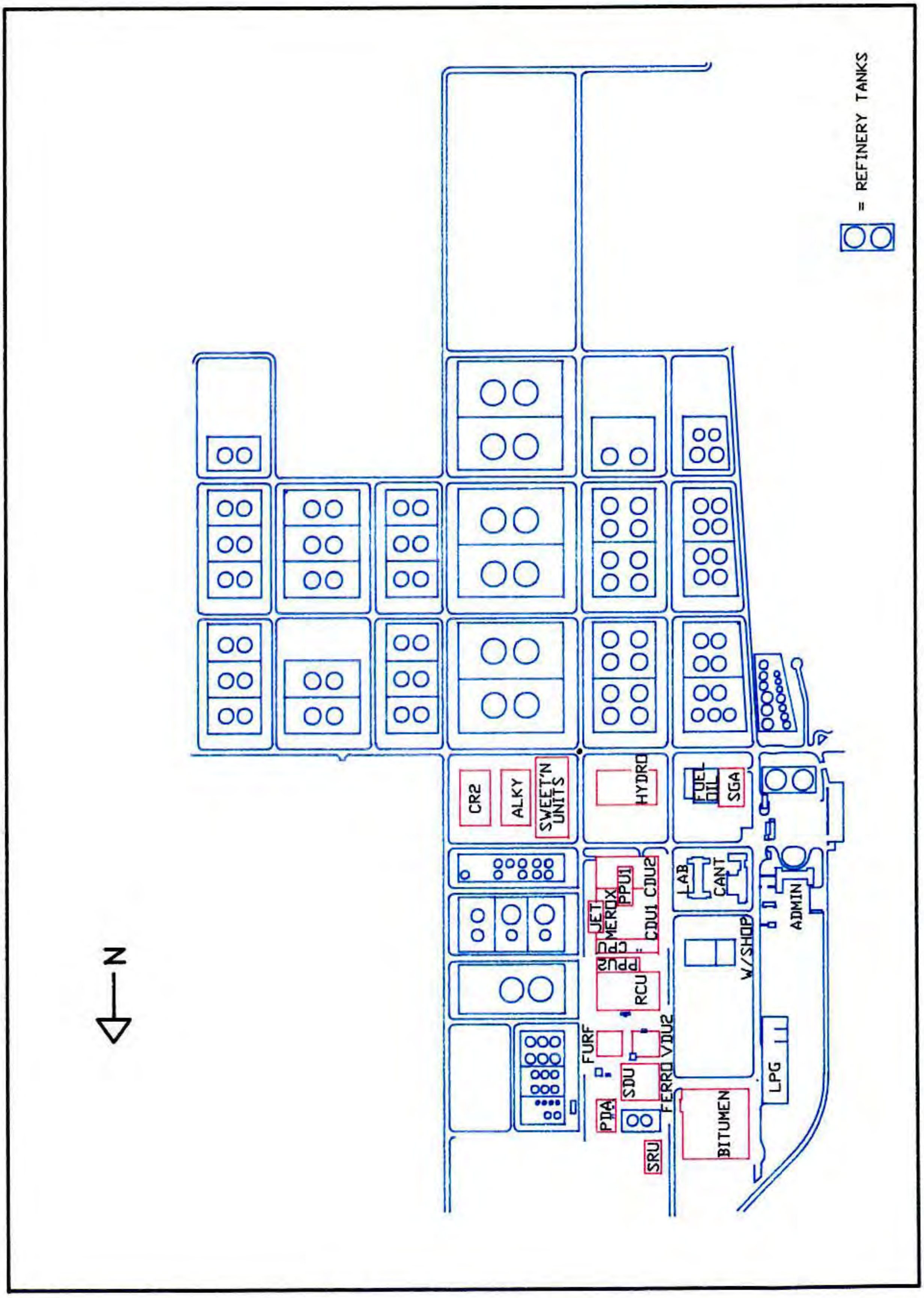


Figure 3.2 Existing Plant Layout

3.2.2 Catalytic Reformer (CR2)

Here the gasoline and naphtha from the Crude Distillation Units are upgraded to provide suitable components for blending into motor spirit (petrol). The Unit has an annual capacity of 700,000 kL of 'reformate'. The vaporised gasoline and naphtha is passed over a platinum catalyst at a temperature of 500°C, and a pressure of approximately 3700 kPa. The process produces chemical reactions to increase the octane number of the feedstock. The octane number is its "anti-knock value" and is a measure of resistance to pre-ignition in a spark ignition engine. Hydrogen-rich gas, a by-product, is an important raw material for other process units and local industries.

3.2.3 Residue Catalytic Cracker (RCU)

With an annual throughput of 1,560,000 kL the Residue Cracker converts heavy oil into lighter, more valuable components. Typical feedstock is residue from the Crude Distillation Units. The large molecules of the residue are broken down, or 'cracked' by alumina silica catalyst at >500°C. The products from the reaction are distilled into cracked spirit, a source of high-octane material for petrol blends, and components for diesel oil and fuel oil. Gas products are used for additional processing and Refinery fuel gas. A small quantity of coke is formed and deposited on the catalyst, which is regenerated by burning the coke in regenerators at >700°C. The catalyst continuously circulates between the reactor and the regeneration section. The cracked spirit is treated with caustic soda and air over an activated charcoal and Merox catalyst to deodorise the product prior to blending into motor spirit.

3.2.4 Catalytic Polymerisation Unit (CPU)

Light gases from the Residue Cracker are converted into high-grade motor spirit, using a phosphoric acid catalyst. The feedstock flows through the beds of catalyst at high pressure (4,000 kPa) and modest temperature (200°C). The annual capacity of this Unit is 110,000 kL of catayltic polymerised gasoline.

3.2.5 Alkylation Plant

Using hydrofluoric acid as a catalyst, butylenes (from the Residue Cracker) are reacted with a large excess of isobutane (from Crude Units, Catalytic Reformer and Residue Cracker) to produce a gasoline component. The so-called 'alkylate' has superior stability and anti-knock quality. It is also suitable for blending into aviation gasoline and motor spirit. The Unit has an annual capacity of 150,000 kL of alkylate.

3.2.6 Lubricating Oil Plant

Each year the Refinery produces approximately 100,000 tonnes of lubricating oils, requiring several stages in their preparation. The various process stages are:

a) The Vacuum Distillation Unit (Figure 3.2) has the capability to process up to 1,150,000 kL per year of atmospheric residue from the Crude Distillation Units to produce three or four waxy distillate side cuts. Vacuum distillation enables the heavy oils to be vaporised at temperatures below their normal boiling point, so preventing breakdown of the oil. Selected cuts of particular viscosities are passed through the Furfural, Ferrofiner and Methyl Ethyl Ketone Units for further processing into lubricating oil basic grades. Vacuum residue from the base of the column passes to either the Propane Deasphalting Unit, the Bitumen Plant or fuel oil.

b) The Propane Deasphalting Unit (Figure 3.2) produces a very high-viscosity lubricating oil base grade, using residue from the Vacuum Distillation Unit. Liquefied propane, mixed with the residue, dissolves the 'oil' fraction and precipitates asphaltenic material which is disposed of to fuel oil or bitumen. The solvent propane is recovered from the oil/propane mixture by distillation. The deasphalted oil goes on to furfural treatment, dewaxing and ferrofining.

c) Furfural extraction improves the viscosity/temperature characteristics and the stability of oils. Desirable materials (known as waxy raffinates) with some furfural, leave the top of the tower for removal of the furfural; undesirable materials extracted with the majority of the furfural, leave the bottom of the tower for similar treatment. Recovered furfural is re-cycled and extract goes to fuel oil or Residue Cracker feed.

d) The waxy raffinates are treated in the Solvent Dewaxing Unit for removal of waxes. Those oil components, solid at ordinary temperatures, interfere with handling and lubrication. The charge stock is dissolved in a warm mixture of methyl ethyl ketone and toluene. The oil/solvent mix is then chilled, using propane as a refrigerant, and the crystallised wax is separated from the mix by rotary cylindrical filters. Solvent is recovered from wax-free oil mix and "slack-wax mix" by distillation and stripping. Slack-wax is used as feedstock for the Residue Cracker.

e) The products at this stage, called wax-free oils, are processed in the Ferrofiner (Figure 3.2). This removes impurities which may be present, and enhances the physical and chemical stability of the product. The treatment uses a BP-developed cobalt molybdenum catalyst, in an atmosphere of hydrogen gas (see Catalytic Reformer) at high temperature and pressure.

The pure lubricating oil base stocks are transported by ship and road tanker to BP blending plants in Australia and overseas where they are blended with additives to control resistance to oxidation, acid formation, tendency to deposit carbon and improve viscosity index. About 25% of the blending stock is exported.

3.2.7 Bitumen Plant

Residue from the Vacuum Distillation Unit enters the blowing tower at 200°C; compressed air is introduced at the base of the tower, and different degrees of hardness are obtained by varying oil temperature and quantity of air. About 90,000 tonnes of bitumen can be produced each year and 2,600 tonnes of the bitumen are now made into 4,000 tonnes per annum of bitumen emulsions in a new plant commissioned in 1988/89.

3.2.8 Hydrofiner

Some diesel oil components from the Crude Distillation Units and the Residue Cracker are treated in the Hydrofiner to remove sulphur compounds and improve stability. The oil passes at high temperature (400°C) and pressure (6,300 kPa) over a catalyst containing cobalt and molybdenum oxides on an alumina base. This is done in the presence of a gas stream, rich in hydrogen, obtained from the Catalytic Reformer. The sulphur compounds breakdown and the hydrogen combines with the sulphur to form hydrogen sulphide.

The hydrogen sulphide is then stripped from the product and is routed to the Sulphur Recovery Unit. Up to 300,000 kL of diesel oil blending components can be treated by the Hydrofiner each year.

3.2.9 Sulphur Recovery Unit (SRU)

The Sulphur Recovery Unit (Figure 3.2) produces liquid sulphur from hydrogen sulphide which would otherwise remain in fuel gas or be burned at the flare and contribute to atmospheric sulphur emissions.

Gases containing hydrogen sulphide are passed through a solvent which absorbs the hydrogen sulphide. The solvent is then heated to release the purified hydrogen sulphide as a concentrated feed gas for the Sulphur Recovery Unit. The hydrogen sulphide is partially combusted to sulphur dioxide which then reacts over a catalyst with the remaining hydrogen sulphide to produce sulphur. The sulphur is condensed and stored as a hot liquid for sale, and is transported by road tanker.

3.2.10 Jet Fuel Treatment Plant

Jet/Kerosene from the Crude Distillation Units is mixed with caustic soda solution and air and passed over an activated charcoal catalyst. The odorous and corrosive mercaptan sulphur compounds in the Jet/Kerosene are oxidised to disulphides with assistance of the Merox Catalyst. The oil soluble disulphides dissolve in the Jet and are separated from the caustic solution which is recycled. The Jet is water washed and dried before being pumped to storage. The Merox Treatment Unit is capable of sweetening up to 700,000 kL of Jet per year.

3.2.11 Sweetening Units

Motor spirit and kerosene components are mixed with copper chloride supported on an inert base. This catalyses the air oxidation of the undesirable sulphur compounds (mercaptans).

3.2.12 Steam Generation Plant (SGA)

Refinery operations require a continuous supply of steam, and this is provided by the Steam Generation Plant (Figure 3.2). The plant, comprising four boilers, is sometimes referred to as the Boiler Battery and consumes 100 kL of fresh water per hour.

3.2.13 Propane Production Units (PPU1 & PPU2)

Combined liquefied petroleum gas (LPG) from the Crude Distillation Units and Catalytic Reformer, and from the Residue Cracking Unit are separated in Propane Production Unit No.1 and Propane Production Unit No.2 respectively into the individual propane and butane streams for direct sales or further processing in the Catalytic Polymerisation and Alkylation Units.

3.3 PROPOSED DEVELOPMENT

The proposed site development and process activities associated with the Feed Flexibility Project are described in the following sections. The environmental discharges from the Refinery following the development are described separately in Section 3.5.

The project would enable the Refinery to process more high sulphur crude while at the same time reducing environmental discharges.

Figure 3.3 shows a simplified flow diagram of the Refinery following the proposed redevelopment, and Figure 3.4 shows the location of the new process units relative to the present site.

3.3.1 New Hydrofiner Unit.

The new Hydrofiner Unit (Figure 3.4) will be capable of processing 1800 tonnes per day of liquid feedstock supplied from storage tanks. The feedstock consists of either Light Cycle Oil (LCO) product from the Residue Cracking Unit or Heavy Gas Oil (HGO) from the Crude Distillation Units or a combination of the two products.

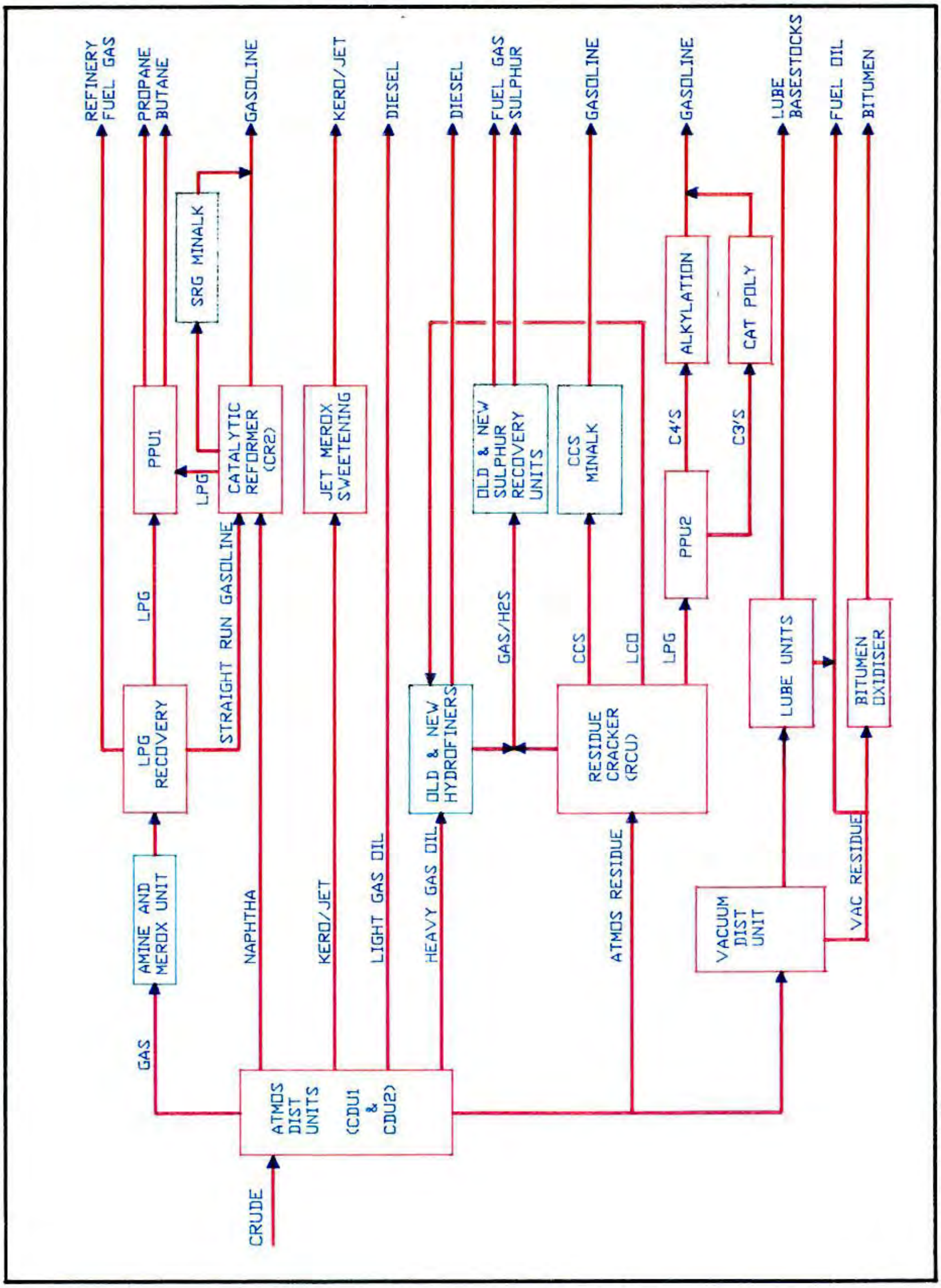


Figure 3.3 Simplified Flow Diagram
After Feed Flexibility Project

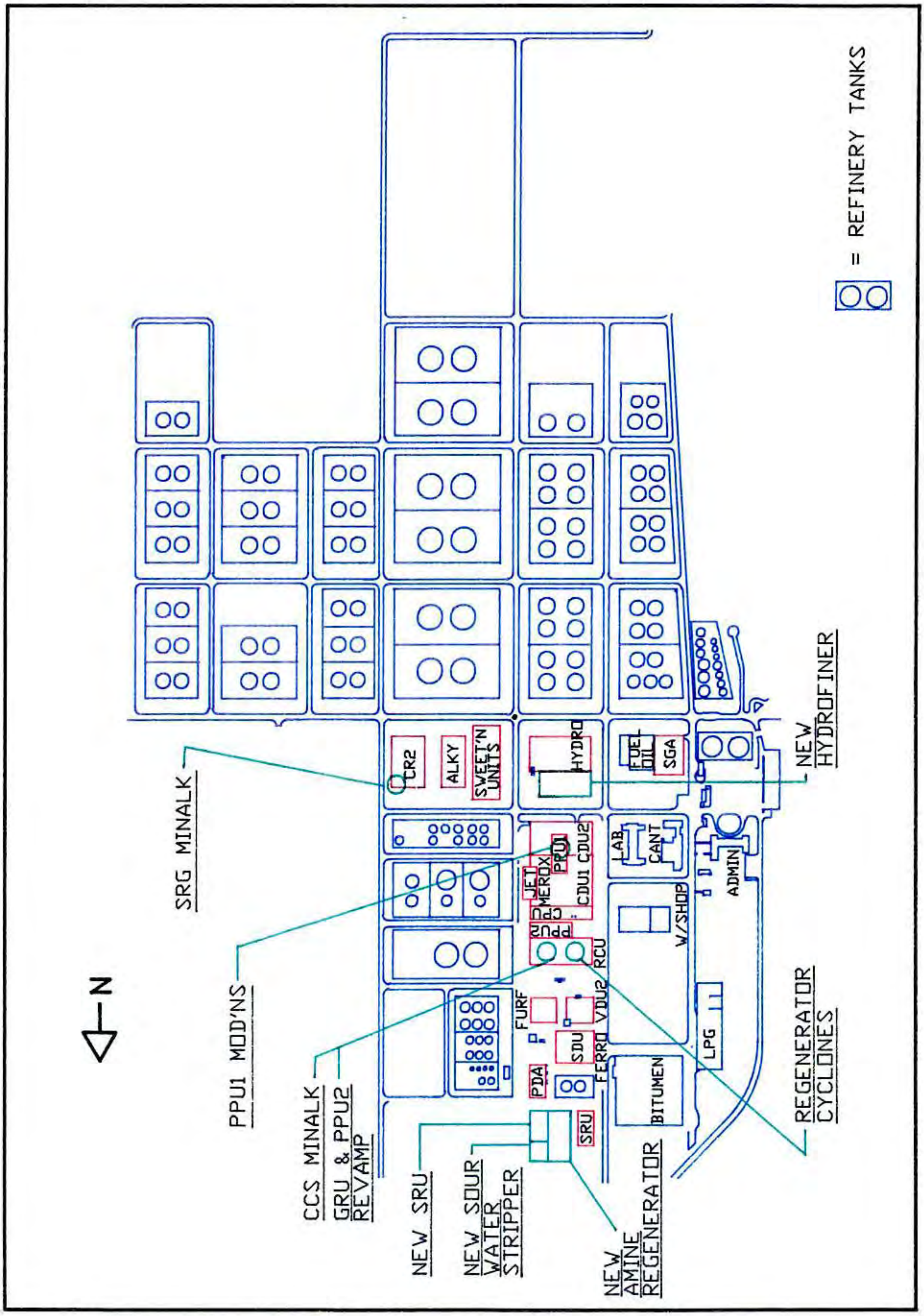


Figure 3.4 Redeveloped Plant Layout

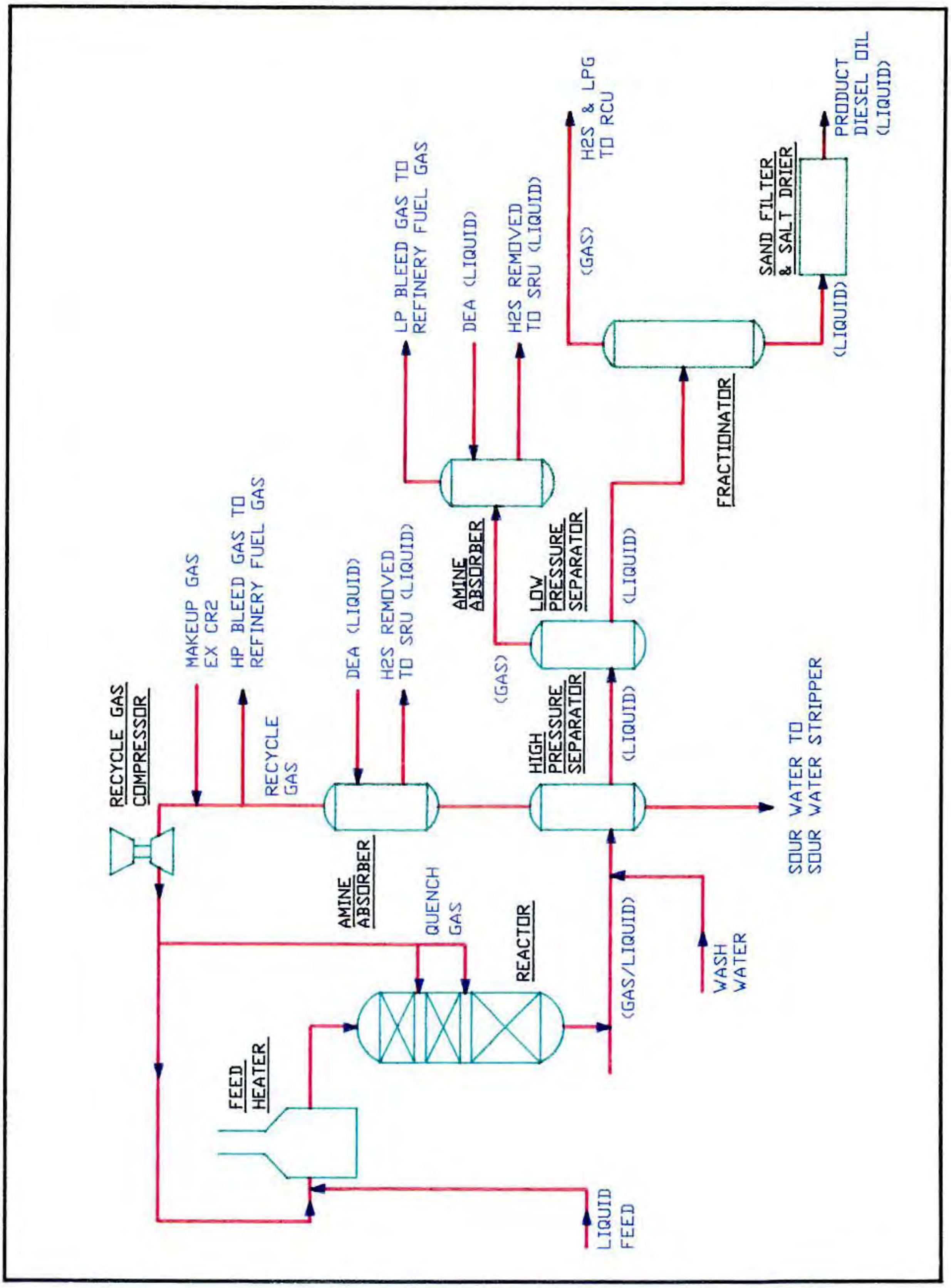


Figure 3.5 Simplified Flow Diagram
New Hydrofiner

The liquid feed would initially be mixed with a hydrogen rich gas stream and the mixture heated in a fired furnace to the required reaction temperature of approximately 350°C. The stream would then pass through a fixed bed catalyst where sulphur compounds in the feedstock are converted to hydrogen sulphide. The catalyst used is cobalt molybdenum on alumina base and operates under a pressure of 7000 kPa. Part of the hydrogen rich gas would be used as quench gas between the three catalyst beds in the reactor for cooling and to improve the conversion of sulphur to hydrogen sulphide.

Reaction products are cooled and the gaseous and liquid product streams split in a high pressure separator followed by a low pressure separator. The hydrogen rich gases would be contacted with diethanolamine (DEA) in the amine absorbers to remove the hydrogen sulphide. Make up gas from the Catalytic Reforming Unit would be added to the high pressure gas stream and the combined stream recycled back to the feed for reuse. The hydrogen sulphide rich amine would be directed to the Sulphur Recovery Unit for recovery of the sulphur and regeneration of the diethanolamine for reuse in the amine absorbers.

The liquid product would be sent to the fractionator, where any remaining hydrogen sulphide and low boiling point products such as LPG would be stripped from the final product, prior to disposal to finished product tankage for blending of diesel oil product. The light material including hydrogen sulphide would be directed to the Residue Cracking Unit for further recovery. The recovered hydrogen sulphide would go to the Sulphur Recovery Unit for conversion to elemental sulphur. Bleed gases from the high pressure and low pressure separators (essentially hydrogen, methane and ethane) would be directed to the fuel gas collection main.

The simplified flow diagram for the Hydrofiner is shown in Figure 3.5.

3.3.2 Modifications to existing Propane Production Unit (PPU1).

When crude oil is distilled the light liquid product, containing hydrogen sulphide, is sent to Propane Production Unit No.1 for recovery of liquid propane and butane. The proposed modifications are designed to remove hydrogen sulphide and odorous mercaptan sulphur from the light liquid feed to the Unit as well as increase the recovery of propane and butane.

The light stream from the Crude Distillation Units would be contacted with diethanolamine in the amine absorber where hydrogen sulphide is absorbed in the diethanolamine. The hydrogen sulphide rich diethanolamine would be sent to the Sulphur Recovery Unit for conversion of the hydrogen sulphide into elemental sulphur and regeneration of the diethanolamine for reuse in the amine absorber.

The light oil stream leaving the amine absorber would go to the deethaniser where the light gases, methane and ethane, are distilled from the propane and butane. The methane/ethane gas would be sent to refinery fuel gas main (Figure 3.6a). The combined propane/butane stream would pass to the Merox section of the plant for removal of the mercaptan sulphur.

In the Merox extraction process the propane/butane feed stream would be mixed with a dilute caustic solution containing the Merox catalyst in the extractor column. The mercaptan sulphur would be transfered from the hydrocarbon to the caustic solution. Air would then be added to the caustic solution in the oxidiser and the resulting reaction would convert the aqueous soluble mercaptans into insoluble disulphide oil. The disulphide oil, which is less dense than the caustic solution, would be decanted in the separator and sent to the Hydrofiner for removal of sulphur. The caustic solution would be returned to the extractor for reuse.(Figure 3.6b).

The propane/butane stream leaving the extractor would initially pass through a settler to remove any entrained caustic and then a sand filter to remove any free water prior to entering the existing depropaniser. In this column propane and butane would be separated and any water present would be removed by the existing molecular sieves. The propane and butane products would then be directed to finished product storage.

Simplified flow diagrams are shown as Figures 3.6a and 3.6b.

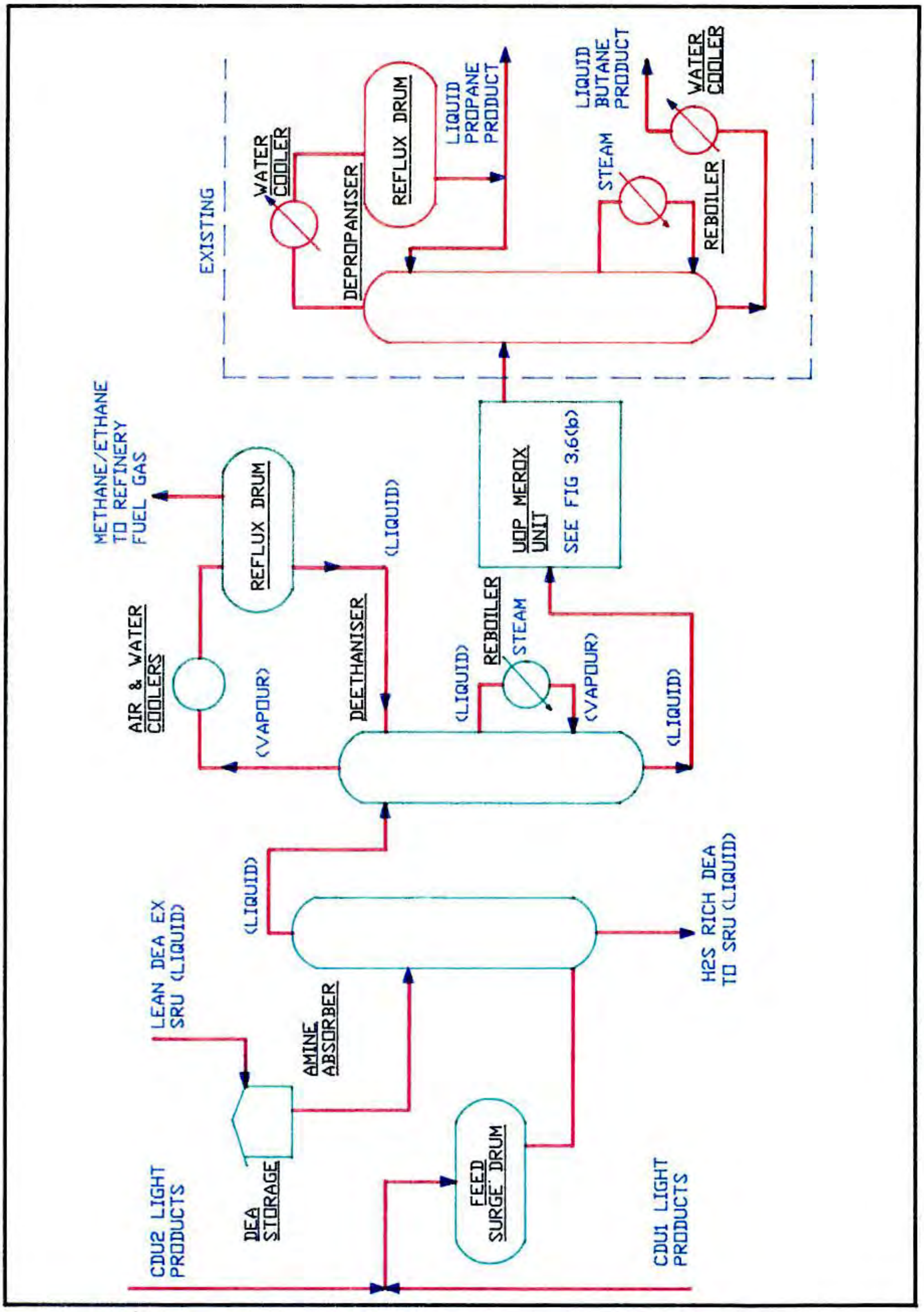


Figure 3.6(a) Simplified Flow Diagram PPU1 Modifications

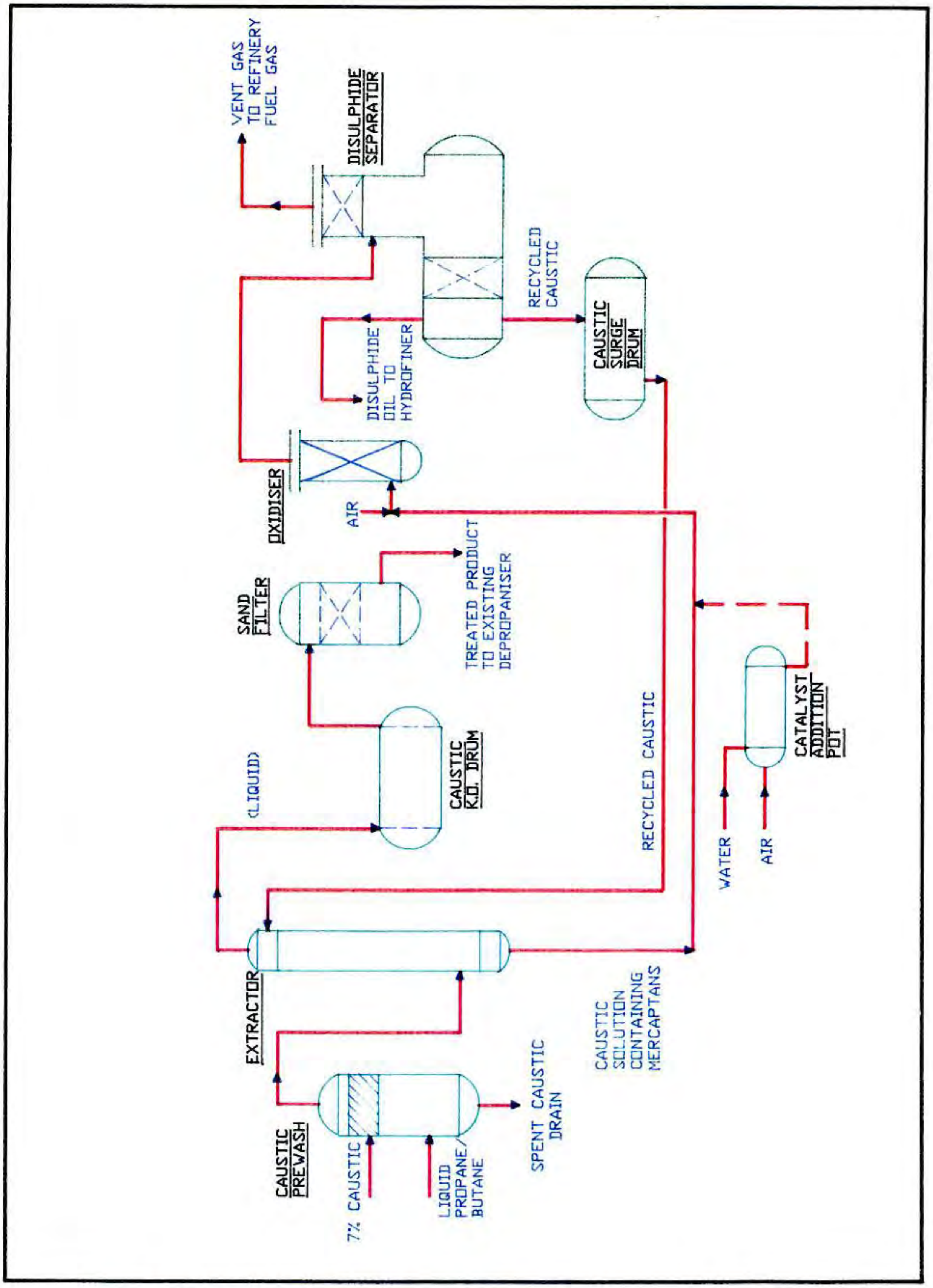


Figure 3.6(b) Simplified Flow Diagram of Merox Extraction Unit for PPU1 Modifications

3.3.3 New Straight Run Gasoline Minalk Unit

Straight run gasoline (SRG) is an overhead product of the existing prefractionator column of the Catalytic Reforming Unit and contains hydrogen sulphide and mercaptan sulphur in small quantities. This new Unit will replace the present antiquated Copper Chloride Sweetening Unit.

Straight run gasoline would first be contacted with dilute 7% caustic solution in the caustic prewash for removal of hydrogen sulphide. The spent caustic (ie. containing hydrogen sulphide) would be sent to the existing spent caustic system for deodorisation in the caustic regeneration facilities on the Crude Distillation Unit No.1. The minute amounts of hydrogen sulphide would be directed to the Crude Distillation Unit No.1 furnace where they are incinerated to form sulphur dioxide. The deodorised caustic would be slowly discharged into the refinery salt cooling water via the caustic tank (Tank 3).

The hydrogen sulphide free straight run gasoline would be mixed with a minimum amount of weak 1.7% caustic solution and air prior to entering the reactor. The mercaptan sulphur in the straight run gasoline would react with the oxygen over a fixed charcoal bed to form disulphide oil and water. The small quantity of disulphide oil would dissolve in the straight run gasoline which is directed to intermediate tankage for blending into motor gasoline. The small quantities of very dilute spent caustic would be drained from the reactor and pumped into the refinery salt cooling water.

A simplified flow diagram is shown in Figure 3.7.

3.3.4 New Catalytic Cracked Spirit Minalk Unit

Catalytically cracked spirit (CCS) produced on the Residue Cracking Unit is hydrogen sulphide free, but does require sweetening to remove mercaptan sulphur. At present the catalytic cracked spirit is sweetened in a liquid/liquid Merox Unit using 10% caustic solution, however this strength caustic also extracts the phenolic compounds present in the catalytic cracked spirit. The proposed new Minalk Unit would utilise 1.7% caustic solution, as in the Straight Run Gasoline Minalk Unit, which would extract less than 1% of the phenolic compounds present, thus reducing the phenols in the refinery salt cooling water.

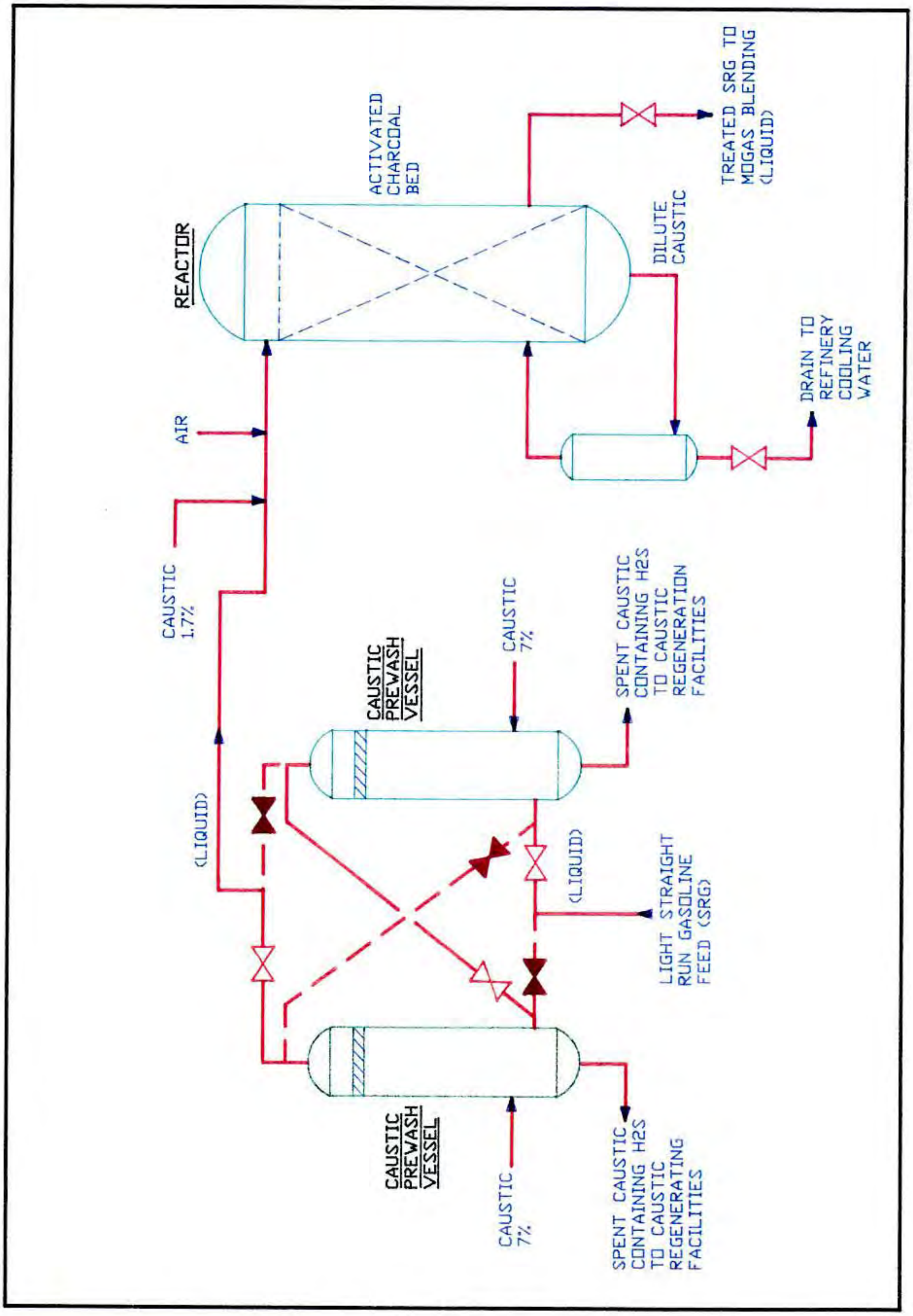


Figure 3.7 Simplified Flow Diagram
New SRG Minalk Unit

The catalytic cracked spirit requires only mixing with air and the 1.7% caustic solution prior to passing to the reactor containing a fixed bed of activated charcoal. As in the Straight Run Gasoline Minalk Unit, the mercaptan sulphur would be converted to a disulphide oil which dissolves in the catalytic cracked spirit. This mercaptan free product would be directed to intermediate product storage for subsequent motor spirit blending and the very dilute spent caustic drainings would be routed to the refinery salt cooling water.

A simplified flow diagram is shown in Figure 3.8.

3.3.5 New Sour Water Treating Facilities.

A new refinery Sour Water Stripper is proposed to replace the existing smaller version which currently only processes sour water generated on the Residue Cracking Unit and does not remove ammonia.

Sour water, containing small quantities of phenolics, ammonia and sulphides, from both the new Hydrofiner and the existing Residue Cracker would be fed to the stripping column. A steam reboiler would be used to strip the offgas from the sour water which would then be sent to the refinery salt cooling water.

The dry odorous offgas, which would contain a small amount of hydrogen sulphide and ammonia, will be directed to the muffle furnace of the new Sulphur Recovery Unit where the hydrogen sulphide will be recovered as liquid sulphur and the ammonia converted to nitrogen gas.

A simplified flow diagram is shown in Figure 3.9.

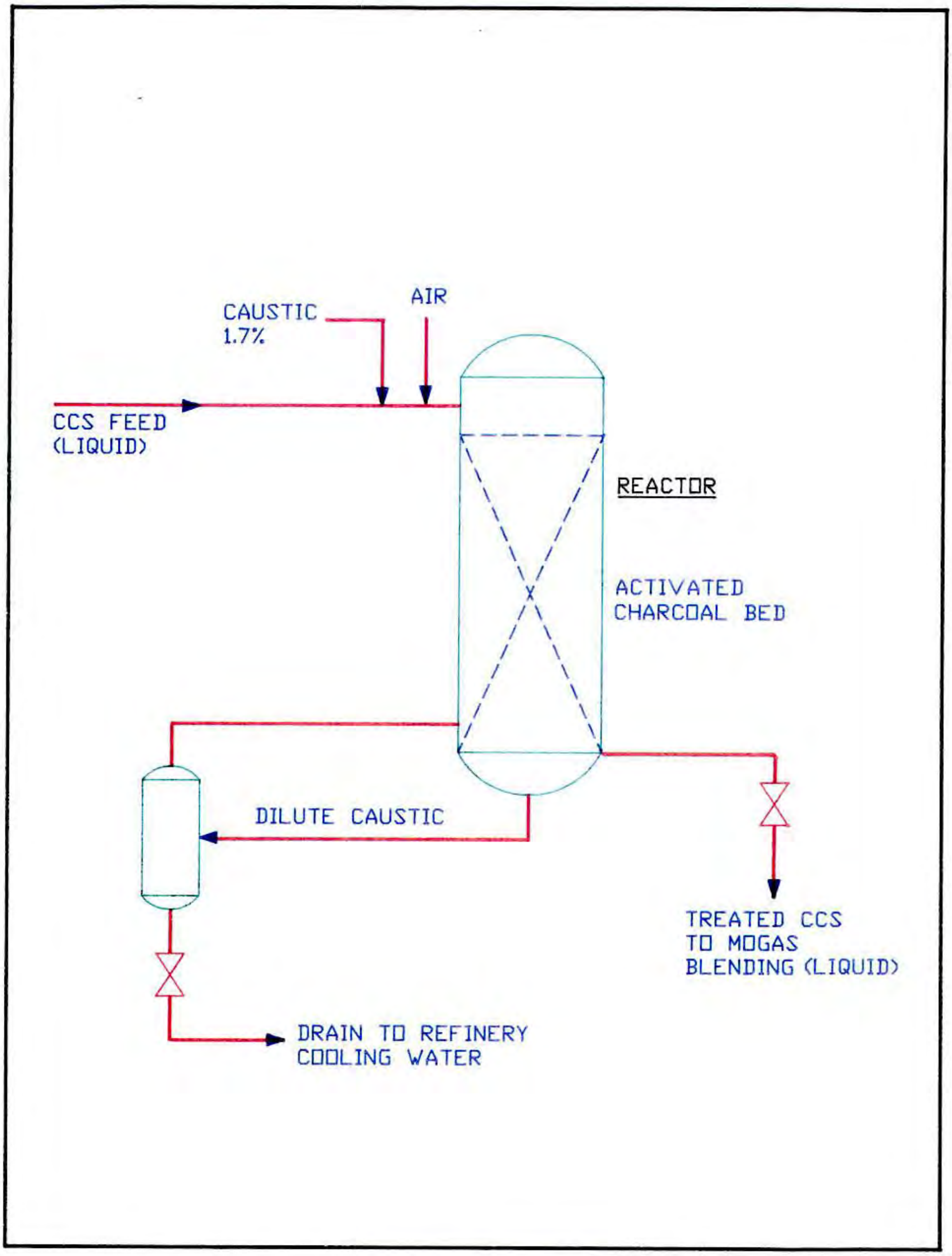


Figure 3.8 Simplified Flow Diagram
CCS Minalk Unit

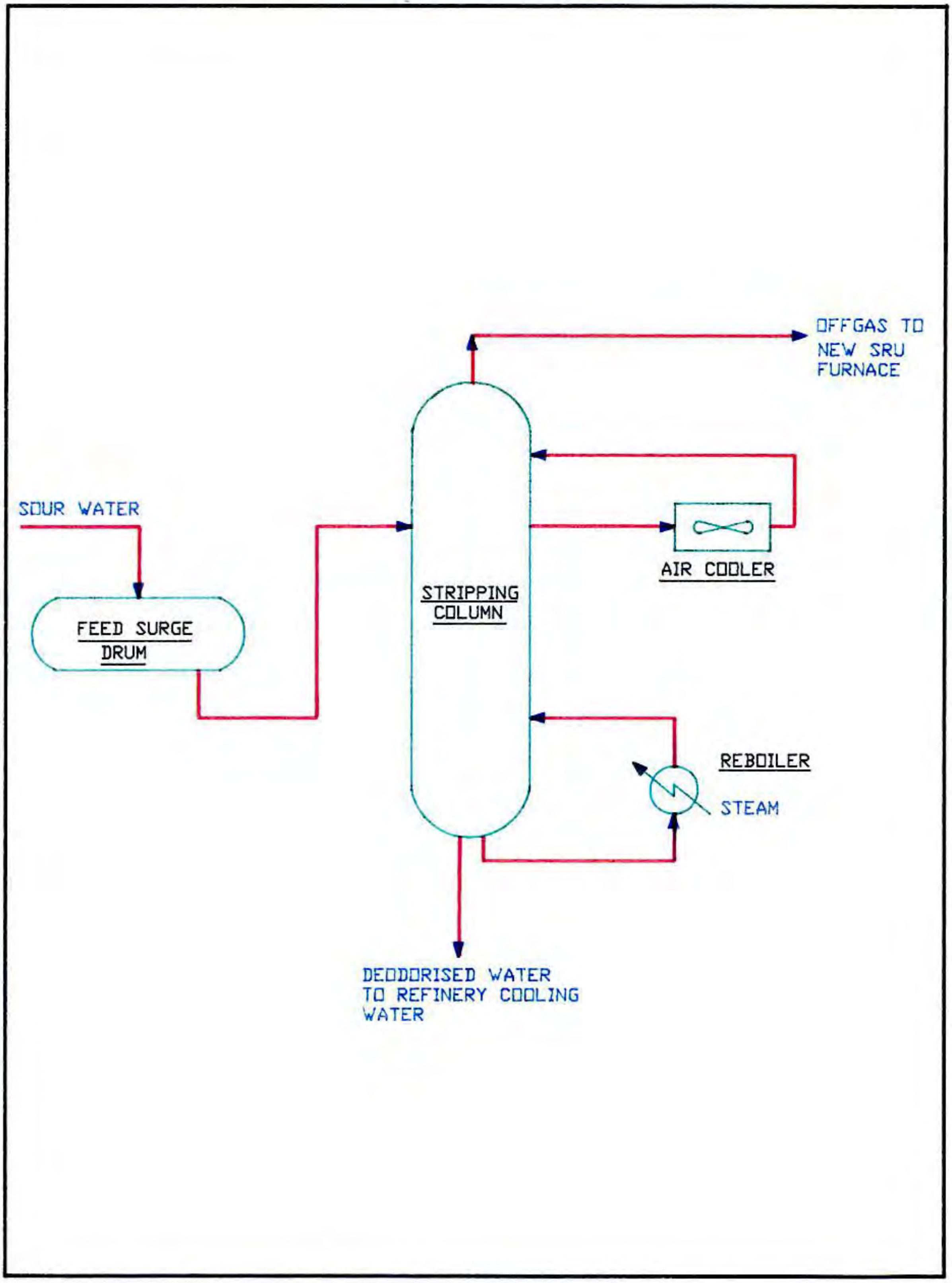


Figure 3.9 Simplified Flow Diagram
New Sour Water Stripper

3.3.6 New Sulphur Recovery Unit.

With implementation of the proposed Feed Flexibility Project modifications the Refinery's existing Sulphur Recovery Unit would not be able to process all the additional hydrogen sulphide. It is proposed, therefore, to build a second Sulphur Recovery Unit in parallel with the one commissioned in 1989.

Hydrogen sulphide rich diethanolamine from the Hydrofiner and Propane Production Unit amine absorbers would be fed to a new amine regeneration section as the present column would be too small to process the increased load. Lean or regenerated amine would be returned to the absorbers for reuse and the freed hydrogen sulphide rich gas would then be directed to the muffle furnace of the Sulphur Recovery Unit together with the dry offgas from the new Sour Water Stripper. One third of the hydrogen sulphide is burnt to sulphur dioxide which then reacts with the remaining hydrogen sulphide and passes over an activated alumina bed to form elemental sulphur and water. The reaction is as follows:

$$H_2S + 3/2\, O_2 \rightleftharpoons SO_2 + H_2O \quad \text{(Combustion)}$$

$$2H_2S + SO_2 + H_2O \rightleftharpoons 3S + 3H_2O \quad \text{(Conversion)}$$

$$3H_2S + 3/2\, O_2 \rightleftharpoons 3S + 3H_2O \quad \text{(Overall)}$$

The reactor products would be cooled to remove elemental liquid sulphur and unreacted gases would then be directed to a second reactor where further reaction takes place resulting in approximately 95% overall conversion of hydrogen sulphide to sulphur.

Traces of unreacted hydrogen sulphide would be incinerated in the final furnace to sulphur dioxide and emitted via the incinerator stack. Condensed elemental sulphur is collected as a liquid in the sulphur pit and sold as a finished product.

A simplified flow diagram is shown in Figure 3.10.

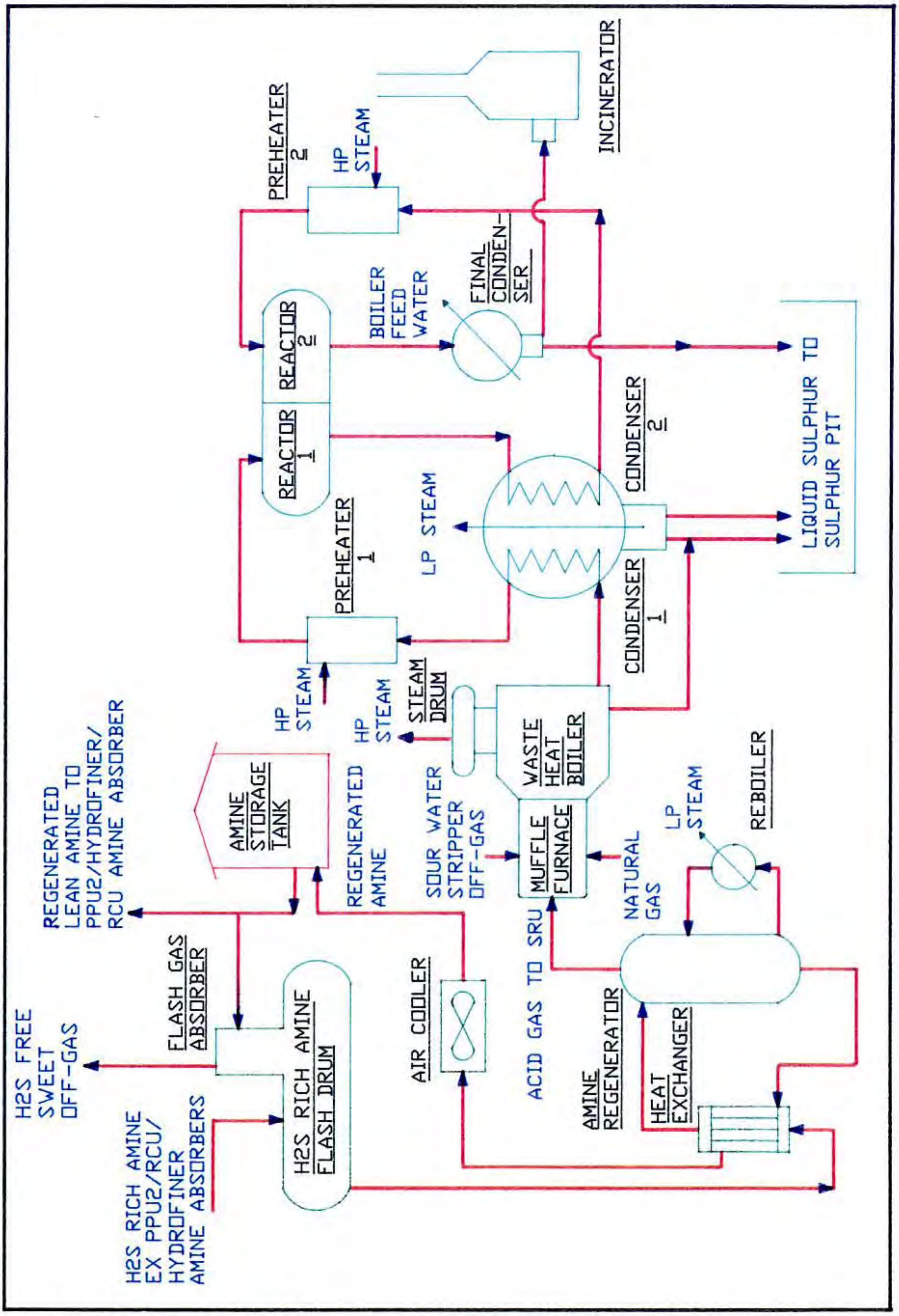


Figure 3.10 Simplified Flow Diagram of New Amine Regenerator & Sulphur Recovery Unit

3.3.7 Residue Cracker Gas Recovery Unit & Propane Production Unit No.2 Modifications.

The modifications proposed to the Residue Cracker Gas Recovery Unit and the Propane Production Unit No.2 embody only changes to increase the throughput to the units; increase energy efficiency and improve the recovery of the products.

The gas recovery section of the Residue Cracking Unit converts the lighter products resulting from the residue cracking process into a liquid LPG stream and an offgas stream. The offgas is then directed to the Sulphur Recovery Unit to remove hydrogen sulphide before entering the fuel gas collection main for burning in the refinery's fired heaters and boilers. The LPG stream is sent to the Propane Production Unit No.2 which is similar to the Propane Production Unit No.1. In Propane Production Unit No.2 the feed stream would first be contacted with diethanolamine in the amine absorber to remove the hydrogen sulphide. The stream would then be divided and enter the two parallel propane/butane splitters where propane is taken off the columns as a liquid overhead product and sent to the propane storage tanks. The butane product streams leaving the bottom of the two splitters would be combined and sent to the Merox extraction Unit to remove the mercaptan sulphur which has concentrated in this stream. The butane product would then be dried and sent to finished storage. Any offgas from the two splitters would be directed to the fuel gas collection main.

A simplified flow diagram is shown in Figure 3.11.

The modifications will not significantly alter the units' configuration in any way. The increased recovery of propane and butane would directionally reduce the density of the fuel gas burnt in the refinery and reduce the frequency of flaring that may take place during the summer months.

3.3.8 Residue Cracking Unit Particulate Emissions.

In order to reduce the particulate emissions from the Residue Cracking Unit stack to below the maximum current licence limit of 250mg/m^3, it is proposed to install latest technology secondary cyclones to the existing primary regenerator cyclone sets. This is predicted, by the process licensors, to reduce the particulate emissions to well below 250mg/m^3.

The second stage cyclones would be connected to the primary cyclone sets which sit on the top of the second regenerator. Other options were considered, which included modifying the existing cyclones and installation of an electrostatic precipitator downstream of the regenerator. However, the latest technology secondary cyclones proposal was deemed the best alternative in a recent study carried out by the process licensors SWEC.

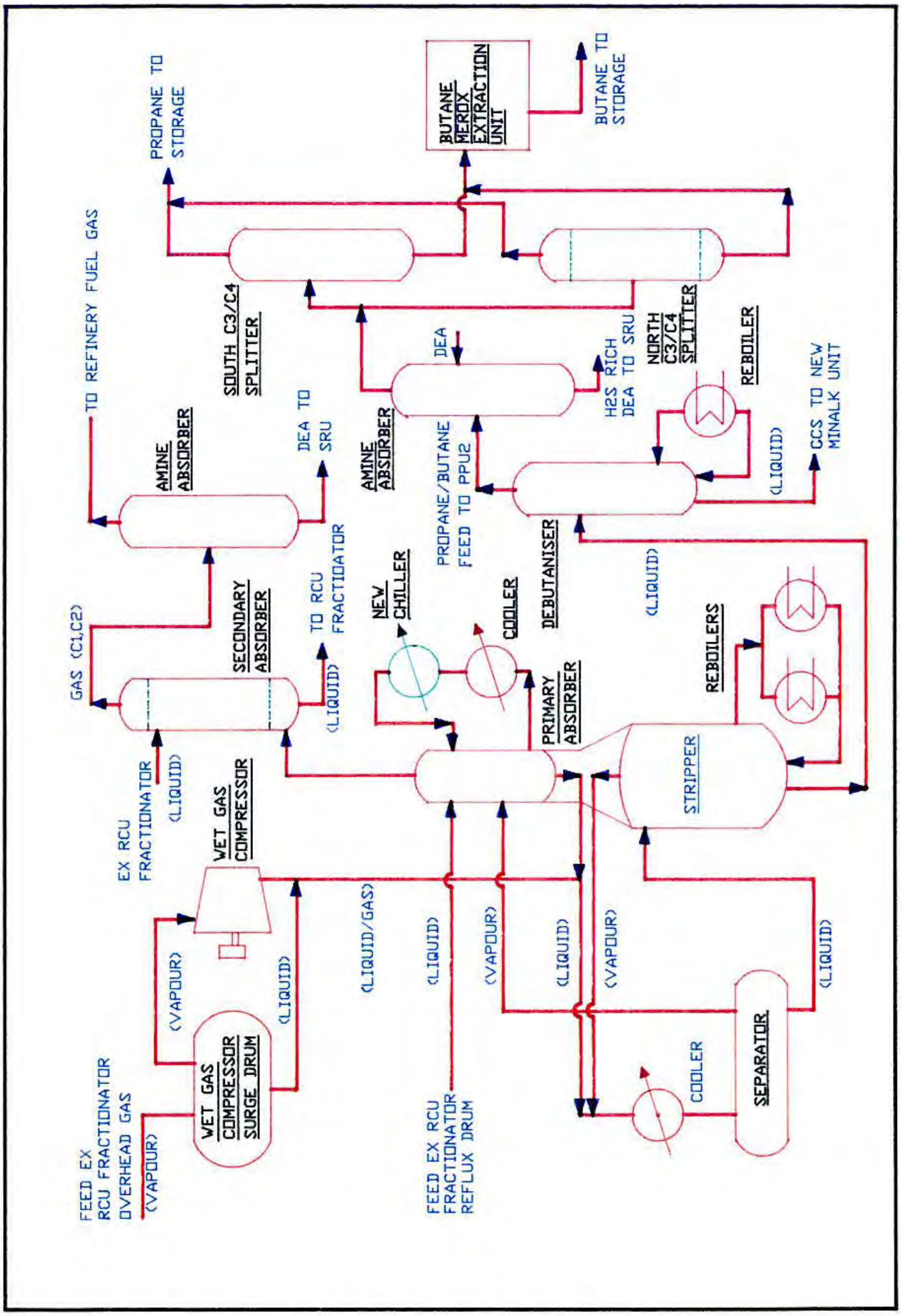


Figure 3.11 Simplified Flow Diagram
Residue Cracker Gas Recovery Unit

3.4 MATERIALS USAGE, PRODUCTION, TRANSPORT AND HANDLING

3.4.1 Crude Supplies and Production Capabilities

BP Refinery Kwinana currently imports some four and half million tonnes per annum of crude oil, condensate and residue. From these imports, a variety of different products are manufactured and transported from the refinery in liquid form using pipelines, tank ships and road tankers. The name plate capacities of the existing major process units and the proposed new units are shown in Table 3.1.

TABLE 3.1 Nameplate Capacities of Major Process Units and New Facilities

Unit	Capacity in kL/Day
Crude Distillation Unit No.1	8 500
Crude Distillation Unit No.2	11 800
Residue Cracking Unit	4 600
Catalytic Reformer No.2	2 500
Alkylation Unit	500 (product)
Catalytic Polymerisation Unit	700 (product)
Propane Production Unit No.1	480
Propane Production Unit No.2	1 200
Bitumen Unit	300
Vacuum Distillation Unit No.2	3 200
Furfural Extraction Unit	1 100
Solvent Dewaxing Unit	800
Propane Deasphalting Unit	400
Hydrofiner Unit	1 000
Jet Merox Unit	2 400
Sulphur Recovery Unit	35 t/day
Copper Chloride Unit	1 000
Steam Generation Area	3 600 t/day
New Facilities	
Hydrofiner unit	2 050
Sulphur Recovery Unit	35 t/day
Straight Run Gasoline Minalk Unit	1 500
Catalytic Cracked Spirit Minalk Unit	3 520
Sour Water Stripper Unit	1 200

The Feed Flexibility Project will provide the Refinery with the flexibility to import and economically process greater quantities of crudes from the Middle East region as opposed to relying on the rapidly diminishing and more expensive indigenous and low sulphur South East Asian crudes. The overall effect will be a small reduction in the Refinery's annual throughput due to the replacement of low sulphur indigenous crudes with high sulphur Middle East crudes. However, with the higher conversion and recovery rates achievable, the product balance will remain essentially the same with only marginal reductions in the production of fuel oil.

As the Middle East crudes contain higher levels of sulphur the modifications have been designed to ensure there is minimal effect on the environment and that the Refinery not only remains within the operating licences and agreements, but also makes significant steps to reduce the Refinery's liquid and odorous emissions.

The net effect of the modifications to the Refinery processes will be a small increase in the Residue Cracking Unit's throughput accompanied by a larger increase in capacity of Propane Production Unit No.2 to recover the additional propane and butane produced. Desulphurisation capacity will increase by 1800 tonnes/day with the new Hydrofiner Unit from the present 900 tonnes/day. The new Sulphur Recovery Unit will add a further 35 tonnes/day of sulphur production capacity to the existing 35 tonnes/day and also provide a contingency for when either of the units are shut down for repairs.

3.4.2 Other Raw Materials.

a) Caustic Soda

Presently the refinery uses 470 tonnes/annum of 100% caustic soda, with the majority discharged to the refinery salt cooling water as dilute spent caustic solution. With the proposed modifications the amount of caustic required for treating and disposal will be reduced by approximately 35% to 290 tonnes/annum.

b) Diethanolamine

The amine system presently exists as a closed system in the Refinery. The addition of the new amine absorbers on Propane Production Unit No.1 and the Hydrofiner will require 20% extra diethanolamine for the initial fill up of the vessels. There will also be a small increase in the make up quantities of diethanolamine, estimated to be of the order of 5 tonnes/year, to cover degradation and losses. Supply is generally in bulk from local chemical suppliers.

c) Catalysts

The new Hydrofiner will require an initial charge of 25 tonnes of new cobalt/molybdenum on alumina catalyst supplied from overseas vendors as the catalyst is unavailable in Australia. Similarly, increased quantities of Residue Cracking zeolitic catalyst of the order of 350 tonnes/annum will be required, together with 115 tonnes of activated charcoal (changed every 5 years) for the Minalk and Merox Units, plus approximately 4 m^3 (changed every 4 years) of activated alumina for the new Sulphur Recovery Unit. The additional catalyst supply will be from existing overseas sources until the equivalent material is available in economic quantities in Australia.

3.4.3 Water Usage.

There will be an increase in sea water usage from 430 ML/day to 435 ML/day associated with the new Hydrofiner. Maximum air cooling will be a design feature of the modifications, but further cooling of products with sea water will be necessary to cool the products to safe temperatures.

There will be little if any change to the use of fresh water (7,000 kL/day), which is purchased from the Water Authority of WA, as a consequence of the proposed modifications.

3.4.4 Energy Supply and Consumption.

Maximum use of air cooling will be a design feature of the project modifications in order to minimise use of sea water for cooling purposes. The combination of this with the increase in throughput of the Residue Cracker, the new Hydrofiner and the new Sulphur Recovery Unit is estimated to result in a net increase in the electricity requirements for the Refinery of approximately 10%.

Kwinana Refinery generates the majority of its fuel gas requirements as a consequence of the processing and conversion of crude oil into the different products. This fuel gas is reticulated around the Refinery via the fuel gas main. A fuel gas balance is maintained by either addition of natural gas or burning the excess gas at the refinery flare (generally only 5 tonnes/day in order to maintain a small flame in case of emergencies). The net effect of the modifications on the refinery gas balance is predicted to be essentially neutral. However, there could be a marginal increase in the requirement for natural gas of the order of 1-2% at certain times of the year.

There will be no effect on the other utilities used at the Refinery.

3.4.5 Transport and Handling.

Most of the Refinery's feedstocks of crude, condensate and residues come in by tankship, with the balance transported by road tanker. This situation will be unaltered by the proposed project. Similarly, the offtake of products will also be unaffected by the modifications and new process units. The transportation of the products is governed by the supply and demand situation which varies widely from month to month. However, a typical delivery scenario would be 50% via pipelines, 45% via tankships and 5% by road tankers.

Apart from the Refinery fuel gas main, the relief system to the emergency flare and some intermediate process streams, all other streams on the Refinery are liquids. All process streams are therefore pumped, with storage of feedstock (crude, condensate and residue), intermediate products for blending and finished products in tanks. The project will not affect this situation nor the number of tanks in the Refinery. There will therefore be no additional safety or hazardous transportation and handling issues as a result of this project.

3.4.6 Operations.

The refinery operates 24 hours a day, 365 days per year. This will remain the case after the implementation of this project.

3.5 WASTE PRODUCTS AND DISPOSAL

The discharges from both the existing and redeveloped plants are in the form of gases, liquids, solids and noise.

3.5.1 Atmospheric Emissions

Gaseous emissions are described in this section in general terms, and discussed in more detail in Chapter 5.

Existing Plant

The major airborne emissions of environmental significance from the Refinery are sulphur oxides (SO_x), nitrogen oxides (NO_x), hydrocarbons, carbon dioxide and particulates. Small amounts of metal oxides are also released bound to the particulates. The Refinery currently has 17 stacks ranging in size from 15.2m to 80m. The emissions, except for the Sulphur Recovery Unit and Residue Cracking Unit stacks, are the result of the combustion of a mixture of refinery fuel gas and natural gas. The gases emitted that are of significance to air quality are:

- nitrogen oxides
- sulphur dioxide
- carbon dioxide
- hydrocarbons

The main source of the gaseous emissions, except for hydrocarbons, from the Refinery is the Residue Cracking Unit stack. This stack accounts for 85% of SO_2 emissions, 39% of NO_x, 40% of CO_2 and 99% of particulate emissions (emission rates are presented in Section 5.3).

Evaporative losses from the Tank Farm and API Separator No.1 account for a large proportion of the hydrocarbon emissions from the Refinery.

The Refinery has taken action in the past to significantly reduce atmospheric emissions. The substitution of Natural Gas for fuel oil as a fuel source and the construction of the Sulphur Recovery Unit has resulted in a significant reduction (about 80%) in sulphur dioxide emissions from the Refinery. Odours from the Refinery have been significantly reduced by fully enclosing the LPG stenching facility, storage of odorous spent caustic in a floating roof tank and installation of secondary seals on light product storage tanks. Hydrocarbon emissions are being reduced by installation of secondary seals on storage tanks, and installation of a closed tank drainage system.

Proposed Development

After completion of the Feed Flexibility Project, there would be significant reductions in odorous air emissions and particulate emissions. Particulate emission controls proposed for the Residue Cracking Unit would result in at least a two thirds reduction in particulate emissions to atmosphere from the Refinery. The new Straight Run Gasoline Minalk Unit will eliminate the odorous mercaptans from Straight Run Gasoline before it is sent to tankage.

There would be no increase in SO_2 or hydrocarbon emissions as a result of the project. Small increases in NO_x (3%) and CO_2 (6%) emissions are expected due to an increase in fuel gas consumption as a result of the new Hydrofiner furnace and increased coke combustion in the Residue Cracking Unit catalyst regenerators.

3.5.2 Wastewater

Wastewater quality is discussed in general terms in this section, and in more detail in Chapter 5.

Existing Plant

Wastewater (salt cooling water and process water) is discharged to Cockburn Sound via three shoreline outfalls. These are referred to as the South outfall, Centre outfall and North outfall (see Figure 1.2).

The North outfall discharges salt cooling water from the Lube Oil Unit and treated spent caustic drainings. All water to this outfall passes through API Separator No.2 to remove any free oil before discharge to Cockburn Sound. The Centre outfall discharges salt cooling water from both the pressure and gravity mains. Water drainings from the Residue Cracking Unit sour water stripper and the Jet Merox Unit are discharged to the gravity main and are the major contributors to the pollutants in this outfall. The South outfall discharges salt cooling water from the pressure main and water from API Separator No.1, which treats all storm water runoff and water from the oily water sewer. The oily water sewer discharge is the major source of pollutants in the South outfall. All salt cooling water to the south and north outfall passes through the south and north circular separators to remove any undissolved oil before discharge to Cockburn Sound.

Flows average 70 ML/day South, 240 ML/day Centre and 130 ML/day North, depending on different unit operations within the Refinery. The pollutants of environmental concern in oil refinery wastewater are:

- petroleum hydrocarbons,
- phenolics,
- sulphides,
- heavy metals,
- ammonia,
- cyanides.

The quality of Refinery wastewater has improved significantly since the Cockburn Sound Study in 1979, which highlighted pollution problems associated with industrial discharges to the Sound (DCE 1979). Major reductions in the oil, phenolic and sulphide loads to Cockburn Sound (Figure 3.12) have been achieved by the installation of two sour water strippers, a Merox Unit and better control of flows to the oily water sewer. Since 1979 loads have reduced from 1000 kg/d to 300 kg/d oil, 520 kg/d to 120 kg/d phenolics, and 590 kg/d to 40 kg/d sulphides.

Proposed Development

The modifications resulting from the proposed Feed Flexibility Project will further improve the quality of wastewater discharged from the Refinery. Significant reductions in phenol, sulphide and ammonia loadings to Cockburn Sound would result. The amount of copper discharged to Cockburn Sound would also be reduced due to the replacement of the Copper Chloride sweeteners with the Straight Run Gasoline Minalk Unit. Other components in Refinery wastewater are expected to remain unchanged.

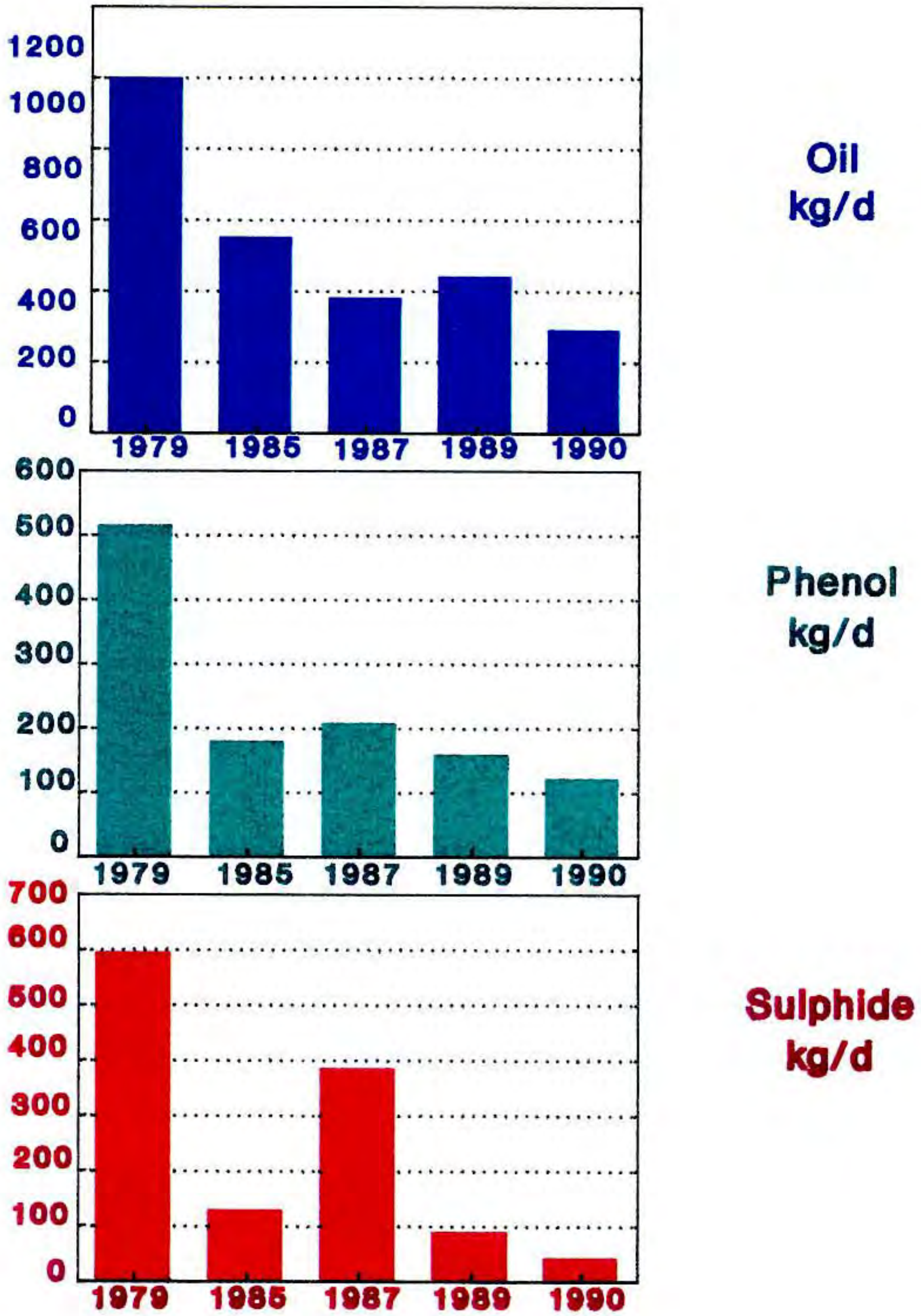


Figure 3.12: Oil, Phenolic and Sulphide Loadings to Cockburn Sound 1979-1990.

3.5.3 Solid Waste

Solid wastes from the existing and redeveloped plants are discussed in general terms in this section. More detailed discussion is provided in Chapter 5.

The categories of solid wastes arising from operation of the Refinery are:

- asbestos
- oily sludges and soils
- spent catalysts
- filter clays
- charcoal
- calcium fluoride
- alkyl lead contaminated scale and rust
- pyrophoric scale
- construction/demolition debris
- general plant waste.

The oily sludges and soils, charcoal, filter clays, calcium fluoride, alkyl lead contaminated material, pyrophoric scale and some spent catalysts are disposed of onsite in designated areas. Some construction/demolition debris (eg. scrap metal) is recycled, the remainder is disposed of at offsite gazetted landfill sites. General plant waste is disposed of at offsite gazetted landfill sites. The spent catalysts not disposed of onsite are being stored while recycling options are being investigated. All asbestos insulation at the Refinery is gradually being removed and is disposed of at offsite gazetted landfill sites.

Extremely small quantities of radioactive material are onsite, completely sealed in analytical equipment, and are disposed of following approved procedures by the Radiation Safety Act 1975-81, which is administered by the Health Department.

In recent years, BP Refinery Kwinana has been successful at finding ways of reducing the amount of solid waste produced at the Refinery. These have included:

- reduction of waste at source,
- recycling/reuse of wastes,
- segregation of wastes,
- process optimisation,
- improved housekeeping,
- waste pretreatment.

Waste minimisation has become and will continue to be a major part of the strategy to progressively reduce the environmental impact of Refinery operations.

Proposed Development

The main changes from the present levels of solid waste would be:

- an increase in the amount of construction debris during the construction phase of the project. This would be disposed of at an offsite gazetted landfill site.

- an increase in the amount of Desulphuriser (Hydrofiner) catalyst and Residue Cracking Unit catalyst for disposal. It is envisaged that an alternative to onsite disposal will be found for these catalysts. Recycling options are being investigated.

- an increase in the amount of Sulphur Recovery Unit catalyst for disposal. This will be disposed of onsite.

- an increase in the amount of charcoal, which would be used in the new Minalk and Merox Units and Sulphur Recovery Unit, for disposal. This will be disposed of onsite.

- an increase in the amount of pyrophoric scale (iron sulphides) for disposal, which will be disposed of onsite.

3.5.4 Noise

Noise from the existing and redeveloped plants is discussed in general terms in this section, and discussed in more detail in Chapter 5.

Existing Plant

Noise levels from all existing plant have been measured. This study identified the major sources of noise within the Refinery. Equipment on some process units could cause onsite noise exposure in excess of 85 dB(A) (8 hour time-weighted average). A Noise Management Programme has been implemented to reduce the noise level emanating from these process units.

Proposed Development

Noise levels generated during construction and operation of new plant would be managed to ensure compliance with the requirements of the Town of Kwinana and the Noise Abatement (Neighbourhood Annoyance) Regulations, 1979 of the Environmental Protection Act, 1986 (as amended).

All new plant will be designed to ensure that noise levels do not exceed 85 dB(A) at 1m from the equipment.

Given both the considerable distance between the Refinery and the nearest residential area, and the existing general background noise levels emanating from the Kwinana Industrial Area, noise generated during construction and normal plant operations would not affect neighbouring residential areas.

3.6 PLANT SAFETY & CONTINGENCY PLANNING

3.6.1 Hazardous Chemicals.

BP has been in the business of producing and refining crude oil since its inception in the early 1900's. The company has a wealth of experience in the refining and handling of hazardous chemicals through its worldwide oil refining and petrochemicals plants. This experience, knowledge and associated data is disseminated throughout the BP group and incorporated at Kwinana Refinery. The Refinery itself has been in operation since 1955, during which time there have been no major catastrophes on-site and no outside fatalities as a result of the refining processes or the handling of any hazardous materials.

Kwinana Refinery is bound by BP's rigorous codes of practice and hazardous material data sheets which are continuously reviewed and updated as new information becomes available. It is the essence of the Refinery's safety policy to minimise risk by adherence to the above documentation in order to continue to make the Refinery a safe place in which to work and to protect the surrounding community.

3.6.2 Hazard Management Process.

It is BP policy to ensure that potential health and safety factors and environmental effects are assessed for all new products, projects, activities and acquisitions. The Hazard Management Process at the Refinery consists of 3 elements:

- the formal Safety Review
- Refinery Permit System
- Refinery Management Systems

These are outlined below.

Since 1978 all new projects at BP Refinery Kwinana have undergone formal Safety Review procedures which consist of a stagewise audit of the safety aspects of the developing project from conception to post-commissioning. The essential item of the Safety Review is the hazard and operability study (HAZOP) which is a systematic procedure for identifying the hazards and operability problems of a facility which could arise under normal and abnormal operating conditions.

The formal Safety Review comprises four to six stages depending on the complexity and magnitude of the project. The six stages are as follows:

Stage	Project Phase	Type of Review
1	Pre-project study.	Typical hazards & environmental problems.
2	Process design.	Check design covers safety & environmental hazards.
3	Detailed engineering.	HAZOP design.
4	Construction.	Check actions from HAZOP are implemented.
5	Pre-commissioning.	Check safety standards are met.
6	Post start-up check.	Check on operation.

Stages 1 & 2 of the Safety Review for all aspects of the Feed Flexibility Project have been completed.

In addition to the above, the Refinery has almost completed a program of retrospective Hazops on all units commissioned prior to 1978. It is also further updating a detailed check on all relief valve systems throughout the Refinery to ensure that they comply with the latest developments in respect of safety standards. Both of these studies are expected to be complete by the end of 1991.

All mechanical work carried out on the Refinery is subject to a strictly enforced permit system. Prior to commencement of work a specific site or refinery permit must be obtained and verified by the Head Operator on shift to ensure that all work conditions and safety precautions are met. Similarly, after completion of the work all conditions must be satisfied before recommissioning takes place. The permit system also encompasses refinery permits to cover special work and project situations of longer duration. The permit itself specifies the safety precautions necessary to avoid hazardous situations.

The following Refinery Management Systems are developed for all aspects of refinery operations:

- manual of hazardous material data sheets,
- written operating procedures,
- routine maintenance, startup and shutdown, and emergency procedures,
- training for employees in the operation, maintenance and safety of the units,
- incident reporting/investigation systems,
- equipmenty testing/inspection schedules,
- alarm and trip testing procedures and schedules,
- periodic auditing programme.

3.6.3 Staff Safety Training.

All onsite personnel, including all contractors, are given instruction in basic firefighting and procedures to be followed in the event of an emergency. All new personnel pass through a formal orientation program which covers all aspects of the Refinery safety regulations and standing orders as well as practical instruction.

The Refinery has an Emergency Response Group whose members are required to take part in regular training sessions which are carried out by the Refinery Fire Officers. The 1990 Training Programme is shown in Table 3.2.

The Fire Officers and crew leaders have all attended external courses such as those run under the auspices of the Australian Institute of Petroleum.

TABLE 3.2 Emergency Response Group Training Modules

Module No.	Description
1.	Fire house and branches - theory/practical
2.	Fire and extinguishment - theory/practical
3.	Firemain and pumps - theory/practical
4.	Foam and equipment - theory/practical
5.	Firetender familiarisation
6.	Firefighting practical
7.	Breathing apparatus - theory/practical
8.	Rescue - theory/practical
9.	Alkylation Plant - theory/practical
10.	Slimjets and associated equipment
11.	Firefighting practical
12.	Command structure
13.	Breathing apparatus - use in smoke
14.	Fire protection equipment
15.	Chemical hazards/gas tight suits
16.	Firefighting practical
17.	Grassfires - theory and equipment
18.	Oil pollution - theory/practical
19.	Jetty fire protection system
20.	Firefighting practical

3.6.4 Medical Facilities.

The Refinery has a fully equipped medical centre capable of handling day to day medical problems as well as initial response to a full scale emergency. The centre is presided over by a qualified nursing sister during normal working hours, but can be used by all specialist first-aiders on the Refinery. These personnel are qualified to Senior First Aid level by the St. John Ambulance and number more than 30 with six rostered per shift. In addition there is also a fully operational ambulance based onsite and a Doctor on call at all times. Recently, an Industrial Hygienist has been employed as a permanent staff member at the Refinery in order to overview the implementation of new legislation and recommend necessary changes as benefiting the welfare of all refinery personnel.

3.6.5 Emergency Response.

Kwinana Refinery has an Emergency Response Plan which gives a continuous twenty-four hour response to any emergency incident on the Refinery, be it a major fire, gas leak, rescue, oil or chemical spill or a medical emergency.

Onsite facilities include two fully equipped fire tenders, an emergency rescue vehicle and a fully equipped ambulance. There is also a system in place whereby back up vehicles, equipment and personnel are available from surrounding industries and the WA Fire Brigade if required.

3.6.6 Fire Fighting.

Kwinana Refinery has its own fire fighting crew for control of any emergency incident onsite. Back up is available from the WA Fire Brigade and from other industries' units if required.

There are a minimum of thirty five trained fire fighters rostered on each shift. Control of the fire fighting operations is by one of three full time Fire & Safety Officers who are required to live within a sixteen kilometre radius of the Refinery and are available on an on-call roster outside of normal working hours.

All major emergency decisions, including overall coordination and combat, are made by the on-call Fire Officer.

3.6.7 KIEMS.

The Kwinana Integrated Emergency Management System (KIEMS) evolved as a project, coordinated by the State Emergency Service, because of concern by the Environmental Protection Authority about the lack of a co-ordinated regional response to large incidents which had the potential to have an effect offsite, and which would be beyond the capacity of any one industry to combat. As one of the principal industries, BP has developed contingency plans for a major emergency (e.g. an explosion, a serious fire or a toxic gas leak) which will be incorporated into the integrated plans drawn up by the State Emergency Service, who will retain overall control. The system includes information and contingency plans for evacuation of personnel, provision of medical services, road services and other means of access.

BP is taking a leading role in this project with the Refinery's Operations Manager as chairman of the KIEMS Industry sub-committee and the Chief Fire & Safety Officer chairing the Industry Assistance Group. The latter have been responsible for review of the network of roads in the area regarding their functionality for emergency services' access and personnel escape within the industrial strip.

In addition to the combined industries aspects, Kwinana Refinery is drawing up a list of equipment and services available where the refinery can provide material assistance to the other industries in the event of an emergency. They are also arranging for a Technica Limited update of the risk analysis data for the refinery. Finally, preparations are in hand for a major review of the hazard management plans.

3.7 SITE FACILITIES AND WORKS

Temporary construction facilities would include hardstand areas for storage of construction materials, and for single-storey demountable huts for contractor use. Any temporary toilet blocks would sewer to in-ground storage tanks, which would be pumped out regularly by approved contractors. These temporary facilities would be removed at completion of the works.

As the proposed Project will not result in any increase in permanent employee numbers there will be no need to build any new amenities buildings.

No new roadworks within the Refinery are required for the proposed project. New process plant areas (Figure 3.4) would be provided with reinforced concrete paving. Road access into the Refinery for delivery of construction materials will be via the northern entrance. Contractors working onsite during the construction phase would enter the Refinery via a temporary security gate situated near the ballast tanks. Temporary car parking would be provided for contractors opposite this security gate, on the western side of Mason Road.

An underground drainage system would connect the new process areas to the Refinery's existing wastewater treatment facilities. Site drainage for storm water control would consist of pavement grades into the underground drainage system.

CHAPTER 4

LAND USE AND RELATED ISSUES

4.1 LAND USE AND PLANNING

4.1.1 Zoning

The BP Refinery Kwinana site is zoned industrial under the Metropolitan Region Scheme (State Planning Commission 1986) and is surrounded by industrial zoned land to the north, east and south (Figure 4.1). The Refinery is located within industrial zoned land under the Town of Kwinana Town Planning Scheme No.1 (1971).

4.1.2 Land Use

- Residential

  The closest urban area, Medina, is located 2.8 km to the east of the Refinery. The major residential area in the region is the Kwinana townsite centred about 4.2 km to the east of the Refinery. The residential areas around Kwinana are screened from the Kwinana Industrial Area by a well-vegetated dune ridge (Figure 4.1). To the South-west of the Refinery, 3.5 km away, is the City of Rockingham.

- Industrial

  The existing major industrial operations in the vicinity of the Refinery are as follows:

  . Kwinana Nitrogen Company Pty Ltd
  . CSBP & Farmers Ltd
  . Western Mining Corporation Ltd
  . Coogee Chemicals Pty Ltd
  . BHP Steel International Group/AIS Pty Ltd
  . Commonwealth Industrial Gases Ltd
  . Co-operative Bulk Handling Ltd
  . State Energy Commission of Western Australia
  . Alcoa of Australia Ltd
  . Nufarm Chemicals Pty Ltd
  . Cockburn Cement Ltd
  . CBI Constructors Pty Ltd
  . Wesfarmers LPG Pty Ltd
  . Electric Power Transmission Pty Ltd
  . Transfield (WA) Pty Ltd
  . Steel Mains Pty Ltd
  . ICI Australia Operations Pty Ltd
  . Tiwest Joint Venture

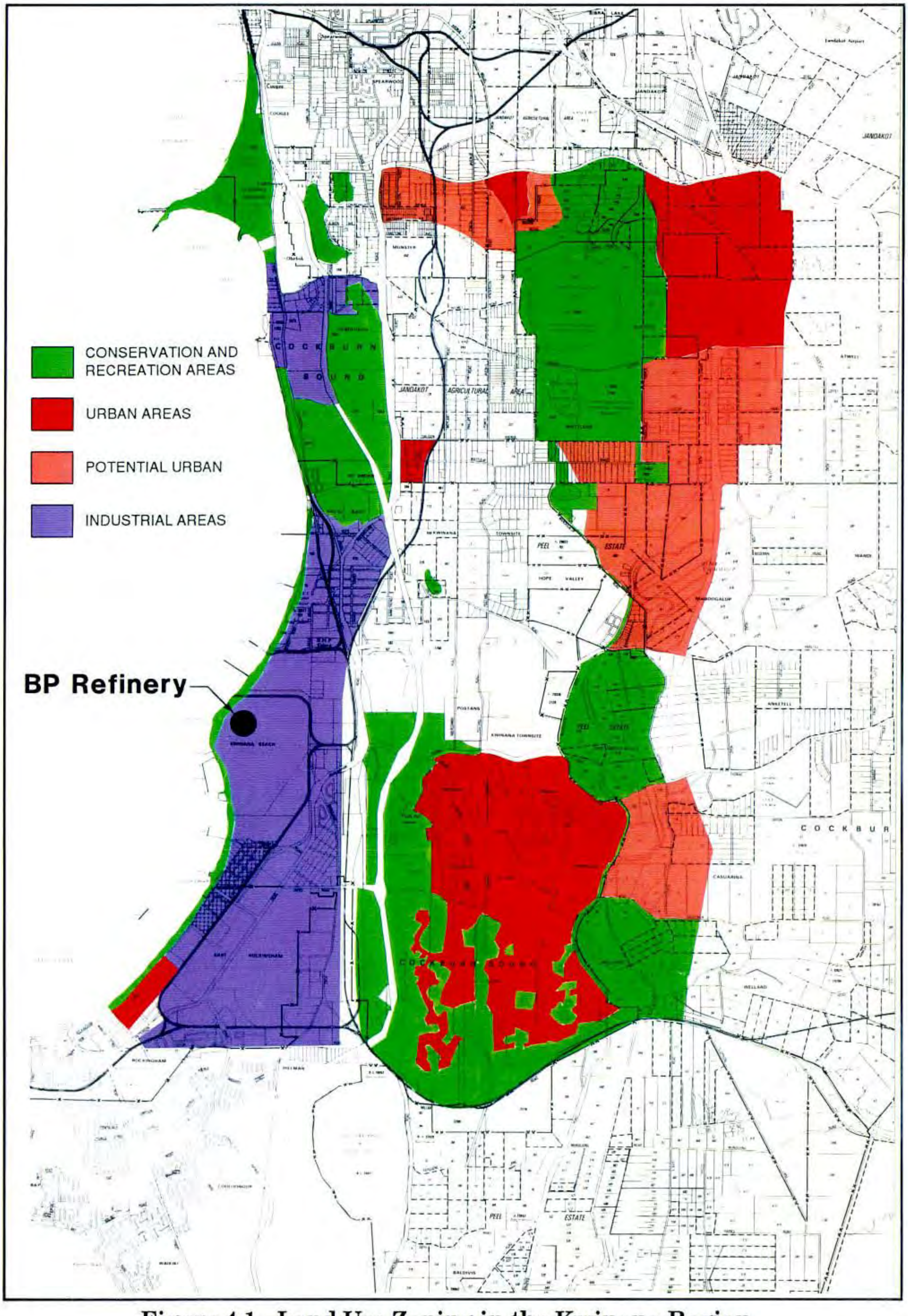


Figure 4.1 - Land Use Zoning in the Kwinana Region.

The location of the major existing industries in relation to the Refinery is shown in Figure 4.2.

- Recreation

The closest important recreational resource to the Refinery is Kwinana Beach and the adjacent Wells Park. A draft coastal management plan (Department of Conservation and Environment 1984) has been prepared for the region. The EPA has commissioned a study to determine the cumulative level of individual risk at the beach from various industries. The outcome of the study will help determine the patterns of public use of this area in the future.

4.2 VISIBILITY

The Feed Flexibility Project includes the construction of some structures; which have been described in detail in Section 3.3; some of these are large and tall most notably the Sour Water Stripper tower 30 m high, second Sulphur Recovery Unit incinerator stack 50 m high, Hydrofiner unit stacks 40 m high, Propane Production Unit No.2 tower 25 m high and the particulates separator vessel 20 m high. The other new process units and the modifications to existing plant would not result in any new structures of significant height relative to existing plant. The size and height of the new structures would be similar to equivalent existing structures within the Refinery.

Figure 3.4 shows the location of the new process units. Because of the proximity of the new structures to existing plant, and the similar physical nature of the structures, the visual impacts of the proposed project should be minimal. The visibility of the Refinery varies from different vantage points throughout the region. Near distance views of the Refinery from the east are effectively screened by a vegetative buffer which runs along Mason Road. It is planned to further reduce the visual impacts of the Refinery by extending the vegetative buffer.

Apart from the visibility of the proposed new process units, the other major visual aspect to be considered is that of air emissions. The major visible air emission from the existing Refinery is the opaque plume from the Residue Cracking Unit due to the particulates concentration. Particulate emissions from the Residue Cracking Unit will be significantly reduced when the proposed emission controls are installed and the plume should be much less conspicuous.

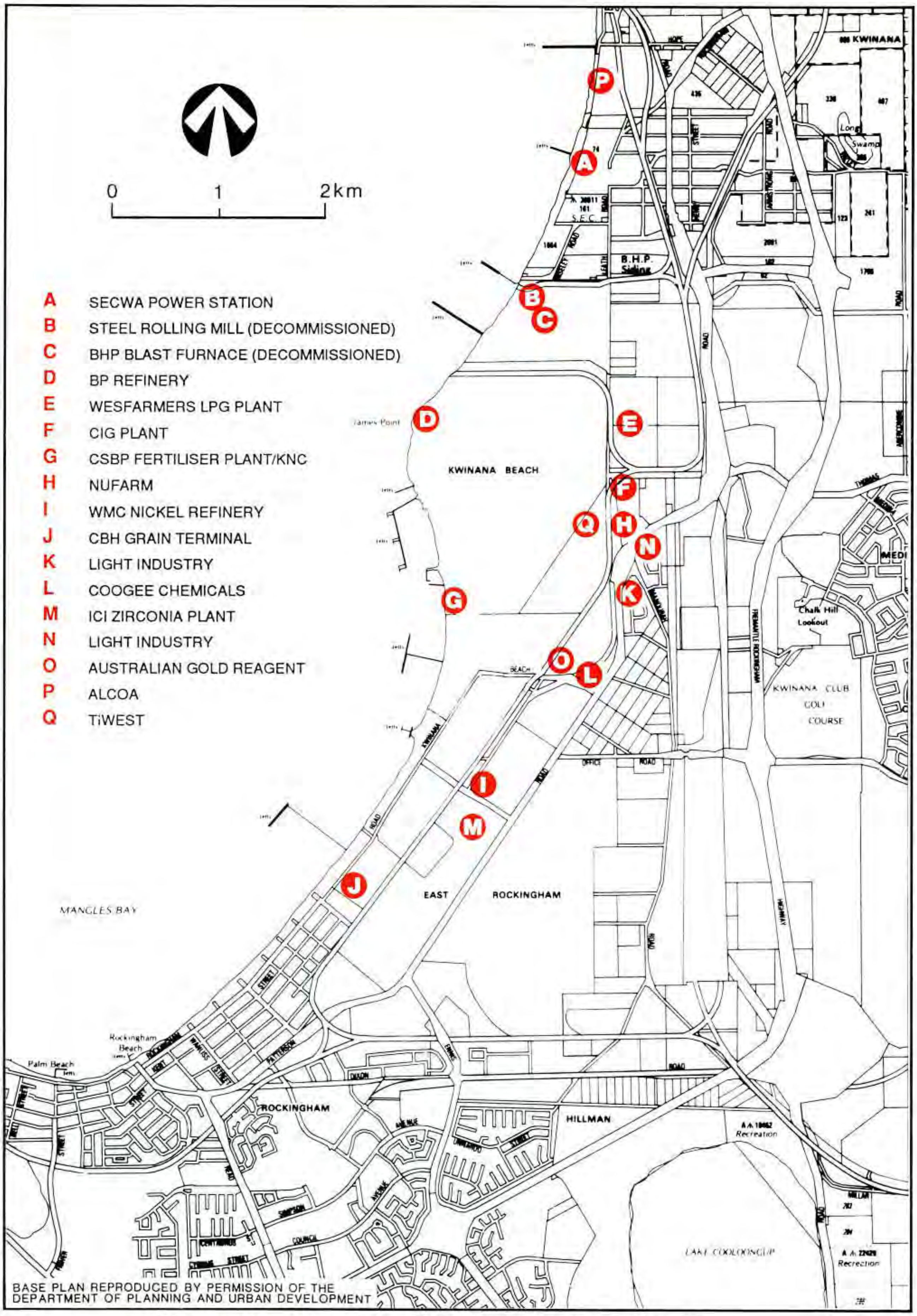


Figure 4.2 - Location of Major Industry at Kwinana.

The flare burns excess refinery fuel gas and periodic excesses of fuel gas result in flaring (large orange flame). The Gas Recovery Unit on the RCU will be modified to improve efficiency and capacity, and this will reduce the incidence of flaring.

Other than the positive effects outlined above the proposed project will have no effect on the visibility of the Refinery's air emissions.

4.3 RISKS AND HAZARDS

The (then) Department of Resources Development commissioned Technica Ltd to carry out a cumulative risk study of the Kwinana Industrial Area in 1986. The study, which was published in 1987, quantified the risk posed by hazardous industries to the surrounding local population. The accident cases that were modelled did not include those incidents which could be hazardous to people within site boundaries, as these incidents would not affect the surrounding local population. The original study covered fourteen major industries in the Kwinana Industrial Area; including the Refinery. The study has been updated for every new proposed industry in the area. The study is currently being updated to take account of proposed plants that have not been built, and for those proposed plants that have been built, of their "as built" status.

The studies showed that, following the previous relocation of residents from Kwinana Beach, the individual risk levels (for residential areas) associated with the industries in the Kwinana Industrial Area were within levels considered acceptable by the EPA. It is intended that the cumulative risk assessment be updated periodically to give an overview of the level of risk to the local population generated by processing and storage of hazardous materials.

BP Refinery Kwinana proposes to update the Refinery database and analysis for the Kwinana Cumulative Risk Analysis within 12 months of approval for this Project. The impacts of the proposed Feed Flexibility Project would be included and assessed. The proposed modifications will not introduce any type of risk or hazard not already present in the Refinery. With the exception of the Sulphur Recovery Unit, the equipment proposed is fundamentally the same as units which have been operated and maintained safely in the Refinery for decades. The existing Sulphur Recovery Unit is relatively new at Kwinana Refinery, but its performance in terms of safety and reliability is achieving the same high standards established elsewhere in the Refinery. Sulphur Recovery Units have a long history worldwide of safe and reliable operation. All of the proposed modifications will be subject to a six stage safety review, including the Hazop as Stage 3.

The process unit on the site that generates most risk is the Hydrogen Fluoride Alkylation Unit. Technica Ltd has carried out a number of risk analyses of HF Alkylation Units in various worldwide locations since the publication of the original cumulative risk study, and has also carried out reviews of the process and toxicological data available. As a result of these reviews Technica has advised that the original assessment of the HF Alkylation Unit overestimated the risk.

4.4 OCCUPATIONAL HEALTH & SAFETY ISSUES

4.4.1 Process and Product Hazards

The Refinery is a complex and efficient interaction of many separate process units and operations yielding a multitude of end products. Technological advancement has enabled the utilisation of almost every fraction of the crude oil, resulting in very little by-product waste.

Major refinery processes include:

- atmospheric and vacuum distillation
- catalytic cracking
- alkylation
- polymerisation
- desulphurisation
- catalytic reforming
- solvent extraction

Products include:

- gasoline (various grades)
- liquefied petroleum gas (butane, propane)
- fuel oil
- diesel
- kerosene and jet fuel
- lube base stocks
- bitumen (various grades)

In addition there are numerous chemical additives and intermediate products associated with Refinery operations.

A wide range of potential occupational health hazards are present in petroleum refineries. Exposures result from skin contact and the inhalation of gases and vapours, mainly hydrocarbons either naturally present in crude oil and fugitively emitted during its refining, or formed and emitted during one of the many transformations in the various process streams.

Due to the intrinsic risks of fire and explosion from many Refinery processes, operations take place in closed systems. Ubiquitous exposure exists mainly to hydrocarbon gases and vapours at usually very low levels, resulting from fugitive emissions from seals and valves. Exposure to dusts and fumes results mostly from maintenance operations.

Administrative and engineering controls, supplemented by atmospheric monitoring, ensure that exposure to airborne contaminants is kept within occupational exposure limits.

4.4.2 Refinery Safety Performance

Since 1988 BP Refinery Kwinana has taken part in the International Safety Rating System (ISRS) which, as the name implies, is a system whereby safety performance is judged against international standards across all aspects of safety and loss control. The system comprises 20 individual elements from leadership and administration to off-the-job safety. To achieve the various rating categories (1 to 5 stars) participants must not only achieve the necessary overall aggregate, but also attain minimum scores on each of the key elements. Monitoring takes place on a quarterly basis with a formal annual audit, by accredited International Safety Rating System representatives, determining the final rating.

A summary of the International Safety Rating System elements is shown in Table 4.1.

In the first year Kwinana Refinery achieved a 3-star rating, placing the Refinery among the best in the BP group. In 1989, this rating had been increased to a 4-star rating, which put Kwinana significantly ahead of other BP refineries in the world and on a par with the best oil and petrochemical plants in the world. The recent audit carried out in November 1990 resulted in 4-star rating for the Refinery.

The Refinery's good safety performance has also been mirrored by a significant reduction in lost time injury and all injury frequencies over the past four years. Although these data are considered to be a less indicative measure of underlying safety and loss control performance than the International Safety Rating System; nevertheless the improvements have been substantial and sustained, and Kwinana is considered to be among the best of the Australian refineries.

The International Safety Rating System philosophy is a cornerstone of Kwinana's safety and loss control policy and features predominantly in all aspects of the Refinery's business.

TABLE 4.1 International Safety Rating System (ISRS) Elements

Elements
1 Leadership & Administration
2 Management Training
3 Planned Inspections
4 Job Analysis and Procedure
5 Accident Investigation
6 Planned job observations
7 Emergency Preparedness
8 Rules & Regulations
9 Accident Analysis
10 Employee Training
11 Personal Protective Equipment
12 Health Control & Services
13 Programme Evaluation system
14 Purchasing & Engineering Controls
15 Personal Communications
16 Group Meetings
17 General Safety Promotion
18 Hiring & Placement
19 Records & Reports
20 Off-The-Job Safety

4.5 EXISTING ENVIRONMENT

The existing environment of the Kwinana Industrial Area is briefly described below. The KIA is the most important industrial area in WA, providing jobs, export income and important domestic production. The area was established in the early 1950's following the Stephenson/Hepburn study which recommended that the Kwinana district be developed as a major industrial centre.

4.5.1 Climate

Kwinana has a Mediterranean climate, that is, mild, wet winters and hot, dry summers. The mean monthly maximum temperature during summer is about 27°C, while the mean winter minimum is about 10°C. Humidity varies from an average of about 60% in summer to 75% in winter. Average rainfall for the area is 790 mm/annum, approximately 70% of which falls between May and August.

Sea/land breezes predominate in the coastal region around Kwinana. Fresh to strong morning easterlies and afternoon south-westerlies are characteristic during summer. The winds are more variable during winter, and the passage of cold fronts across the coast result in north-westerly/south-westerly storms of 1 - 3 days duration.

A more detailed description of the atmospheric and meteorological conditions in the Kwinana region is contained in the Kwinana Air Modelling Study Report (Department of Conservation and Environment 1982).

4.5.2 Landform and Soils

The Refinery is located over the Becher - Rockingham beach ridge plain, which comprises a section of the Quindalup Dune System. This coastal dune formation of unconsolidated aerolian deposits has a low undulating relic foredune topography that slopes towards the north-west.

The Safety Bay sand found in the area is characterised by white, medium-grained calcareous sand which overlies limestone at relatively shallow depth.

4.5.3 Hydrology

The porous nature of the sandy soils and underlying calcareous material allows rapid infiltration of rainwater to the underlying shallow unconfined aquifer, hence surface water runoff is minimal.

The depth to groundwater in the area is approximately 3 - 5 m; the direction of groundwater flow is towards the northwest. The groundwater in the unconfined aquifer is brackish. There are four aquifers in the region, the Safety Bay Sands, Tamala Limestone, Leederville Formation and Yarragadee Formations.

4.5.4 Air Quality

Several industries, including BP Refinery Kwinana, discharge air pollutants, including sulphur dioxide and nitrogen oxides.

Sulphur dioxide is a colorless, pungent gas; its odour has been responsible for numerous complaints by residents in surrounding areas. Sulphur dioxide emissions have decreased significantly during the past five years, predominantly due to several industries converting from fuel oil to natural gas as a fuel source. The commissioning of the SRU at BP Refinery Kwinana in 1989 further reduced sulphur dioxide emissions. A draft Environmental Protection Policy for Sulphur Dioxide and Dust in the Kwinana region was released by the EPA in December 1989.

Nitrogen oxides are formed and released in all common types of combustion and are introduced into the atmosphere from furnace stacks and similar sources. The most common nitrogen oxides are nitric oxide (a colourless, odourless gas) and nitrogen dioxide (an orange-brown gas with a pungent odour). Most industries in the Kwinana Industrial Area discharge nitrogen oxides. The EPA has monitored nitrogen dioxide ground level concentrations in surrounding residential areas and the results show that levels are within accepted standards.

4.5.5 Noise

The Kwinana Industrial Area has a continuous industrial background noise level, due to the operation of heavy industry, most of which operates 24 hours per day, seven days a week. Background noise levels at Hope Valley were monitored by the EPA in 1988. Hope Valley was determined as the most critical area for receival of plant noise from studies of ground topography and prevailing atmospheric conditions.

An arithmetic average of the L90 percentile levels (ie. noise levels were below these for 90% of the time) was taken over the daytime period 0700 to 2200 hours and night-time period 2200 to 0700 hours. The daytime levels were 41 dB(A), while night-time levels were 34 dB(A).

CHAPTER 5

ENVIRONMENTAL IMPACTS

5.1 INTRODUCTION

In earlier chapters of the PER, the background to the proposed Feed Flexibility Project has been described, the proposed modifications have been detailed and existing Refinery operations, within which the proposed modifications will be incorporated, have been described. This chapter examines the potential environmental impacts of the proposal. Examination of both construction and operational phases are carried out and conclusions to principal environmental impacts are drawn.

5.2 CONSTRUCTION PHASE

The principal impacts on the human environment during the construction phase of industrial projects are generally associated with the generation of dust and noise. Due to the distance from the Refinery to the nearest urban areas (Section 4.1.2) these impacts should be minimal. The risk of dust generation during the construction phase of most projects is greatest during activities associated with site preparation earthworks when heavy machinery is used. The sites of the new process units have previously been cleared and levelled, and only minor earthworks will be required prior to construction. Dust generation would be minimised through the implementation of dust management practices, including the application of water from sprinklers or water tankers. These management practices would ensure that dust does not cause a nuisance to surrounding areas and the local community. Dust levels will comply with the requirements of the Department of Occupational Health, Safety and Welfare and the Environmental Protection Authority.

It is considered that the noise levels generated during the construction phase, while difficult to accurately assess, would be within acceptable limits. The Noise Abatement (Neighbourhood Annoyance) Regulations 1982, as amended by the Environmental Protection Act 1986, state the assigned outdoor neighbourhood noise level for residential areas as 35 - 45 dB(A) depending on the time of day; while for industrial areas it is 65 dB(A).

Noise levels will comply with the requirements of the Department of Occupational Health, Safety and Welfare, as they relate to the construction workforce and the public, and with the requirements of the Environmental Protection Authority.

The work-force for the construction phase would mostly reside in and commute from the Perth - Fremantle and Rockingham - Kwinana areas. As a result, the construction work-force would not contribute toward any increased demand on the existing accommodation market or community infrastructure.

Increased traffic levels during the construction phase would be up to 300 vehicle movements per day. Close liaison will be maintained with local authorities to ensure that traffic impacts are minimised.

Wastes generated during the construction phase would be mostly unreactive solids, typical of wastes normally generated on building sites throughout the metropolitan area. These wastes would be disposed of in an appropriate gazetted landfill site.

Construction activities on new units would be restricted to normal construction industry working hours.

5.3 OPERATIONAL PHASE

5.3.1 Atmospheric Emissions

This section describes the air emissions associated with the existing plant, and the predicted air emissions and air quality impact of the redeveloped plant.

Background to Air Quality Assessment

The nature and quantity of the air emissions from the existing and redeveloped plants were determined in order to prepare air emissions inventories for use in an air dispersion model. The inventories list relevant information such as stack details (height), total flow rate, and individual gas emissions rates.

A dispersion model was then used to predict ground level concentrations (glcs) of air pollutants for both the existing and redeveloped plants. The ground level concentrations were compared with air quality criteria issued by National Health and Medical Research Council, USEPA, Victorian EPA and World Health Organisation, and standards and limits proposed in the Draft Environmental Protection Policy (EPP) for Sulphur Dioxide and Dust in the Kwinana Region (EPA 1989).

The air quality modelling was carried out by Dames and Moore Pty Ltd. The existing emissions data for all the other Kwinana industries was provided by the EPA to Dames and Moore.

Quantification of Air Emissions

The air emissions sources from the existing and redeveloped plants are described in Section 3.5.1. The air pollutants that have been quantified at the Refinery are SO_2, NO_x and particulates. NO_x is the sum of nitric oxide (NO) and nitrogen dioxide (NO_2) expressed as NO_2. The air emission sources are shown in Figure 5.1, and emissions inventories in Tables 5.1 and 5.2 for the existing and redeveloped plant scenarios.

TABLE 5.1 Stack Details

Source	Height (m)	Density at exit temperature (kg/m^3)	Volume at exit temperature (m^3/s)
Crude Distillation Unit No.1	63.1	0.699	21.4
Crude Distillation Unit No.2	65.5	0.745	28.2
Vacuum Distillation Unit No.2	48.8	0.747	3.4
Propane Deasphalting Unit	21.3	0.497	5.4
Furfural Extraction Unit	30.3	0.577	1.1
Ferrofiner Unit	18.2	0.456	0.8
Bitumen Unit	17.2	0.399	0.6
Catalytic Reformer No.2 - 1	33.7	0.786	28.7
Catalytic Reformer No.2 - 2	33.7	0.565	4.5
Hydrofiner Unit - 1	15.2	0.619	0.6
Hydrofiner Unit - 2	22.9	0.598	1.1
Hydrofiner Unit - New	40.0	0.598	1.1
Alkylation Unit	70.5	0.745	4.9
Steam Generation Area - 1	27.6	0.795	12.5
Steam Generation Area - 2	27.6	0.795	25.1
Residue Cracking Unit	80.0	0.591	75.0
Flare	70.0	0.600	40.0
Sulphur Recovery Unit - 1	50.0	0.428	6.6
Sulphur Recovery Unit - NEW	50.0	0.428	6.6

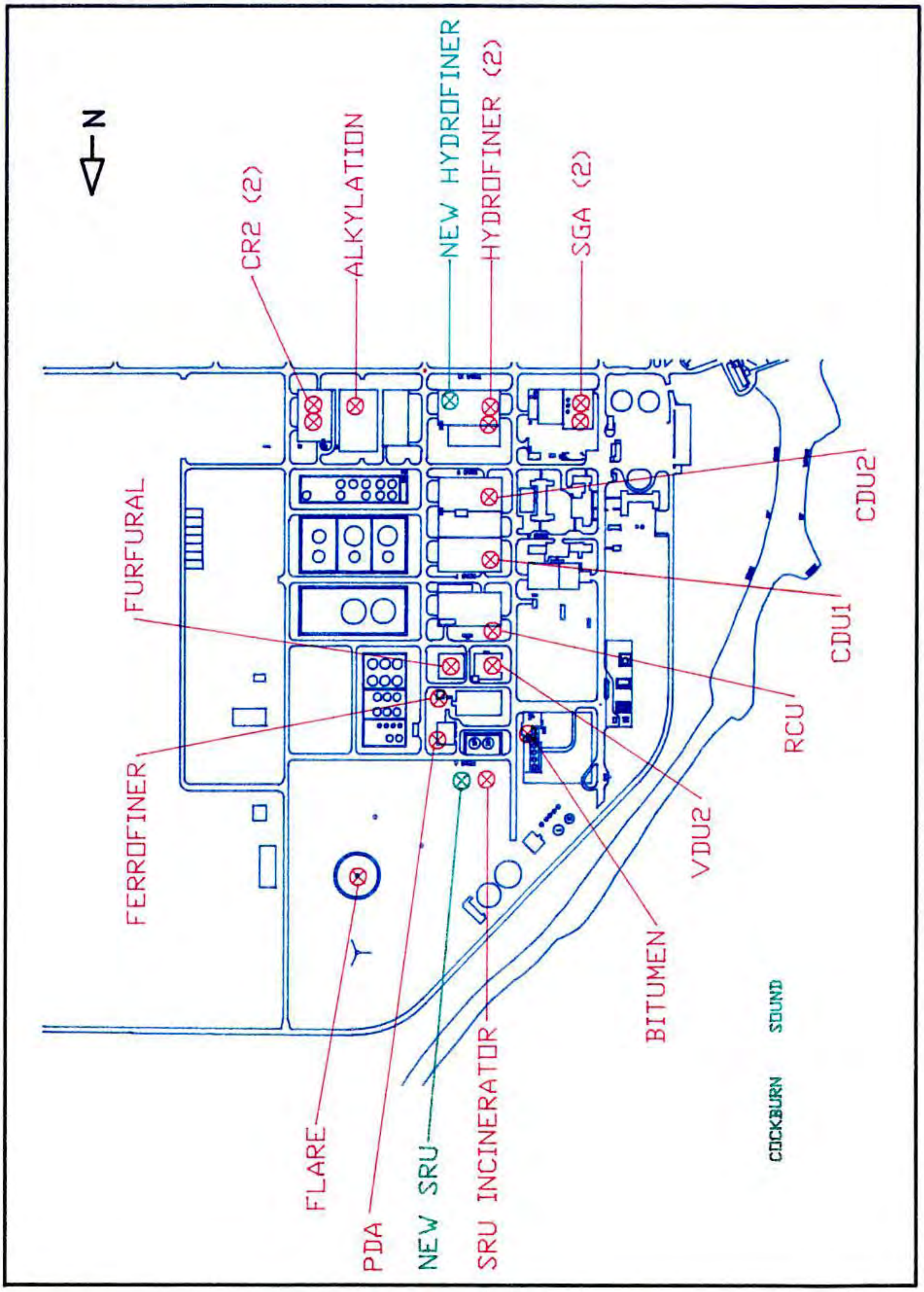


Figure 5.1 Location of Air Emission Sources

TABLE 5.2 Mass Emission Rates

Source	Sulphur Dioxide		Nitrogen Dioxide	
	Existing (g/s)	Proposed (g/s)	Existing (g/s)	Proposed (g/s)
Crude Distillation Unit No.1	0.3	0.1	2.8	2.8
Crude Distillation Unit No.2	0.5	0.3	4.0	4.0
Vacuum Distillation Unit No.2	0.1	<0.1	0.5	0.5
Propane Deasphalting Unit	<0.1	<0.1	0.1	0.1
Furfural Unit	0.1	<0.1	0.5	0.5
Ferrofiner Unit	<0.1	<0.1	0.1	0.1
Bitumen Unit	<0.1	<0.1	<0.1	<0.1
Catalytic Reformer No.2 - 1	0.4	0.2	4.2	4.2
Catalytic Reformer No.2 - 2	0.1	<0.1	0.5	0.5
Hydrofiner Unit - 1	<0.1	<0.1	0.1	0.1
Hydrofiner Unit - 2	<0.1	<0.1	0.1	0.1
Hydrofiner Unit - New	N/A[1]	<0.1	N/A	0.1
Alkylation Unit	0.1	<0.1	0.7	0.7
Steam Generation Area - 1	0.2	0.1	1.9	1.9
Steam Generation Area - 2	0.4	0.2	3.8	3.8
Residue Cracking Unit	261.6	238.0	12.7	12.7
Flare	2.3	2.3	0.2	0.2
Sulphur Recovery Unit - 1	41.7	37.0	0.2	0.2
Sulphur Recovery Unit - NEW	N/A	28.0	N/A	0.2
TOTAL	308.3	307.2	32.5	32.8

N/A[1] = Not applicable

The information presented in Table 5.2 shows that there would be a marginal decrease in the normal total emission rate of sulphur dioxide and a slight increase in the emission rate of nitrogen oxides with the proposed Feed Flexibility Project. The slight reduction in sulphur dioxide emissions is achieved in spite of an increase in sulphur throughput at the Refinery. Without the second Sulphur Recovery Unit sulphur dioxide emissions would increase by up to 70 tonnes/day.

From the brief operations history of the existing Sulphur Recovery Unit it has been estimated that total Sulphur Recovery Unit unplanned shutdowns would total 49 hours a year (or 0.56 percent of the time). Under an unplanned shutdown scenario, the sulphur dioxide that would have been removed from the gas stream by the Sulphur Recovery Unit would be diverted to the other stacks. This would result in a large increase in the total sulphur dioxide emissions as shown in Table 5.3.

TABLE 5.3: Mass Emission Rates of Sulphur Dioxide when one Sulphur Recovery Unit Fails. (Worst case scenario)

Source	Sulphur Dioxide Emission Rate (g/s)
Crude Distillation Unit No.1	81.3
Crude Distillation Unit No.2	114.7
Vacuum Distillation Unit No.2	14.4
Propane Deasphalting Unit	3.5
Furfural Unit	15.0
Ferrofiner Unit	2.3
Bitumen Unit	1.2
Catalytic Reformer No.2 - 1	123.5
Catalytic Reformer No.2 - 2	13.7
Hydrofiner Unit - 1	1.9
Hydrofiner Unit - 2	3.9
Hydrofiner Unit - New	3.9
Alkylation Unit	19.6
Steam Generation Area - 1	54.3
Steam Generation Area - 2	108.7
Residue Cracking Unit	261.6
Flare	280.1
Sulphur Recovery Unit - 1	0.0
Sulphur Recovery Unit - NEW	28.0
TOTAL	1131.6

Particulate emissions from all sources, except the Residue Cracker (RCU) are expected to remain at the present level of 2.5 mg/m^3. The particulate emissions from the Residue Cracking Unit are predicted to decrease from the current level of about 450 mg/m^3 to less than 250 mg/m^3 with the proposed modifications.

Meteorological Data

The meteorological data used for the dispersion modelling was obtained from the EPA. The data was collected at the Hope Valley monitoring station (see Figure 5.2) between 1 January and 31 December 1980. These data were further processed by the EPA to produce a file containing atmospheric stability, mixing depths, wind speed and wind direction along with other parametres.

The data collected from the Hope Valley monitoring station between 1 January and 31 December 1980 are summarised in monthly and annual wind roses in Figure 5.3. These wind roses show that winds blow from the south-west and south-south-west for over 20 percent of the time on an annual basis, and predominate in spring and summer. In general, the prevailing winds swing from the north-east sector in autumn and winter (particularly May, June and July) to the south-west sector in spring and summer (particularly November, December and January).

Within the Kwinana region, the synoptic winds are generally easterlies. Large daytime mixing depths develop over the land surface and strong convective motions develop within the mixed layer (DCE, 1982). The predominant synoptic winds have the effect of carrying most air-borne emissions offshore, thereby reducing air pollution impacts on land.

During summer, in particular, the general synoptic easterly winds are disrupted by two phenomena:

- the sea breeze; and
- the "West Coast Trough"

The sea breeze occurs when air over the land is heated more rapidly than it is over the sea and, as a result, the heated inland air rises and flows out over the sea. The loss of the inland air causes the inland air pressure to fall, resulting in a return onshore flow of cool air at the low levels. This onshore air flow is commonly referred to as a sea breeze.

The "West Coast Trough" results from summer easterlies being cooled over the ocean resulting in a pressure gradient which leads to more southerly winds.

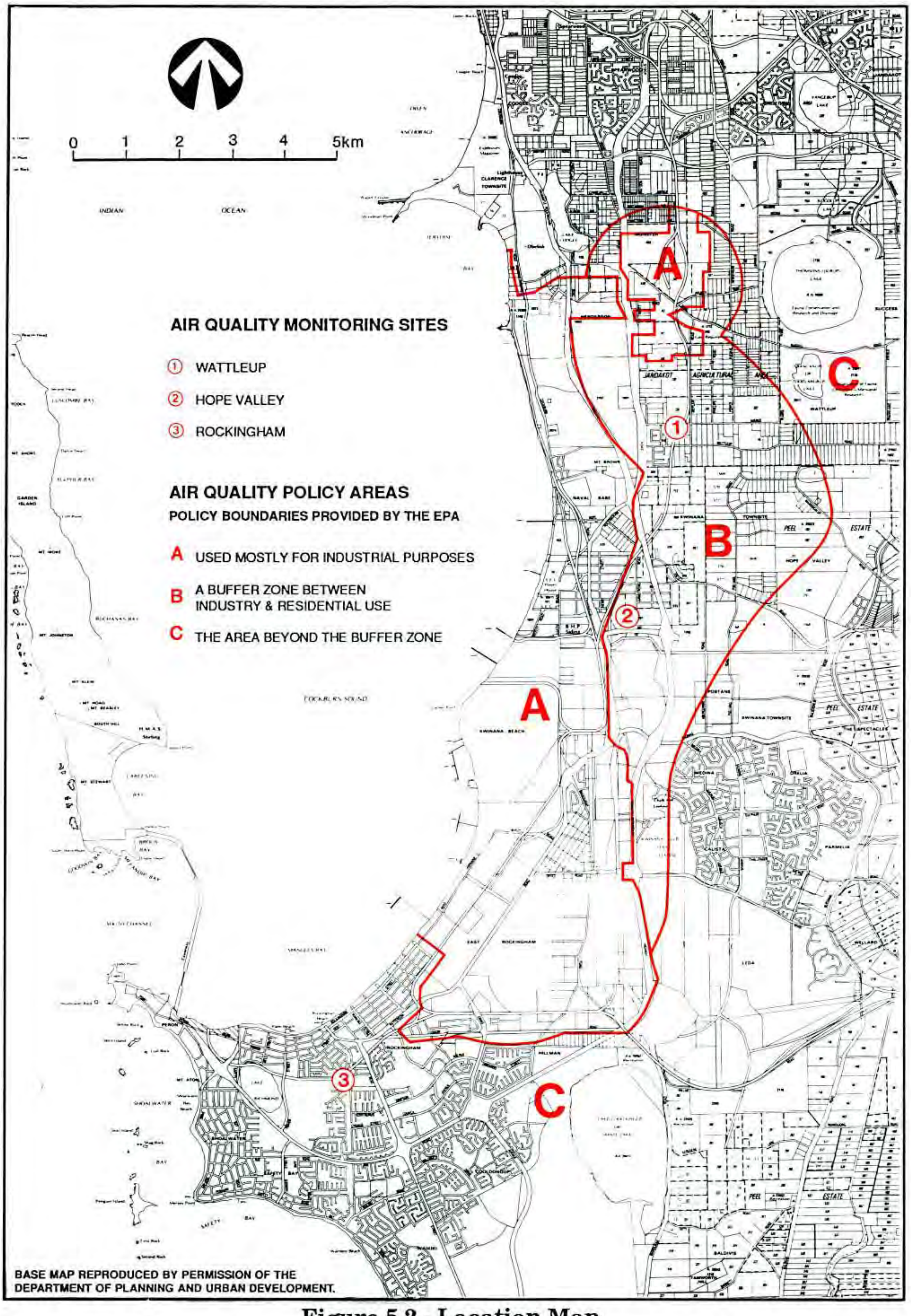


Figure 5.2 - Location Map

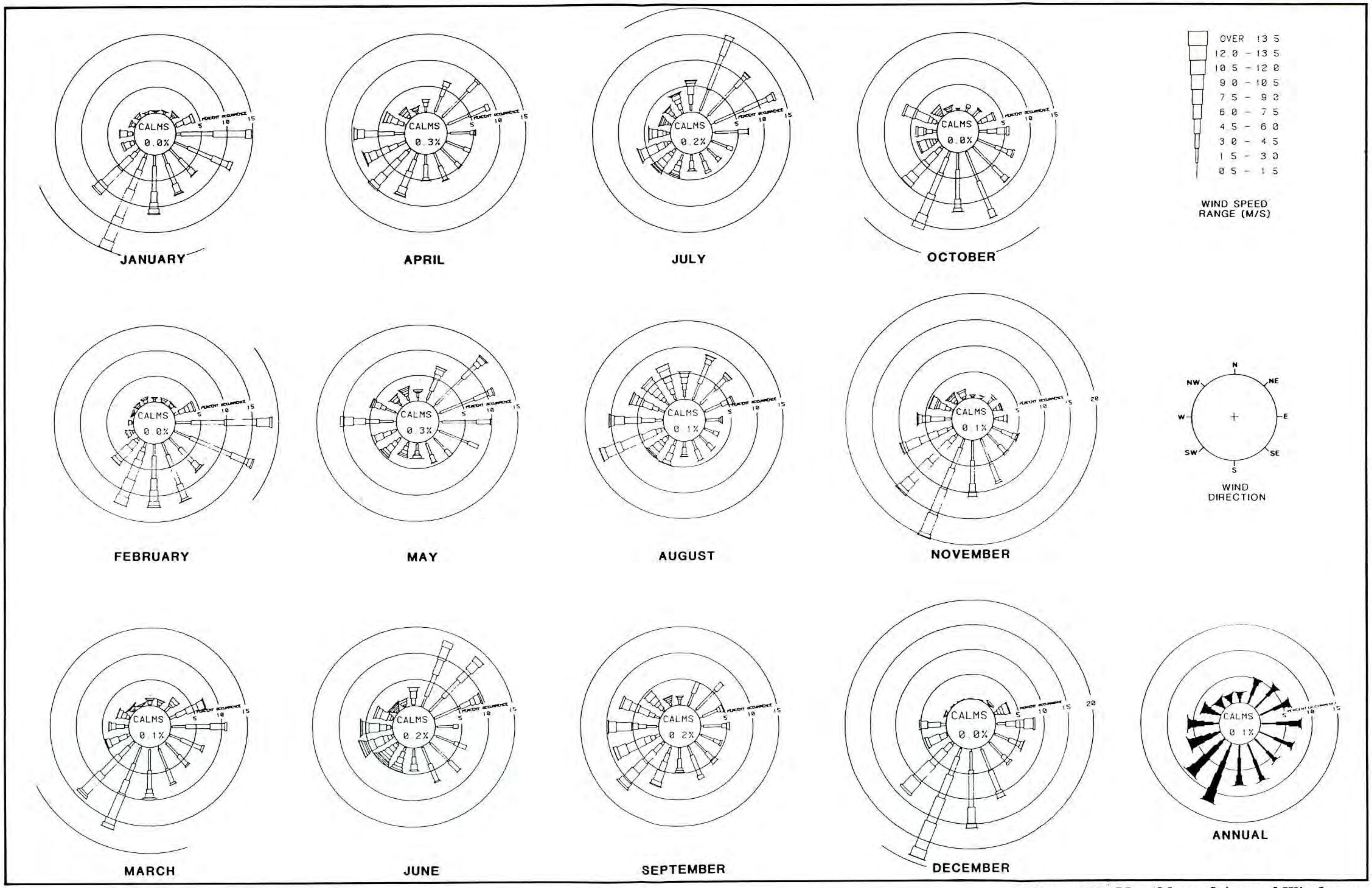


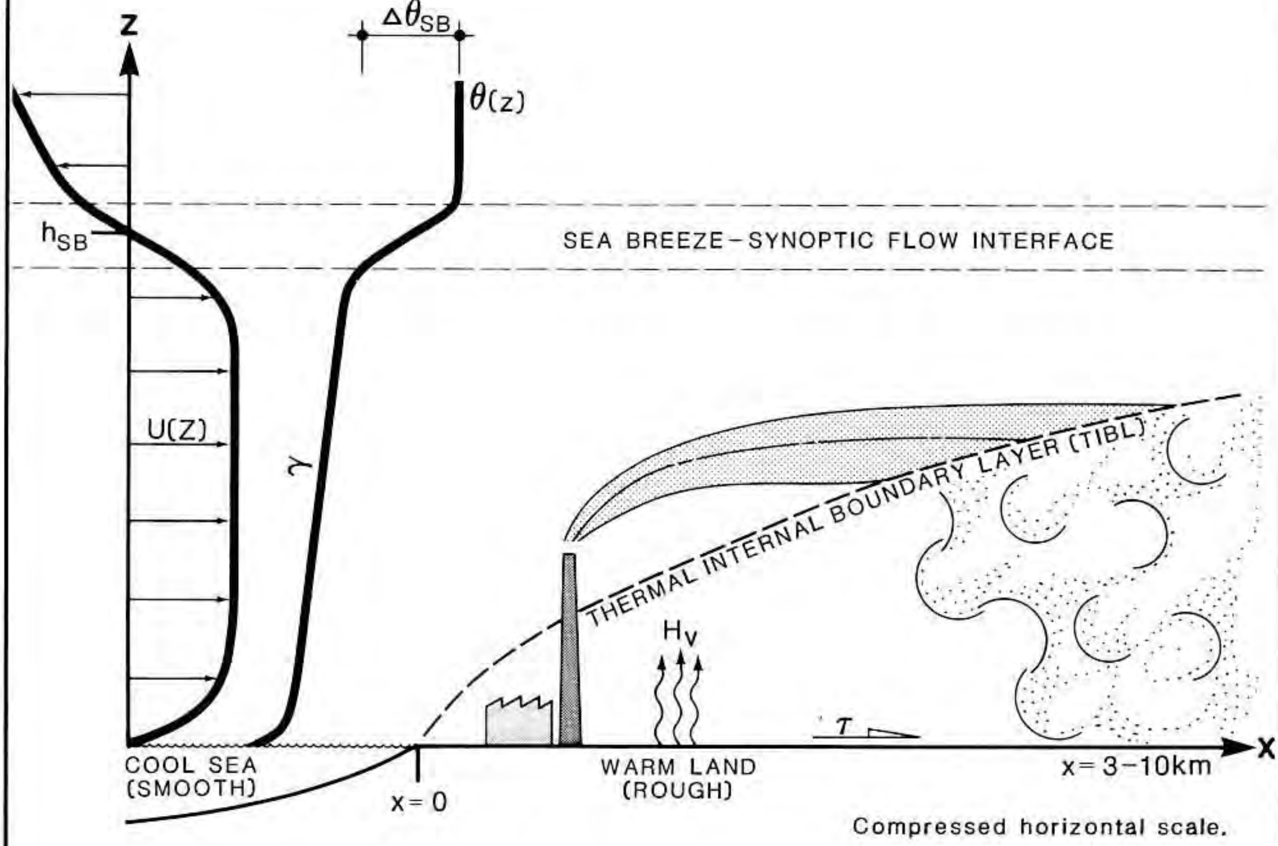
Figure 5.3 - Monthly and Annual Windroses Hope Valley Base Station (1980)

The sea breeze and the "West Coast Trough" may cause limited mixing depths. The Kwinana Air Modelling Study (KAMS) (DCE, 1982) found that the formation of a Thermal Internal Boundary Layer (TIBL) during day-time onshore flows was one of the major factors affecting groundlevel concentration levels in the Kwinana region due to a phenomenon known as shoreline fumigation. The effect of the Thermal Internal Boundary Layer is illustrated in Figure 5.4 and shows how a plume may be released into the stable marine air and then impact the Thermal Internal Boundary Layer at some distance downwind. Once the plume has impacted the Thermal Internal Boundary Layer, it is rapidly fumigated to ground, resulting in high short term groundlevel concentrations.

The representativeness of the 1980 meteorological data was assessed by comparing the annual 1980 wind rose to the average annual wind rose for the meteorological data collected by the EPA at the Hope Valley monitoring station between October 1988 and September 1990 (ie. two years of data). These two annual wind roses are presented in Figure 5.5 and show that during 1980, there were more winds originating from the arc from southerly to westerly winds than in the 1988/1990 wind rose. The 1988/1990 wind rose has more winds originating from the arc east-north-east to east-south-east than the 1980 wind rose. There is also a higher occurrence of north-north-easterly winds in 1980 than in 1988/1990. Using 1980 or 1989/1990 meteorological data would give different predictions of ground level concentrations. However, the 1980 data set will give conservative predictions of groundlevel concentrations because of the above factors.

Air Pollution Dispersion Model

The EPA has, over a number of years, allocated significant resources to investigate the behaviour of atmospheric emissions in coastal areas at Kwinana. The first major investigation was the Kwinana Air Modelling Study (DCE, 1982) which led to the development of DISPMOD, a Gaussian plume dispersion model capable of modelling shoreline fumigation events during sea breeze conditions. The model was documented during KAMS and further by Rayner (1987) and therefore is not discussed here.



Z - HEIGHT ABOVE THE GROUND

h_{SB} - DEPTH OF THE SEA BREEZE

$U(Z)$ - WIND SPEED WITH HEIGHT

$\theta(z)$ - POTENTIAL TEMPERATURE WITH HEIGHT

$\Delta\theta_{SB}$ - POTENTIAL TEMPERATURE CHANGE ACROSS THE SEA BREEZE INTERFACE

γ - POTENTIAL TEMPERATURE LAPSE RATE OF SEA BREEZE

X - DOWNWIND DISTANCE FROM COAST

H_V - VIRTUAL HEAT FLUX

τ - SURFACE SHEAR STRESS

Figure 5.4 - Mixing height/sea breeze with a TIBL
(After Rayner, 1987)

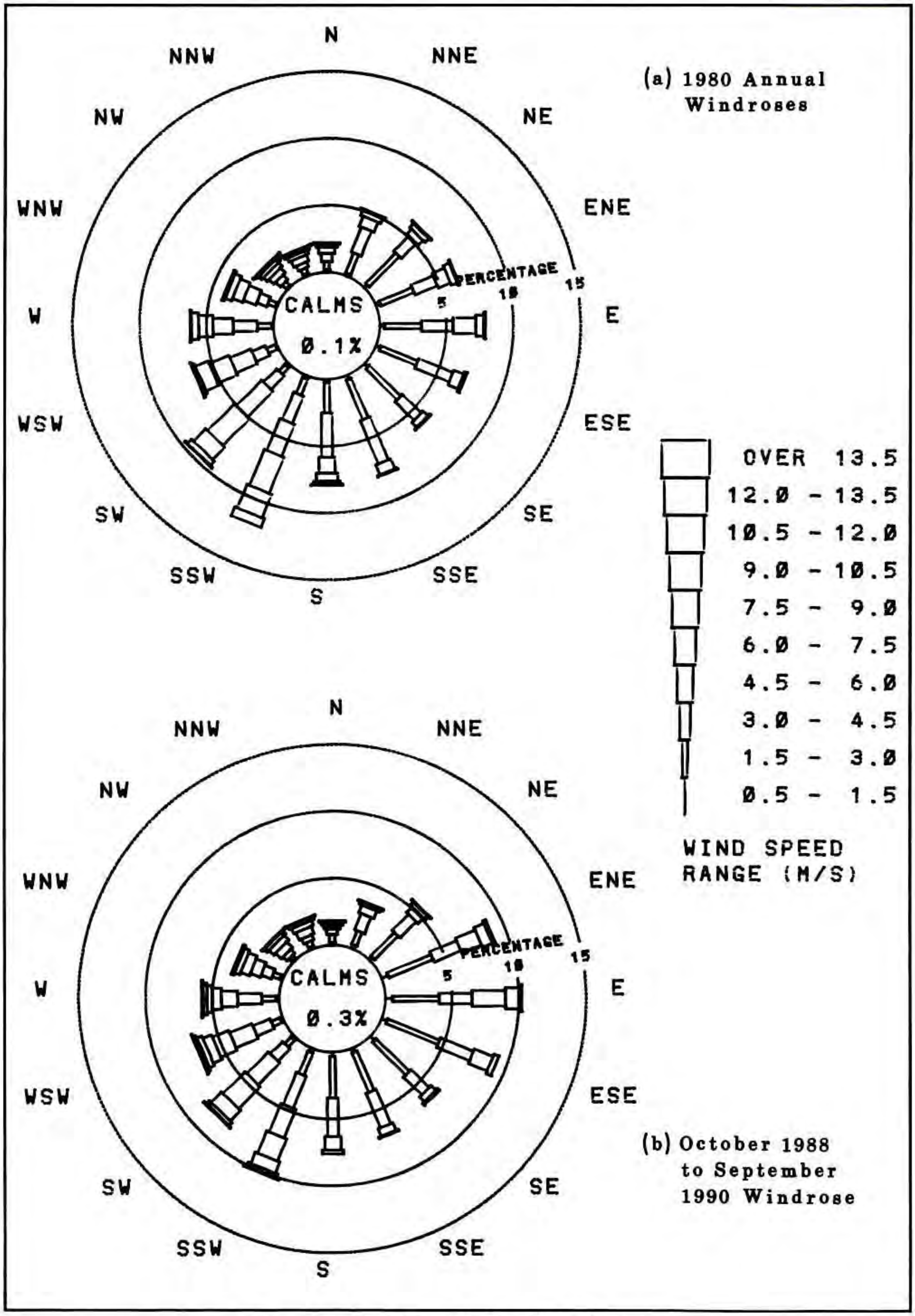


Figure 5.5 - Hope Valley Windroses

As part of the work associated with the eventual implementation of the Draft Environmental Protection Policy for Sulphur Dioxide and Dust in the Kwinana region, the Environmental Protection Authority has been reviewing DISPMOD and updating some aspects of the model. Again, data collected during the KAMS work is being used for validation purposes.

The most recent version of DISPMOD was used for this modelling study.

Air Quality Criteria

In general, the EPA has not adopted a fixed set of air quality criteria, and tends to refer to criteria established by other Australian and International bodies such as those listed in Table 5.4.

TABLE 5.4: Summary of Relevant Air Quality Criteria

Substance	Authority	Averaging Period	Groundlevel Concentration (ug/m^3)
Sulphur Dioxide	NH&MRC	Annual 1-hour 10-minute	60 700 1400
	USEPA	Annual 24-hour, primary(1) 3-hour, secondary(2)	80 365 1300
	VEPA	24-hour, acceptable(3) 1-hour, acceptable 24-hour, detrimental(4) 1-hour, detrimental	171 486 314 972
	WHO	Annual(5) 24-hour(5) 1-hour(6)	30 100 350
Particulate Matter	NH&MRC	Annual	90
	USEPA	Annual, primary 24-hour, primary	50 260
Nitrogen Dioxide	NH&MRC	1-hour	320
	USEPA	Annual	100
	VEPA	24-hour, acceptable 1-hour, acceptable 24-hour, detrimental 1-hour, detrimental Annual(5)	112 282 282 470 3
	WHO	24-hour(6) 1-hour(6)	150 400
Carbon Dioxide		No criterion set	

Note:
VEPA - Victorian Environment Protection Authority (Vic.Govt, 1981).
NH&MRC - National Health and Medical Research Council (NH&MRC, 1986).
WHO - World Health Organisation (WHO, 1987).
USEPA - United States Environmental Protection Agency (USEPA 1977).
(1) - primary - to protect public health.
(2) - secondary - to protect aesthetics, property and vegetation.
(3) - acceptable - levels should not be exceeded for more than three days per year.
(4) - detrimental - levels should never be exceeded.
(5) - protection of sensitive ecosystems.
(6) - protection of sensitive asthmatics.

In addition to these criteria, the EPA is developing a series of Environmental Protection Policies that contain various standards and limits designed to protect the beneficial use of an area. The beneficial use is defined as a use of a specified part of the environment for the overall benefit of the community (EPA, 1989). The "Draft Environmental Protection Policy for Sulphur Dioxide and Dust in the Kwinana Region" (EPA, 1989), referred to hereinafter as the Draft EPP, will lead to one such EPP.

The Draft EPP seeks to establish ambient standards and limits for three regions of impact (see Figure 5.2) as indicated in Table 5.5.

Table 5.5 Proposed Standards and Limits for Sulphur Dioxide and Total Suspended Particulates in Kwinana (EPA, 1989)

1-Hour average Sulphur Dioxide Concentrations		
	Standard (Desirable Level) (ug/m^3)	Limit (Never to be Exceeded) (ug/m^3)
Area A[1]	700	1400
Area B	500	1000
Area C	350	700

24-Hour Average Total Suspended Particulate Concentrations		
	Standard (Desirable Level) (ug/m^3)	Limit (Never to be Exceeded) (ug/m^3)
Area A[1]	150	260
Area B	90	260
Area C	90	150

1 Figure 5.2 shows the proposed zone boundaries.

The Draft EPP defines three air quality impact zones (see Figure 5.2):

- Area A - used mostly for industrial purposes;
- Area B - a buffer zone between industry and residential use;
- Area C - the area beyond the buffer zone.

At the time of this report, the EPA is still finalising the exact definition of the impact zone boundaries. As a result the boundaries presented in Figure 5.2 may be different when the final form of the EPP is released.

The EPA have equated the Draft EPP standard to the 9th highest 1-hour average concentration. The use of the 9th highest 1-hour average concentration is widely accepted as a means of eliminating extreme meteorological conditions for which model accuracy is known to be poor. The Victorian EPA (VEPA, 1985) use the 9th highest 1-hour concentration to represent a reasonable "worst case" concentration. Therefore, in terms of modelling the cumulative impact of pollutants, the 9th highest 1-hour groundlevel concentration should be assessed against the Draft EPP standard for each of the air quality zones.

Existing Air Quality

a) Ambient Monitoring Results

The EPA have been monitoring ambient levels of sulphur dioxide in the Kwinana area intermittently since 1978 at the Wattleup and Hope Valley monitoring stations (see Figure 5.2). The Rockingham monitoring station became operational in July 1988. Table 5.6 contains a summary of the number of times the 1-hour average concentration of sulphur dioxide exceeded various stated concentrations at each monitoring station. This table only provides information over the intervals where each monitoring station was in operation for one or more full years.

TABLE 5.6 Sulphur Dioxide Continuous Monitoring Statistics

(Number of Hours in Excess of Various Concentrations)

1-Hour Average Concentration (ug/m^3)	Wattleup						Hope Valley			Rockingham
	1979	1980	1986	1987	1988	1989	1987	1988	1989	1989
>100	836	862	281	125	228	224	121	235	196	63
>200	605	631	102	33	86	62	43	85	77	10
>300	451	483	38	10	34	23	20	35	29	1
>400	348	343	13	4	10	7	10	9	18	0
>500	261	250	6	2	4	3	3	5	11	0
>600	204	174	3	2	2	1	2	2	8	0
>700	143	125	1	2	1	1	2	0	5	0
>1000	50	30	0	1	0	0	1	0	1	0
>1500	8	1	0	1	0	0	0	0	0	0

One of the most significant features of this table is the dramatic improvement in the air quality that occurred at Wattleup between 1980 and 1986. Table 5.6 clearly shows a significant reduction in the number of hours where the monitored sulphur dioxide levels exceeded a specified level. For example, over 1979 and 1980, there were, on average, 849 hours a year when the ambient concentration exceeded 100 ug/m^3 at Wattleup. This dropped by almost a factor of 4 to an average of about 215 hours a year over the years 1986 through to 1989. This was largely due to Alcoa, BP Refinery and the State Energy Commission of WA (SECWA) converting to natural gas.

Since the conversion to natural gas by industry, the air quality has remained similar with the occasional high 1 -hour average concentration being recorded. Between 1986 and 1989, there were on average, about 184 hours a year when the ambient concentrations were greater than 100 ug/m^3 at Hope Valley. The one year of data from Rockingham indicates that 100 ug/m^3 has been exceeded for only 63 hours.

When Alcoa and SECWA started burning natural gas, BP Refinery Kwinana became the largest emitter of sulphur dioxide. In August 1989, the Refinery commissioned the Sulphur Recovery Unit which decreased the Refinery emissions to their current levels, and resulted in a significant reduction in the average emission rate of sulphur dioxide. Table 5.7 presents a comparison of the continuous sulphur dioxide monitoring statistics for the periods 1 January to 31 October 1989 and 1 January to 31 October 1990 for all three of the EPA monitoring stations.

TABLE 5.7 Sulphur Dioxide Continuous Monitoring Statistics
(Number of Hours in Excess of Various Concentrations in 1989 and 1990 - 1 January to 31 October)

1-Hour Average Concentration (ug/m^3)	Wattleup		Hope Valley		Rockingham	
	1989	1990	1989	1990	1989	1990
>100	183	30	162	34	63	3
>200	58	6	64	5	10	0
>300	23	1	24	1	1	0
>400	7	0	13	0	0	0
>500	3	0	10	0	0	0
>600	1	0	7	0		
>800	0	0	3	0		
>900			2	0		
>1000			1	0		
>1100			1	0		
>1200			0	0		
10-Month Average[1] (ug/m^3)	9.4	4.5	8.3	4.1	8.0	3.9

1 One hour sulphur dioxide concentration.

Table 5.7 clearly shows that there has been a significant reduction in the monitored ambient concentrations of sulphur dioxide during 1990 at all three monitoring stations. Although no information is available concerning the emissions variations of other industries during this time, it is quite likely that most of this improvement in air quality can be attributed to the Refinery reducing its sulphur dioxide output. In addition to this information, Table 5.7 shows that the 10 month average (7 296 hours) of the sulphur dioxide levels has been more than halved at each of the three monitoring stations.

b) Modelling Results

The DISPMOD plume dispersion model was used to predict the existing sulphur dioxide groundlevel concentrations, using the emissions data for existing Kwinana industry as supplied by the EPA and using meteorological data collected from the Hope Valley monitoring station between 1 January and 31 December 1980. The results are presented in Figure 5.6; and show the 9th highest 1-hour average groundlevel concentrations predicted over the Kwinana region, using a 1km grid spacing. The predicted contours on Figure 5.6 indicate that existing groundlevel concentrations of sulphur dioxide in Area C are well below the Draft EPP 1-hour standard of 350 ug/m^3. In fact, the predicted groundlevel concentrations in Area C are below 300 ug/m^3 everywhere except for a small non-residential area directly east of the Refinery.

The selection of the grid spacing used within a modelling study can significantly affect the predicted groundlevel concentrations due to the distance between calculation points. As the grid spacing becomes smaller, the resolution of the predicted contours becomes greater. The grid spacing should be selected to account for:

- the size of the area being investigated;
- the level of model resolution required;
- the time taken to run the model; and
- computer and program restrictions in the determination of the overall modelled area.

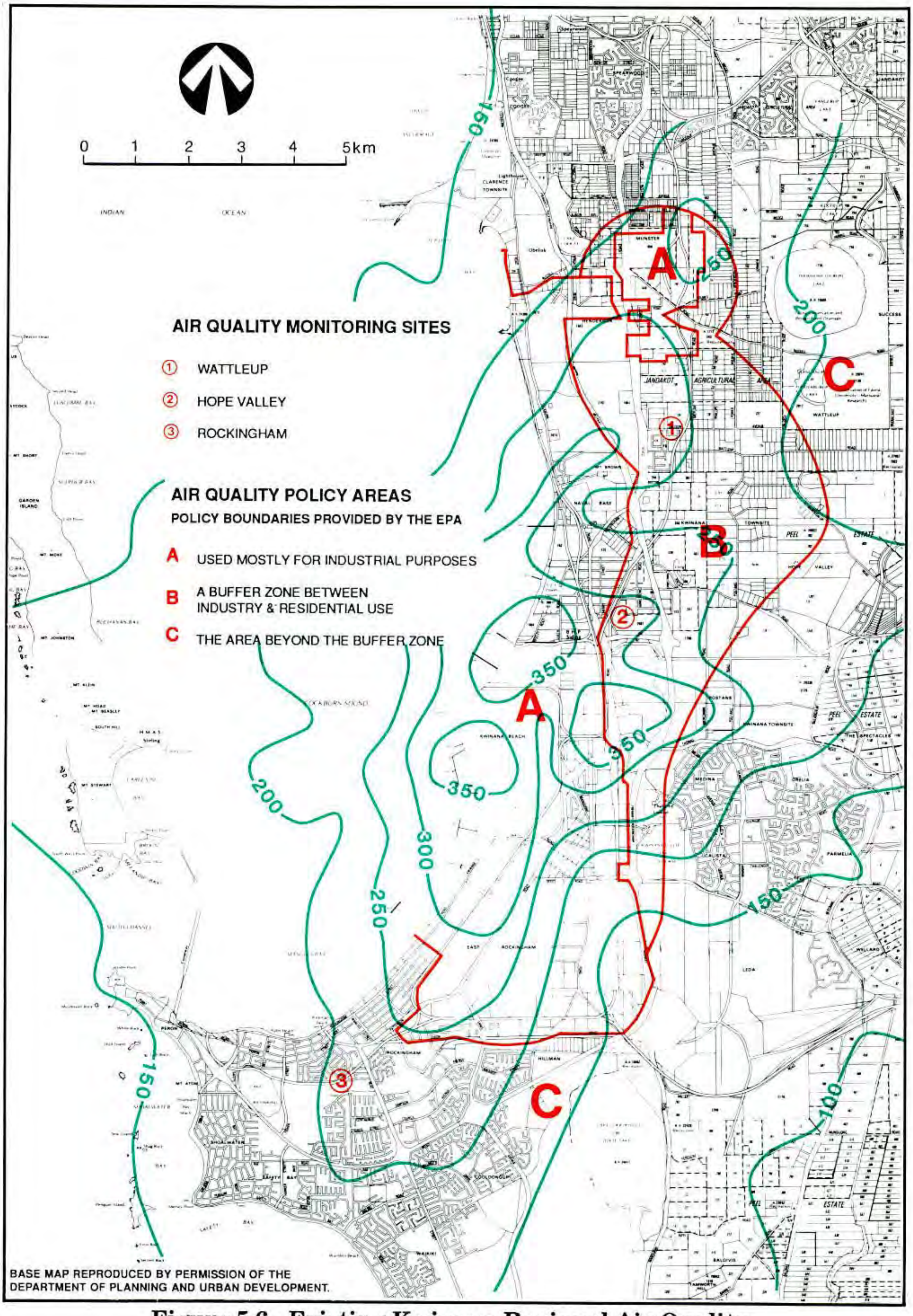


Figure 5.6 - Existing Kwinana Regional Air Quality. Predicted 9th highest 1-hour average Groundlevel Concentrations of Sulphur Dioxide. (1km grid)

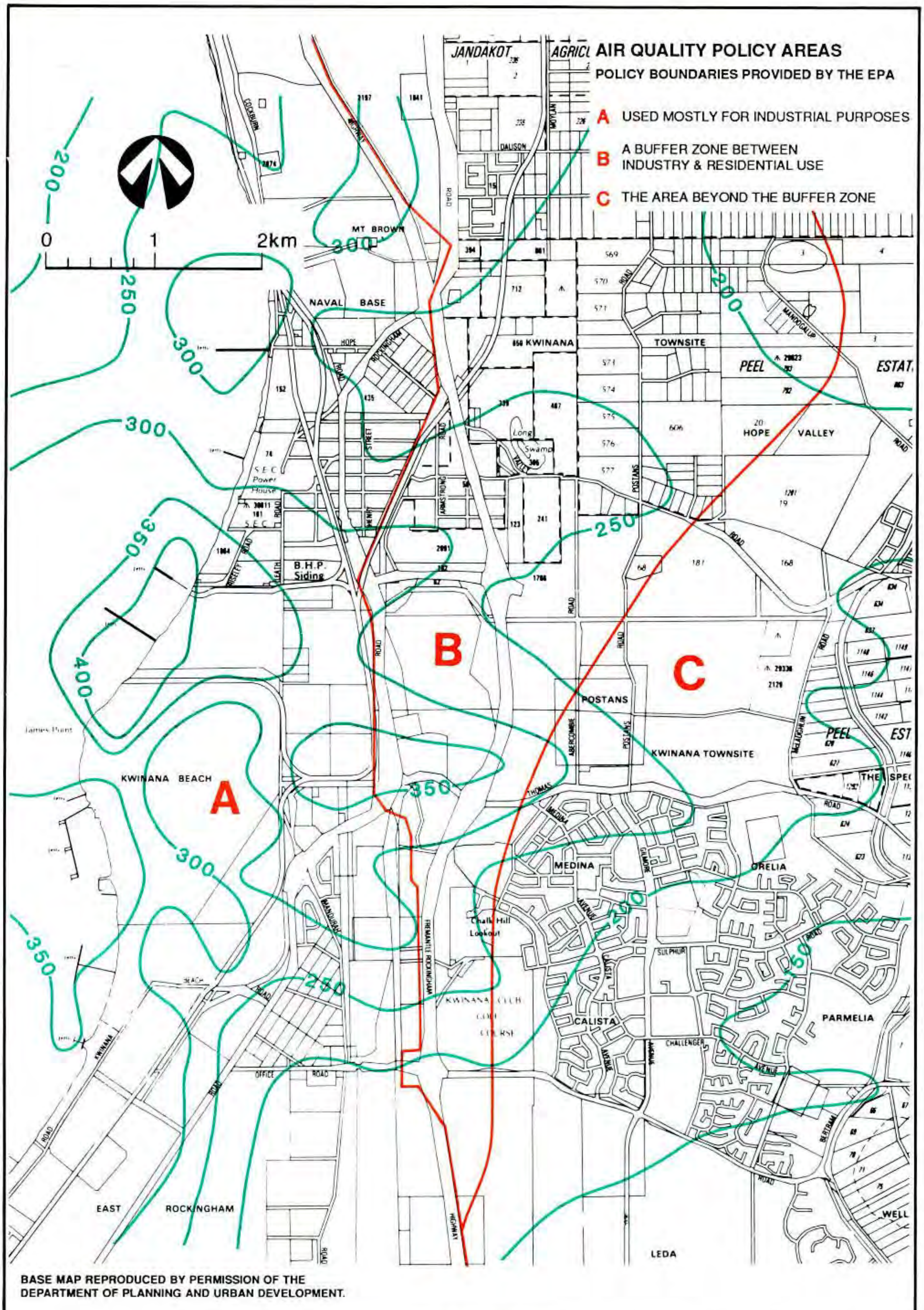


Figure 5.7 - Existing Air Quality near BP Refinery. Predicted 9th highest 1-hour average Groundlevel Concentrations of Sulphur Dioxide (500m grid)

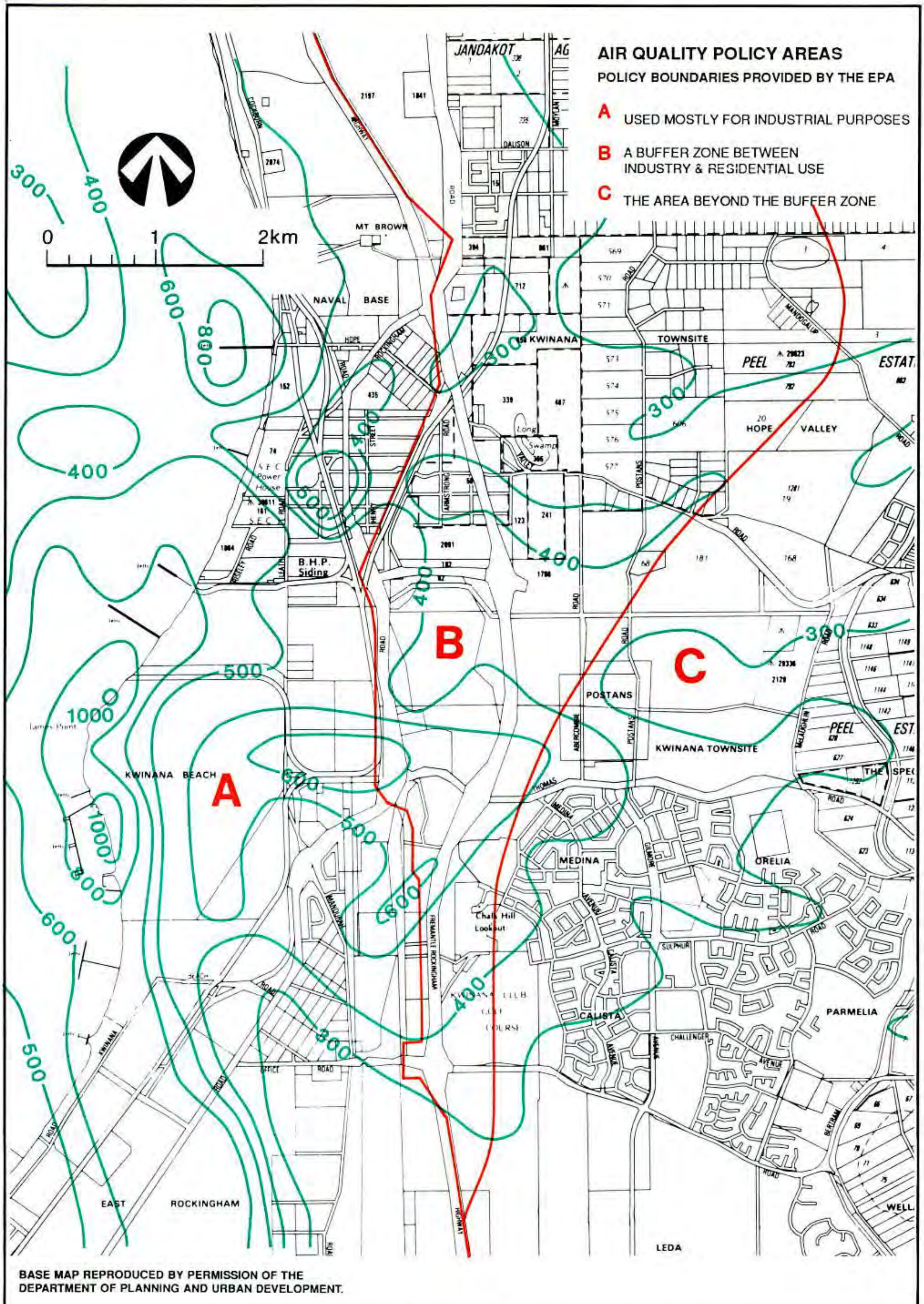


Figure 5.8 - Existing Air Quality near BP Refinery. Predicted maximum 1-hour average Groundlevel Concentrations of Sulphur Dioxide

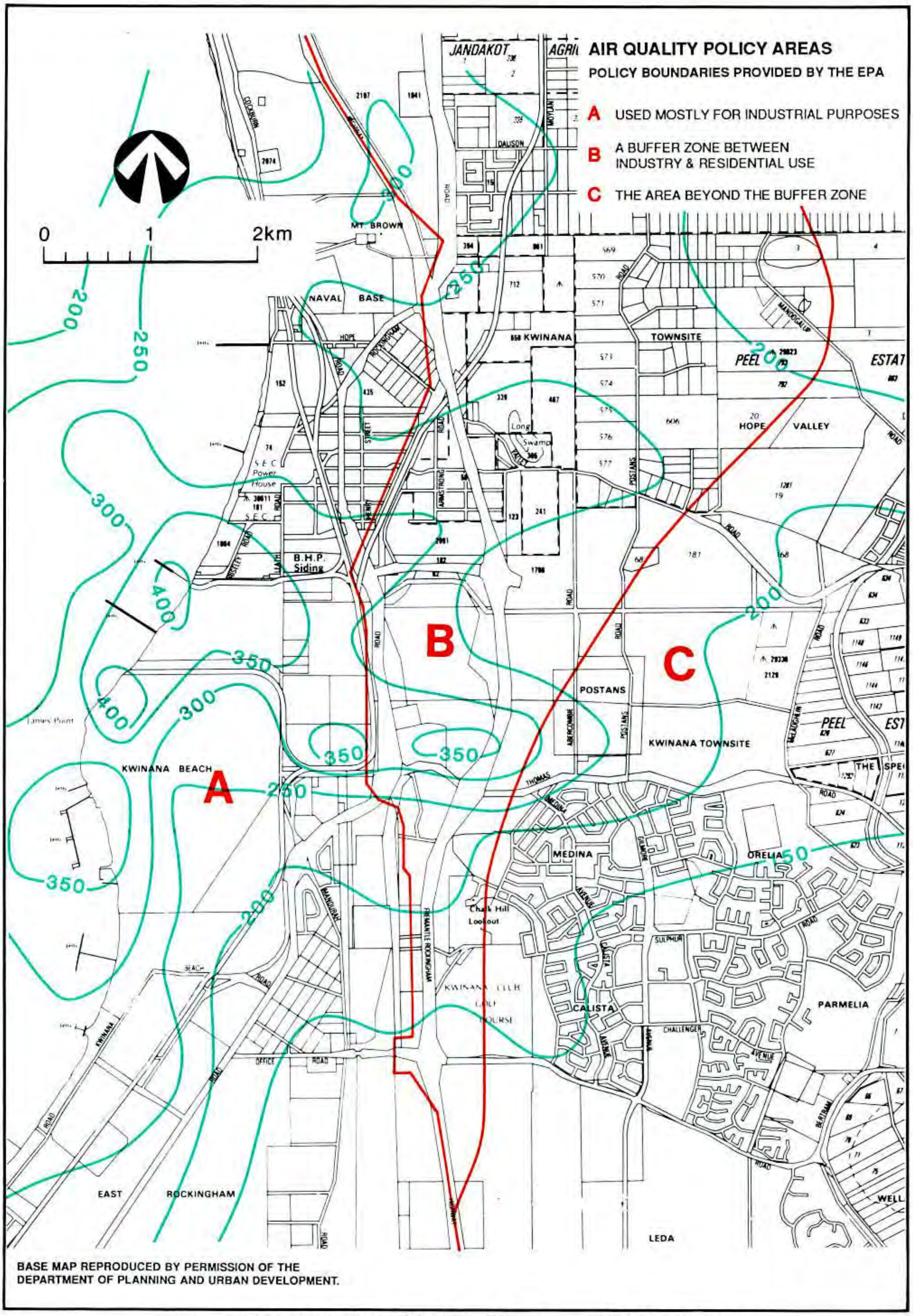


Figure 5.9 - Existing Air Quality near BP Refinery.
No TiWEST and reduced CSBP emissions.
Predicted 9th highest 1-hour average
Groundlevel Concentrations of Sulphur Dioxide.

Future Air Quality

a) Sulphur Dioxide

With the proposed Feed Flexibility Project the total emissions of sulphur dioxide from the Refinery would be marginally lower than the existing level (Table 5.2). As such, under normal operating conditions, it is expected that the groundlevel concentrations of sulphur dioxide would also be marginally lower than they are at the present time in Area C.

DISPMOD has been used to predict the groundlevel concentrations of sulphur dioxide using the predicted Refinery emissions (Table 5.2) and the existing emissions scenario for the other industries as supplied by the EPA. The predicted 9th highest 1-hour average groundlevel concentrations of sulphur dioxide are presented in Figure 5.10. When compared to Figure 5.7, which shows the results for a conservative emissions scenario, it can be seen that the predicted groundlevel concentrations to the east of the Refinery have been reduced, albeit insignificantly. Conversely the predicted 1-hour average groundlevel concentrations in the near vicinity of the Refinery have increased. Concentrations near the north end of the Refinery (near the new Sulphur Recovery Unit) would exceed 500 ug/m^3, while the area within the 400 ug/m^3 contour would increase to include the Refinery jetties. These trends have resulted from a general reduction in the sulphur dioxide emissions from most of the Refinery stacks and the addition of the second Sulphur Recovery Unit to the north end of the Refinery.

Although not presented, the predicted maximum 1-hour average groundlevel concentrations show a similar trend, with an overall slight reduction in the maximum values.

An additional DISPMOD run was carried out to show the emissions scenario that is more representative of the existing situation in combination with the proposed Refinery emissions (ie. no Tiwest and reduced CSBP sulphur dioxide emissions). The predicted 9th highest 1-hour average groundlevel concentrations of sulphur dioxide for the more representative emissions scenario are shown in Figure 5.11. As would be expected, the predicted groundlevel concentrations are lower than those presented in Figure 5.10 and show the 300 ug/m^3 contour pulling away from north Medina.

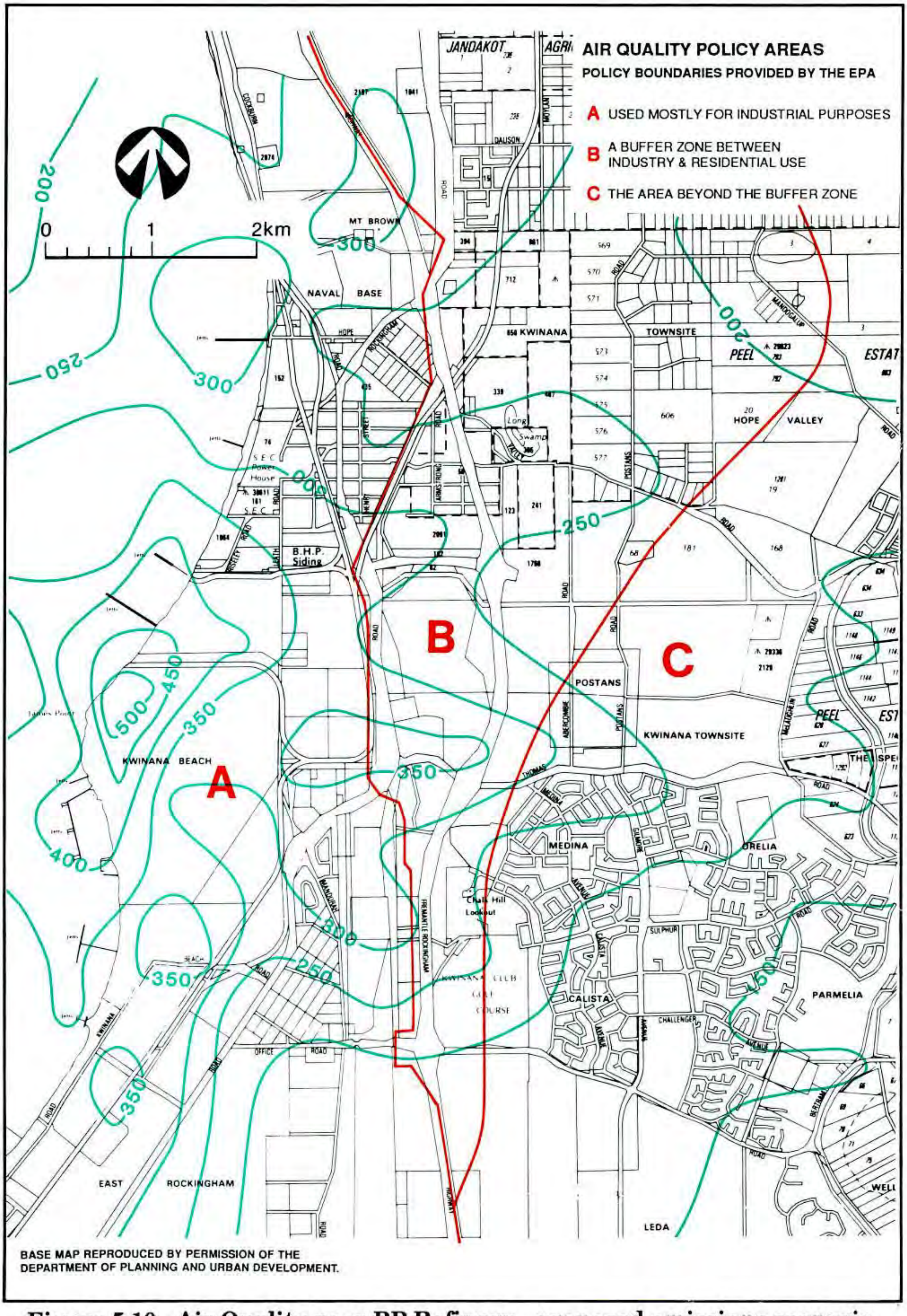


Figure 5.10 - Air Quality near BP Refinery - proposed emissions scenario. Predicted 9th highest 1-hour average Groundlevel Concentrations of Sulphur Dioxide.

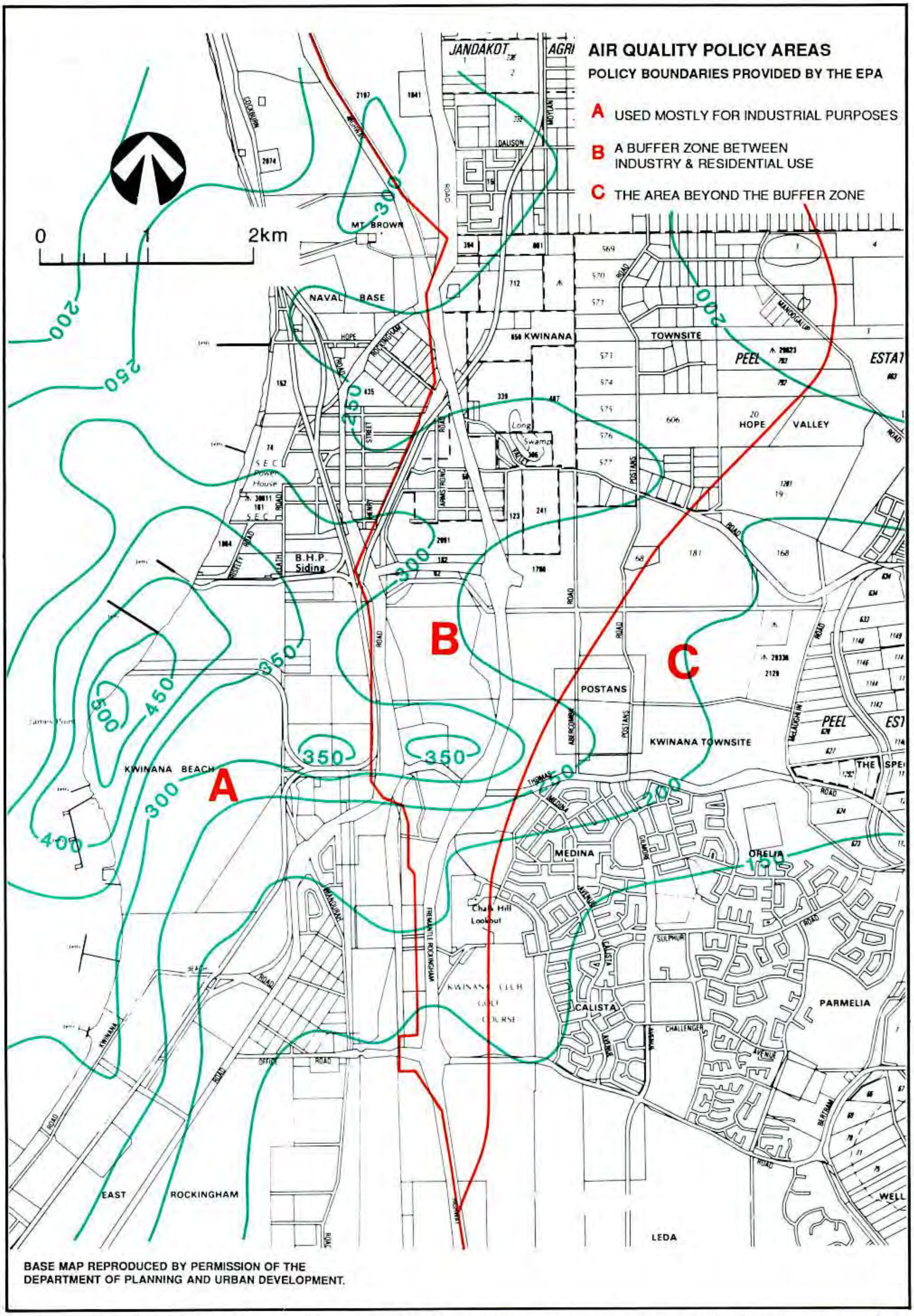


Figure 5.11 - Air Quality near BP Refinery - Proposed emissions scenario. No TiWEST and reduced CSBP emissions. Predicted 9th highest 1-hour average Groundlevel Concentrations of Sulphur Dioxide.

b) Oxides of Nitrogen

The existing emission rates of oxides of nitrogen from other industries in the Kwinana Region are not known. As such, the groundlevel concentrations of oxides of nitrogen from the Refinery have been predicted in isolation from the other industrial sources. The information presented in Table 5.2 indicates that under the proposed emissions scenario, the total emissions of nitrogen dioxide are only expected to marginally increase over current levels.

DISPMOD has been used to model the air quality impact of the Refinery emissions of nitrogen dioxide and the results are presented in Figure 5.12. The maximum predicted 9th highest 1-hour average groundlevel concentration anywhere over the modelled grid is 112 ug/m^3, which is less than half the most stringent hourly standard of 282 ug/m^3 (Victorian EPA) (see Table 5.4). Although not presented, the predicted maximum 1-hour average groundlevel concentration of nitrogen dioxide is 178 ug/m^3, which is also below the most stringent standard.

The above results are conservative, as it has been assumed that all of the oxides of nitrogen that are released are in the form of nitrogen dioxide. In fact, most of the oxides of nitrogen are released as nitric oxide, which slowly oxidises to nitrogen dioxide. Therefore, the actual levels of nitrogen dioxide are likely to be significantly lower than the predicted levels.

c) Particulates

The existing emission rates of particulates from other industries in the Kwinana region are unknown. As such, the groundlevel concentrations of particulates have been predicted by modelling the proposed particulate emissions from the Refinery in isolation from other sources. While modelling the particulate dispersion, gravitational settling has been ignored.

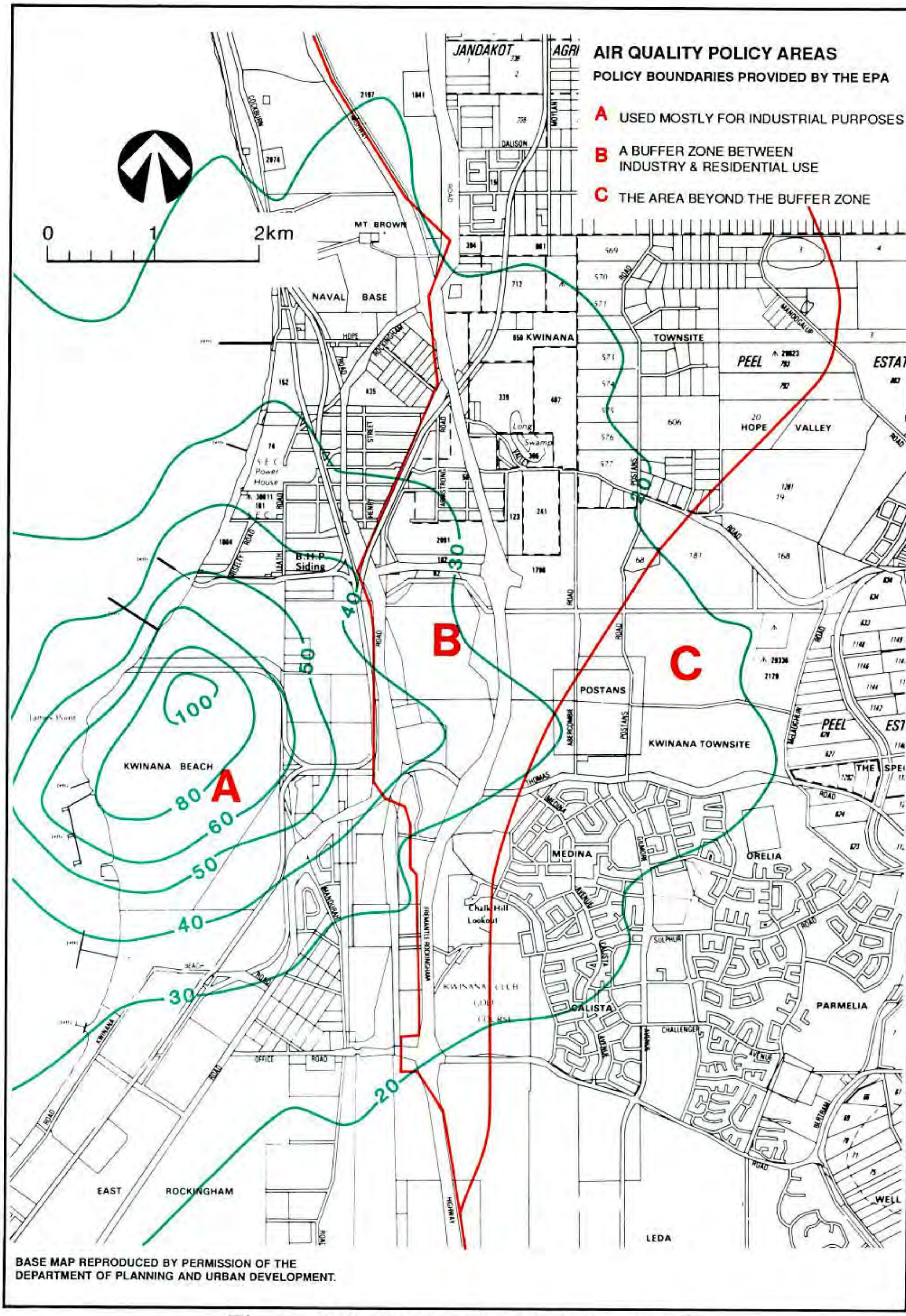


Figure 5.12 - Proposed emission scenario 9th highest 1-hour average Groundlevel Concentrations of Nitrogen Dioxide resulting from BP Refinery in isolation.

The maximum predicted 24-hour groundlevel concentration of particulates was 1.2 ug/m^3. This maximum can be compared to the proposed Draft EPP standards and limits presented in Table 5.5. The predicted maximum groundlevel concentration is well below the Draft EPP standard of 90 ug/m^3 in Areas B and C, and 150 ug/m^3 in Area A. Since the values are so small relative to the proposed Draft EPP standards, contours of the groundlevel concentrations have not been presented.

Sulphur Recovery Unit Unplanned Shutdowns

Based on previous operating history, it has been estimated that total Sulphur Recovery Unit unplanned downtime will average 49-hours per year (0.56 percent of the time).

The possibility of both the Sulphur Recovery units failing at the same time is extremely small, less than one occasion every ten years. As such, the only failure case that has been considered further is the failure of one of the Sulphur Recovery units. Table 5.3 presents the estimated worst case emissions figures of sulphur dioxide for this failure case. In the case of such a failure sulphur dioxide would be emitted by all the stacks in the Refinery. Total sulphur dioxide emissions would increase from 307.2 g/s to 1131.6 g/s (Table 5.3). Even though this is a significant increase in the sulphur dioxide emission rate, the operating Sulphur Recovery Unit would still be removing hydrogen sulphide from the gas streams. In fact, under this failure case the total sulphur dioxide emission rate would only be marginally greater than the emission rate that would occur in the existing situation if the one, and only, Sulphur Recovery Unit failed.

The EPA ambient sulphur dioxide monitoring results prior to the first Sulphur Recovery Unit being commissioned, and the DISPMOD results for the two Sulphur Recovery Unit emissions scenario, indicate that the Draft EPP standards and limits would likely be exceeded in all of the policy areas under an Sulphur Recovery Unit failure case. In a letter to BP Refinery Kwinana (dated 28 September 1990), the EPA stated that for the Sulphur Recovery Unit failure case to be acceptable, the following would need to be demonstrated:

- the probability of the standard being exceeded needed to be much smaller than 9 times per year; and
- the probability of the limit being exceeded needed to be much smaller than once per year.

In order to determine these probabilities, DISPMOD has been used to predict the groundlevel concentrations resulting from the existing emission sources (excluding Tiwest) and including the Refinery sulphur dioxide emissions under the Sulphur Recovery Unit failure case for a full year. The total number of hours that DISPMOD predicted the standard and limit to be exceeded in each of the policy areas is presented in Table 5.8

TABLE 5.8 Predicted Number of Hours in Excess of Various Groundlevel Concentrations of Sulphur Dioxide for the Sulphur Recovery Unit Failure Case for a Full Year.

Policy Area	Number of Hours in Excess of				
	350 (ug/m^3)	500 (ug/m^3)	700 (ug/m^3)	1000 (ug/m^3)	1400 (ug/m^3)
A	1406	880	487	139	27
B	690	390	120	25	4
C	300	120	32	5	0

The results from Table 5.8 have been multiplied by the probability of SRU failure per year (0.56 percent) to produce the annual probabilities given in Table 5.9. Table 5.9 shows the probable number of 1-hour events per year when the standards and limits would be exceeded in each of the policy areas, assuming a failure rate of 0.56 percent.

TABLE 5.9 Probability of the Draft EPP Standards and Limits Being Exceeded as a Result of One Sulphur Recovery Unit Failing for 0.56 Percent of the Year
(Number of 1-Hour Events per Year)

Policy Area	Standard	Limit
A	2.7	0.15
B	2.2	0.14
C	1.7	0.18

Table 5.9 predicts that the Draft EPP standards could be exceeded between 1 and 3 times per year in each of the policy areas as a result of Sulphur Recovery Unit failures.

The Draft EPP limit is predicted to be exceeded once every 5.9 years in Area C and less frequently in the other policy areas. Under the structure of the Draft EPP, the EPA must review the EPP if any of the limits are exceeded, once the EPP has been implemented.

BP Refinery Kwinana will ensure that, should emissions of sulphur dioxide from the Refinery occur, or be likely to occur, which exceed the requirements of the Draft Environmental Protection Policy for Sulphur Dioxide and Dust in the Kwinana region, then all appropriate operational and management steps will be taken to ensure that sulphur dioxide emissions are reduced to levels acceptable to the Environmental Protection Authority.

Air Quality Impacts

A brief analysis of the EPA ambient sulphur dioxide monitoring results for the Wattleup, Hope Valley and Rockingham stations has indicated a significant decrease in groundlevel concentrations of sulphur dioxide in the first 10 months of 1990. The first Sulphur Recovery Unit that was installed at BP Refinery Kwinana in August 1989, is believed to be the most significant contributing factor to these decreases.

The modelling results from DISPMOD indicate that under normal operating conditions, the proposed Feed Flexibility Project modifications would not significantly change the existing air quality. The total sulphur dioxide emission rate would reduce slightly, particulate emissions would reduce significantly and nitrogen dioxide emissions would increase marginally. Under normal operating conditions predicted groundlevel concentrations of sulphur dioxide, nitrogen oxides and particulates are well within regulatory requirements.

Under conditions when one of the Sulphur Recovery units fail, the groundlevel concentrations are predicted to exceed the proposed Draft EPP limits on an average of once every 5.9 years in areas which may be residential (ie Area C). However, the total emission rate of sulphur dioxide would be only marginally greater than the emission rate from the existing single Sulphur Recovery Unit failure scenario.

The prediction that the proposed Draft EPP limits will be exceeded on an average of once every 5.9 years is an overestimate. The worst case scenario, that high sulphur crude was the feedstock for all Sulphur Recovery Unit failures, was considered in this prediction. Low sulphur crude will make up about one third of Refinery throughput after the Feed Flexibility Project and some of the Sulphur Recovery Unit failures will occur while running low sulphur crudes. A Sulphur Recovery Unit failure while processing low sulphur crude will not result in the proposed Draft EPP limits being exceeded.

As noted above, BP Refinery Kwinana will take all the appropriate operational and management steps necessary to ensure that sulphur dioxide emissions are reduced to levels acceptable to the Environmental Protection Authority should a Sulphur Recovery Unit failure occur.

Carbon Dioxide and the Greenhouse Effect

The Greenhouse Effect hypothesis predicts a continual warming of the earth's atmosphere due to increasing levels of various insulating gases such as carbon dioxide, methane, chlorofluorocarbons, ozone and nitrous oxide. While these gases collectively are all referred to as Greenhouse gases, global effort has focused on reducing the emissions of carbon dioxide which accounts for about 50% of the potential global warming increment.

The Australian and New Zealand Environmental Council (ANZEC) (1990) estimated that Australia contributes less than 2 percent of the total world emissions of Greenhouse gases. SECWA (1990) estimated that the total emission rate of carbon dioxide in Australia is 400 Mtpa or 1.3 percent of the world's emission rate. Of this, Western Australia has a total emission rate of approximately 30 Mtpa or 0.1 percent of the world's emissions. The Refinery currently emits approximately 0.86 Mtpa of carbon dioxide which represents 2.9 percent of Western Australia's present total carbon dioxide emissions. Carbon dioxide emissions are expected to increase to 0.91 Mtpa with the proposed Feed Flexibility Project modifications. The total emission rate of carbon dioxide would represent 3 percent of Western Australia's present total carbon dioxide emissions, and approximately 0.004 percent of the world's present total carbon dioxide emissions.

The increased carbon dioxide emissions from the Refinery due to the proposed modifications are attributable to the production of products which are either used in Australia or exported overseas. Since the total demand for these goods is determined by the world market, the requirement to refine higher sulphur crude oil would otherwise be satisfied by other refineries. The proposed modifications to the Refinery would therefore not affect global carbon dioxide emissions.

Over the last 5 years energy efficiency at the Refinery has been improving at about 7% per year as a result of equipment modifications and tighter operating controls. However, desulphurisation requires additional energy and hence increased emissions of carbon dioxide. It is anticipated that the trend towards improved energy efficiency will continue as new technologies develop, but that the benefit will be offset to some extent by further tightening of product quality specifications (eg. unleaded motor spirit requires more energy to make than leaded motor spirit).

BP Refinery Kwinana will provide an accurate annual estimate of greenhouse gas emissions to the Environmental Protection Authority each year.

5.3.2 Wastewater

Wastewater Chemistry and Loadings

The wastewater from current Refinery operations is a complex mixture of aqueous liquids from several process units that are treated by primary separation. The wastewater quality is subject to considerable variation, even on an hourly basis. The proposed development would also produce wastewater from several sources. Table 5.10 presents some basic physical and chemical data for current operations and the proposed development. The effects of the proposed modifications on wastewater quality can be reliably predicted from related plant installed at overseas refineries.

The proposed Feed Flexibility Project modifications would significantly reduce the phenolic, sulphide and ammonia loadings from the Refinery. The reduction in hydrocarbon emissions will be brought about by improved source control procedures and projects that are currently being implemented.

TABLE 5.10 **Wastewater Chemistry, and Quantities Discharged to Cockburn Sound.**

Parametre	Units	Jan - Oct 1990		Proposed Development
		Average	Range	Average
pH	pH units	8.2	8.0 - 8.9	8.2
Temperature (increase above ambient)	°C	12	6.0 - 14.5	12
Petroleum hydrocarbons	kg/day	416	72 - 1342	300
Phenolics	kg/day	188	50 - 349	50
Sulphides	kg/day	29	1 - 822	<30
Ammonia	kg/day	218	4 - 798	100

Wastewater Treatment and Disposal

Salt Cooling Water and Oily Water

Kwinana Refinery uses some 430,000 kL/day of once through sea water as a cooling medium in the processing units. As there is no intimate contact with the individual process streams no oil is normally added to the cooling water. The cooling water treatment facilities consist of the North and South circular separators and an API Separator for detection and skimming of any undissolved oil due to occasional leaks from heat exchangers. These treatment facilities also act as radiators and lower the temperature of the sea water (generally 10-12°C above ambient) before discharge to Cockburn Sound.

The majority of the salt cooling water used by the Refinery (280,000 kL/day) flows through a pressure main which collects water from the Residue Cracker, Crude Distillation units, Catalytic Reformer and the existing Hydrofiner. A gravity main collects some 30,000 kL/day of water from the Residue Cracking Unit Sour Water Stripper, the Catalytic Polymerisation Unit, Propane Production Unit No.2 and also any bleed off from the Alkylation Unit fresh cooling water closed system. In addition the Jet Merox Unit releases dilute caustic into the gravity main together with the used cooling water. The pressure and gravity mains flow into the inlet boxes to the North and South circular separators and then out through the South and Centre outfalls to Cockburn Sound (Figure 5.13).

The Lubricating oil plant has its own cooling water disposal system handling approximately 130,000 kL/day which flows into API Separator No.2 and then to the North outfall (Figure 5.13). Refinery treated spent caustic, collected in Tank 3, is slowly drained into API Separator No.2 in a controlled manner when necessary.

The refinery also has an oily water sewer system for collection of all surface drainage, equipment drainings, unit washings, intermittent steam condensate blowdown for dissolved solids control, flare seal pot overflow and the Vacuum Unit Sour Water Stripper effluent. The combined stream enters API Separator No.1 where the water flows slowly under and over a series of baffles into collection bays where undissolved oil is skimmed off. The water is then discharged via the South outfall to Cockburn Sound.

Desalter effluent water from the Crude Distillation Units, and ballast water are collected in Tanks 1 and 2 for settling and primary separation before discharge to Cockburn Sound via the circular separators.

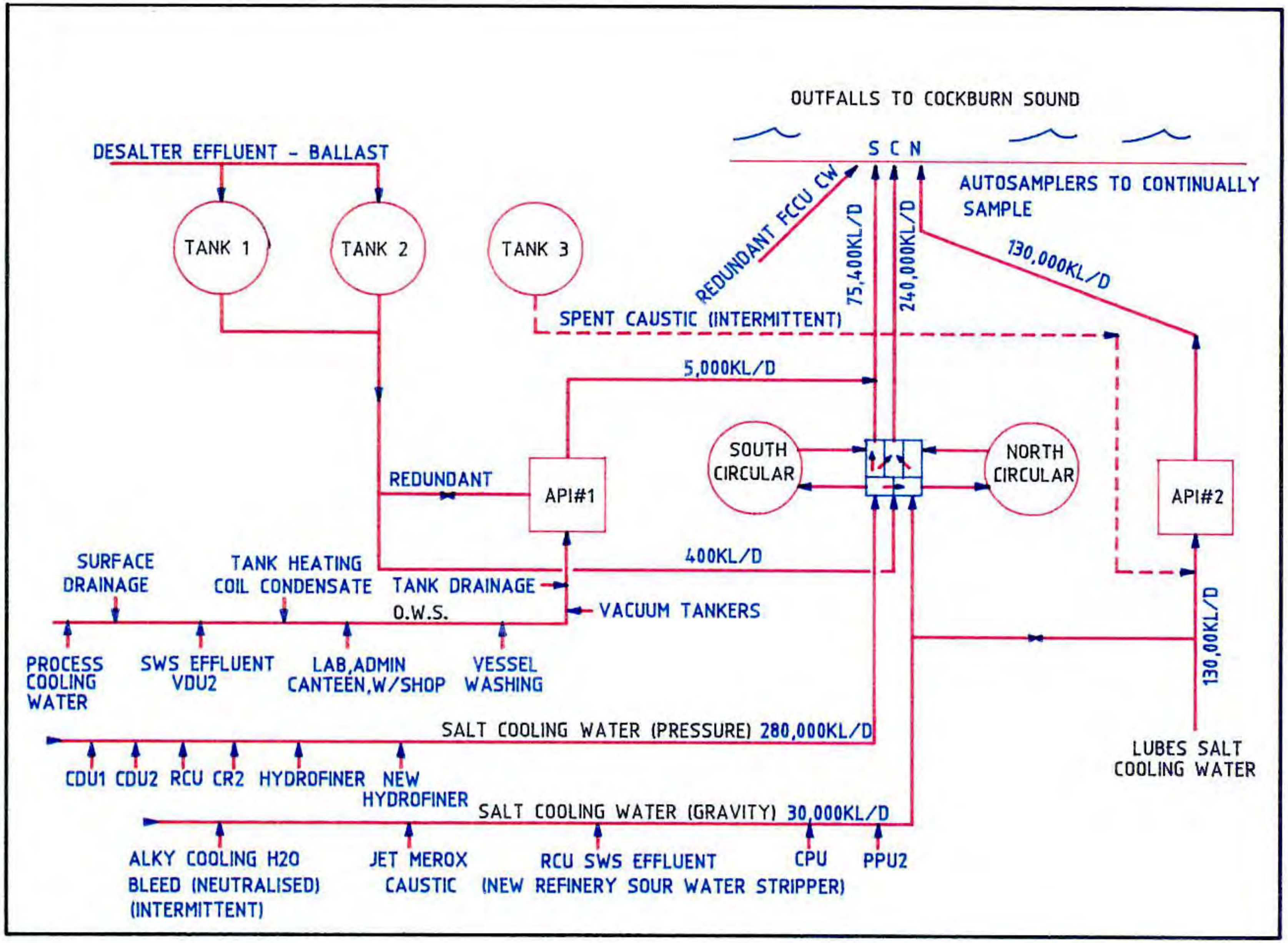


Figure 5.13 Simplified Flow Plan
Wastewater Treatment & Outfall Location

Sour Water

Sour water consists of any water drainings which have been in contact with hydrogen sulphide or other components which could cause the water to have an unpleasant odour. Sour water is presently treated in two small sour water strippers associated with the Residue Cracker and the Vacuum Distillation Units respectively. These existing columns have limited capacity and were not designed to remove significant quantities of ammonia present in the feed water.

A new refinery Sour Water Stripper will be built to deodorise the combined water from the Residue Cracker and the new Hydrofiner. A steam reboiler (see Figure 3.9) will provide the heat required for stripping of the odorous gases and air cooling of the overhead gases will condense out the vaporised water. The relatively dry offgases containing hydrogen sulphide and ammonia will be sent to the Sulphur Recovery unit muffle furnace for conversion to sulphur dioxide and nitrogen gas. The deodorised water will be directed to either the gravity main or the oily water sewer depending on the final quality. The new unit has been designed for 1200 kL/day operation although it is anticipated that only 800-1000 kL/day of sour water will be processed.

Process Water (Fresh water)

Kwinana Refinery presently uses some 7000 kL/day of mains water. About half of this is used as make up boiler feed water for raising steam on the refinery, with the balance used for process and domestic purposes. This process water is directed to the oily water sewer and API Separator No.1 for removal of undissolved oil and solids before discharge to Cockburn Sound. Part of the process water can be made up with bore water (up to 700 kL/day), but this has been found to have a detrimental effect on certain critical heat exchangers because of the high iron concentration naturally present in the groundwater. There will be no change in the quantity of process water used as a result of the Feed Flexibility Project.

Spent Caustic Soda Solution

Presently the Refinery uses the equivalent of 470 tonnes/annum of 100% caustic soda (NaOH), resulting in an average of 4,000 kL/annum of dilute spent caustic being disposed of into the Refinery's salt cooling water system. Spent caustic continuously generated from the Crude Distillation Unit No.1 caustic wash, the Residue Cracker Catalytic Cracked Spirit Merox Unit, Propane Production Unit No.2 prewash and Merox Unit, and intermittently from the the Copper Chloride sweetening unit, the Crude Distillation Unit No.1 solutisers, the Catalytic Polymerisation Unit propane wash and the Jet Merox Unit is collected in Tank 74. Some 2 tonnes/day of spent caustic is sent to Crude Distillation Unit No.1 for pH control and the balance directed to the caustic regenerator on Crude Distillation Unit No.1 for deodorisation using heat and air. The odorous gases, containing traces of hydrogen sulphide, from the caustic regenerator are sent to the Crude Distillation Unit No.1 furnace for incineration and the caustic directed to Tank 3 (maximum capacity 150 tonnes). From Tank 3 the dilute deodorised spent caustic solution is drained in a slow controlled manner to the inlet of API Separator No.2. In addition, dilute spent caustic from the pre-wash of the Jet Merox Unit is continually drained to the gravity main.

With the existing facilities caustic management is achieved through the procurement of the requisite quantities of low sulphur crudes necessary to prevent excessive accumulation of spent caustic in Tank 74 (maximum capacity 5000 tonnes) and maintain the tank close to its minimum working level of 1000 tonnes. No foreseeable change to this philosophy would be envisaged until the Feed Flexibility modifications were commissioned and the Crude Distillation Unit caustic wash/solutisers shut down. After this it is expected that the remaining dilute spent caustic in Tank 74 would be processed through the caustic regeneration system within a few months. The Refinery would then be in balance with regard to caustic management.

Shutdown of the Crude Distillation Unit No.1 caustic wash/solutisers, the Copper Chloride Units and the catalytic cracked spirit Merox Unit, which all use stronger than 10% caustic solution, will significantly decrease the amount of spent caustic to be deodorised and disposed of. This will result in a significant improvement in the quality of the wastewater discharging to Cockburn Sound.

The proposed Feed Flexibility Project modifications will reduce the amount of 100% caustic soda used by the Refinery by 35% or 180 tonnes/annum. The change in caustic usage is shown in Table 5.11.

TABLE 5.11 Change in Caustic Use After the Feed Flexibility Project Modifications.

Modification	Change in 100% NaOH per annum (tonnes)
1. New Propane Production Unit No.1 Merox Unit	+ 0.8
2. Shutdown of Crude Distillation Unit No.1 caustic wash/solutisers	-157.0
3. Shutdown of Copper Chloride units	-11.0
4. Straight Run Gasoline Minalk prewash	+15.7
5. Straight Run Gasoline Minalk reactor	+ 1.6
6. Catalytic Cracked Spirit Minalk reactor	+ 2.8
7. Shutdown of Catalytic Cracked Spirit Merox	-32.4
Total	-179.5

The additional sources of spent caustic from the new Catalytic Cracked Spirit and Straight Run Gasoline Minalk Unit reactors of approximately 0.85 tonnes/day of less than 1.7% mass caustic solution will be drained directly to the Refinery cooling water and are expected to be of the following quality:

1.	Appearance	Yellow to amber
2.	Percent spent	10 - 70%
3.	Total alkalinity	0.5 - 1.5% as NaOH
4.	pH	7.5 - 9
5.	Total sulphur	0-0.4% mass as $Na_2S_xO_y$
6.	Mercaptide	Less than 1ppm $RS^=$ mass
7.	Sulphide	Less than 1ppmS mass
8.	Undissolved oils	Less than 1% vol.
9.	Phenolic compounds	14 kg/day maximum

The Propane Production Unit No.1 and Straight Run Gasoline prewash spent caustic solution will be discharged to the refinery spent caustic system on a weekly basis for deodorisation and subsequent disposal via Tanks 74 and 3. The quality of the caustic from the prewash vessels is anticipated to be as follows:

1.	Appearance	Yellow to dark brown
2.	Percent spent	70 - 90%
3.	Total alkalinity	0.7 - 2.1% as NaOH
4.	pH	7.5 - 9
5.	Total sulphur	3-4% mass as $Na_2S_xO_y$
6.	Mercaptide	3-4% mass as NaRS
7.	Sulphide	3-4% mass as Na_2S
8.	Undissolved oils	Less than 1% vol.

The Refinery is continuing to look for ways to rationalise the use of caustic soda in order to reduce consumption and subsequent disposal of the resulting spent caustic solution.

Amine Drainage (Closed Systems)

All drainings from the amine systems are collected in the closed systems on Propane Production Unit No.1 and the new Hydrofiner and returned to the Sulphur Recovery Unit with the hydrogen sulphide rich amine stream for recovery of the diethanolamine.

Alternatives

a) Technology

The only possible alternatives to the Minalk units are the existing Copper Chloride and Merox Sweetening units which use more concentrated caustic soda solutions. Higher concentrations of caustic soda result in more phenolic compounds being dissolved and requiring disposal with the spent caustic. The Minalk units, therefore, not only reduce the amount of caustic required, but also significantly reduce discharge of phenolic material to Cockburn Sound.

Sour water stripping is the only practical method of removing volatile odorous material from water drainings. Use of a steam reboiler and air cooler have been chosen over "live steam" stripping and inert gas stripping in order to maximise the efficiency of the stripping operation to remove any dissolved ammonia and at the same time minimise overall water usage.

b) Recycling & Reuse

The Feed Flexibility Project is another step in the process of rationalising the use of caustic soda on the Refinery with an estimated reduction in usage of 35%. Further investigation is planned with a view to minimising overall caustic consumption through increased secondary and tertiary usage.

Currently, some 60% of the boiler feed water requirements for raising steam on the Refinery comes from returned condensate.

Certain process water effluent streams are also recycled, generally to the Crude Distillation units as desalter water. Investigations are underway to examine the feasibility of recycling the new Refinery Sour Water Stripper water to the No.2 Crude Distillation Unit desalters as well as other options.

Wastewater Disposal Impacts

Ecological studies (Le Provost et al 1990) have shown that the discharge of Refinery wastewater to Cockburn Sound has only localised impacts on the environment. These environmental impacts have not been assessed for the Feed Flexibility Project because:

a) the quality of wastewater discharged to Cockburn Sound will be significantly improved as a result of the proposed Project, and

b) the Refinery has plans to further upgrade the wastewater treatment facilities at Kwinana over the next four years.

Preliminary cost estimates indicate that the new wastewater treatment facilities will cost in the order of A$25 Million, and provisional planning is for the new facilities to be operational by the end of 1994. The new facilities will add secondary (solids removal) and tertiary (biological degradation) treatment stages to the existing primary (gravity separation) wastewater treatment system. The loading of oil, phenolics and sulphides to Cockburn Sound will be substantially reduced. An assessment of the impacts of Refinery wastewater discharge on Cockburn Sound will form part of the EPA assessment documentation for that Project.

5.3.3 Groundwater Impacts

Extraction

Kwinana Refinery has two separate Water Authority of Western Australia licensed groundwater extraction systems, each with their associated bores. The first is capable of suppling up to 750 kL/day of groundwater to the process water system on a continuous basis. It is presently not in use because of the high natural iron concentration in the groundwater, which causes problems with certain critical heat exchangers associated with the Steam Generating Area compressors. It is anticipated that a solution to this problem will be found shortly and that groundwater will again be used to make up process water.

The second bore system, commissioned in 1990, is purely for reticulation of the garden and lawn areas around the Refinery and uses up to 40 kL/day of groundwater on an intermittent basis, mostly in the hot summer months.

There will be no change to this situation as a result of the implementation of the proposed Feed Flexibility Project.

Pollution

Existing Refinery Operations:

Over the 35 years of Refinery operations a large amount of oil has leaked into the ground and has accumulated as a pool under the process units and parts of the tank farm. In summer the oil sits just above the water table, and therefore does not actually float on the groundwater.

The main sources of oil are thought to have been leakage from underground oily water sewer pipes and the practice of draining water from storage tanks onto the ground. The oily water sewer was constructed in the early 1950's and consists of a network of concrete pipes and sumps. With age the concrete developed stress fractures which allowed oily water to leak into the ground.

It was an accepted industry practice, when the Refinery was built, to drain water from the crude and product storage tanks onto the ground. Most water would have been drained from the crude oil storage tanks. Crude oil is transported by ship and some water invariably contaminates the crude oil. The drained water only contains a small amount of entrained oil, but over 35 years this would amount to a significant load.

The Refinery has adopted a remedial strategy which has three components:

- recover the oil,
- stop leakage of oil to the ground,
- prevent discharge of the oil to Cockburn Sound.

The Refinery first started recovering the underground oil in the early 1970's. The recovery programme was stepped up in 1985 and has been upgraded repeatedly since then. Currently there are 70 recovery bores and wells, from which about 5 tonnes per day of oil are recovered. It has been estimated that there has been a one third reduction in the volume of oil under the Refinery since 1985.

Since 1986 a multimillion dollar oily water sewer leak repair program has been in progress. Priority has been given to areas of greatest concern. The main oily water sewer lines have all been fitted with an 8 mm fibreglass liner or replaced depending on their condition. All the branch and trunk lines are being systematically tested for leaks and repaired as necessary. Since 1988 the tank farm has been progressively fitted with a closed tank drainage system linked to the wastewater treatment system. The crude tanks drains were completed in 1990. The motor spirit and motor spirit component tanks drains will be completed in 1992 and the remaining finished product tanks shortly thereafter.

Intensive monitoring is undertaken to detect any movement of the underground oil towards Cockburn Sound. A network of some 120 bores is monitored every fortnight. Small diametre vapour bores are also being monitored between the leading edge of the oil plume and Cockburn Sound to detect any advance of oil towards the Sound. An interceptor trench has been installed at the oil's closest point to Cockburn Sound. No significant movement of the oil has been detected since this monitoring program commenced in 1985.

Proposed Development:

There will be no impacts on groundwater quality resulting from the Feed Flexibility Project.

5.3.4 Solid Waste

Sources and Quantities

Table 5.12 summarises the amount of solid wastes produced by the existing and redeveloped plants.

TABLE 5.12 Solid Waste for Existing and Proposed Operations. (Quantities are estimates unless otherwise indicated).

Solid Wastes	Existing Operations	Proposed Operations
Oily sludges and soils	1000 tonnes/yr	no change
Filter Clays	100 tonnes/yr	70 tonnes/yr
Charcoal	45 tonnes/yr	70 tonnes/yr
Calcium fluoride	10 tonnes/yr	no change
Alkyl lead contaminated scale & rust	50 tonnes/yr	no change
Pyrophoric scale	1 tonne/yr	2 tonne/yr
Construction/demolition debris	NM[1]	increase during construction phase/ no long term change
General Plant waste	NM	no change
Fluoride deactivation pellets	5 tonnes/yr	no change
Asbestos	NM	no change
Spent Catalysts		
° Residue cracking catalyst[2]	4.5 tonnes/day	9.5 tonnes/day
° Desulphuriser catalyst	8 tonnes/yr	16 tonnes/yr
° Catalytic Polymerisation catalyst	130 tonnes/yr	no change
° Sulphur Recovery Unit catalyst	3 tonnes/yr	6 tonnes/yr

1 NM = not measured.
2 Measured.

The Feed Flexibility Project will increase the amount of charcoal, pyrophoric scale, Residue Cracker catalyst, Desulphuriser catalyst and Sulphur Recovery Unit catalyst to be disposed of. Shutting down the Copper Chloride sweeteners will result in a significant reduction in the amount of filter clay to be disposed of. The most significant increase will be the extra 5 tonnes/day of Residue Cracking catalyst for disposal. If trials continue to be successful Residue Cracking catalyst may be recycled as a speciality cement component.

Solid Waste Treatment and Disposal
Onsite Landfill

The onsite landfill is a designated Waste Management Area. The area has been surveyed in case there is a need in the future to relocate any of the waste material. Different types of waste are buried in separate areas within the Waste Management Area.

The wastes disposed of at the onsite landfill are:

- Residue Cracking Unit catalyst

  This is a zeolite catalyst. Typically the metals content of the spent catalyst is nickel 0.2-0.4%, vanadium 0.12%, copper 50-150ppm and up to 1% rare earths.

- Desulphuriser catalyst

  This is an alumina based catalyst which when spent contains about 13% molybdenum and 4% nickel and/or 3% cobalt. It is presently stored in containers onsite. This material was previously recycled to recover the metals, but the previous user is no longer able to process it. New recycling options and chemical fixation are being investigated.

- Catalytic Polymerisation Unit catalyst

  This is a calcined composite of phosphoric acid on diatomaceous earth in 6-9mm pellet form. The spent catalyst is mixed with lime sands to neutralise the acid.

- Sulphur Recovery Unit catalyst

  This is an activated alumina catalyst.

- Alkylation Plant fluoride deactivation pellets

  These pellets are activated alumina and are used to deactivate trace quantities of fluoride in propane and butane. Disposal is infrequent. Permission is currently being sought from the Health Department to dispose of the pellets at an offsite gazetted landfill site.

- Calcium Fluoride

  Aqueous drainings from the Alkylation Unit are first neutralised with soda ash and then any fluoride present is precipitated as calcium fluoride.

- Alkyl lead contaminated scale and scrap

  These are weathered in accordance with OCTEL procedures before disposal.

- Landfarm

  Landfarming is the term used to describe a biological treatment method which utilises naturally occurring soil microbes to biodegrade hydrocarbons in oil contaminated wastes. The microbes obtain the energy and cell carbon they need to grow from the oxidation of the hydrocarbons. This process is called biodegradation. The final end products of microbial degradation of hydrocarbons are carbon dioxide and water. The landfarm area is managed (eg nutrient addition; regular soil cultivation) to optimise the degradation rate.

  The wastes disposed of at the onsite landfarm are:

- Oily Sludge and Soil

  These are landfarmed onsite and any organics present are biodegraded. The landfarms are managed to optimise biodegradation.

- Charcoal

  The charcoal is landfarmed so that any hydrocarbons it may have adsorbed are biodegraded.

- Filter clays

  The clay is used to filter naphthenates from products such as aviation kerosene. The clay is landfarmed onsite, and natural degradation destroys the organics.

- Pyrophoric scale

  The scale is oxidised in open drums until it no longer presents a fire hazard and is then spread on the onsite landfarm. Batches are very infrequent.

Offsite Gazetted Landfill

The following wastes are disposed of at gazetted offsite landfill sites:

- General Plant Waste
- Construction/Demolition Debris
- Asbestos

Solid Waste Recycling

The solid wastes listed above are those which cannot be recycled in-house. However, external recycling of the largest waste (RCU catalyst) is being investigated and looks promising. It is anticipated that, if trials continue to be successful, recycling of RCU catalyst as a speciality cement component will start in early 1991.

A recycling outlet for desulphuriser catalyst is actively being sought. This catalyst contains nickel, cobalt and molybdenum.

Solid Waste Disposal Impacts

The onsite disposal of solid wastes is confined to a designated Waste Management Area. No waste can be moved without a Refinery permit. The permit provides a record of the type of waste and the estimated quantity, as well as the proposed treatment process and destination.

5.3.5 Noise Emissions

Existing Plant Noise Levels

The noise levels resulting from existing Refinery operations have been measured. The majority of measurements were obtained over a four day period in November 1988. The maximum levels are given in Table 5.13. Equipment items that could cause noise exposure in excess of 85 dB(A), eight hour time weighted average, were identified for engineering noise reduction control.

TABLE 5.13: **Existing Plant Noise Levels**

Location	Date of Measurement	$L_{Aeq, 8h}$ dB(A) @ 1 m Maximum	Peak dB(lin)	General Plant Noise dB(A) @ 1 m	Major Noise Source
Alkylation Unit	02/11/88	90	106	85	Heaters
Bitumen Unit	21/01/89	98	112	85	Air Compressors
Bitumen Emulsion Unit	19/01/89	87	-	85	Pumps
Catalytic Reformer 2	05/11/88	113	129	95	Heaters
Cooling Water Pump Hse	05/11/88	93	106	90	Pumps
Copper Chloride Unit	05/11/88	94	111	85	Pumps
CFR Test House	01/02/89	95	110	85	Supercharge Engine
Crude Desalting Unit	20/01/89	96	114	85	Charge pumps
Crude Distillation Unit 1	06/11/88	98	121	85	Heaters & Pumps
Crude Distillation Unit 2	06/11/88	95	112	85	Pump cooling fan
Furfural Unit	03/11/88	104	121	90	Heater
Hydrofiner Unit	21/01/89	97	112	85	Charge Pump
LPG Plant	06/11/88	84	-	85	Butane Pumps
Maintenannce Workshops	03/11/88	85	-	85	Fixed Equipment
Merox Treatment Unit	04/11/88	82	-	85	Pumps
Propane Deasphalting Unit	21/01/89	106	123	85	Furnace
Propane Production Unit 1	06/11/88	95	109	85	Pumps
Residue Fluid Catalytic Cracker	21/07/88	101	116	90	Compressors
Separators	06/11/88	84	-	85	Pumps
Solvent Dewaxing Unit	03/11/88	102	120	85	Compressors/Heaters
Steam Generation Unit	02/11/88	98	118	90	Air Compressors
Vacuum Distillation Unit	22/01/89	102	113	90	Steam Ejectors

Proposed Development

The proposed Project would not contribute significantly to the total plant sound power levels from existing continuous plant operations.

Design criteria will include a requirement for the maximum noise level generated by any new equipment item to be restricted to 85 dB(A) at a distance of 1 metre. Equipment would be selected to minimise noise, or would be controlled to reduce noise levels. During commissioning noise level measurements will be performed to confirm the specification to 85 dB(A) has been achieved. If these noise measurements indicated levels in excess of 85 dB(A) further noise mitigation measures would be assessed and implemented as practicable.

Noise Impacts

All new plant will be designed to a specification that noise levels do not exceed 85 dB(A). A sound pressure level of 85 dB(A) will attenuate to 30 dB(A), within about 560 metres, due to simple radial divergence. The Noise Abatement (Neighbourhood Annoyance) Regulations 1982, as amended by the Environmental Protection Act 1986, state the assigned outdoor noise level for residential areas as 35 - 45 dB(A), depending on time of day. Given the distance between the Refinery and the nearest residential areas (>2.5 km), noise from plant operations, following commissioning of the proposed Project, would not affect neighbouring residential areas.

BP Refinery Kwinana will design and operate the plant so as to control noise generation and noise levels at the boundary of the Refinery at all times to the satisfaction of the Environmental Protection Authority.

5.3.6 Social Impacts

Odours

Emissions of odours from the Refinery will be reduced due to the installation of the new Straight Run Gasoline Minalk Unit and the modifications to Propane Production Unit No.1 proposed as part of the Project. Other initiatives have already commenced, such as secondary seals on storage tanks, to further reduce emissions of odours from the Refinery. Short-term emission of odours may still occur during abnormal operating conditions, such as during an unplanned Sulphur Recovery Unit shutdown, but such events would be infrequent and of short duration.

Noise

Noise levels generated during construction and operation would be managed to ensure compliance with the requirements of the Town of Kwinana and the Noise Abatement (Neighbourhood Annoyance) Regulations 1982, as amended by the Environmental Protection Act 1986.

During construction and operation of the plant, all relevant legislation pertaining to noise levels and work-force safety, including the Occupational Health, Safety and Welfare Act, 1988 and the Construction Safety Act, 1972 (as amended), would be complied with.

Traffic

The increase in traffic movements in the region during the construction phase of the Project would be negligible. Patterson Road, Rockingham Road and other major roads in the area cope well with existing traffic and have ample capacity to accommodate the increase in regional traffic movements during the construction phase.

Aesthetics

Because of the proximity of the new structures to existing plant, and the similar physical nature of the structures, the visual impacts of the proposed project would be minimal (Section 4.2). The proposed extension of the vegetative buffer around the site perimetre will improve the local amenity.

Public Amenity

The Wells Park and Kwinana Beach reserves are utilised by the general public for recreation and are important as they provide access to Cockburn Sound. The public amenity of these reserves would not be affected by the proposed Feed Flexibility Project.

5.3.7 Risks & Hazards

The Feed Flexibility Project will not result in any increase in the inventory of hazardous material stored onsite. The modifications will increase the number of pressure vessels onsite, thereby marginally increasing the statistical risk of a potential hazard occurring.

The modifications do not embody any new process technology and in essence simply increase the efficiency of the present processing techniques. They do, however, result in a decrease in the use and handling of caustic soda solution through the shutting down of the Crude Distillation Unit No.1 caustic washers/solutisers, the Copper Chloride sweetening units and the Catalytic Cracked Spirit Merox Unit which all utilise solutions greater than 10% mass NaOH.

All work to be carried out will comply with the relevant Australian Standards and/or BP codes of Engineering Practice, whichever is the most stringent. In addition, the design will meet certain USA or UK Oil Refining Standards, where these meet with BP's approval. In general, all plant will be designed for a four year operating cycle with a comprehensive maintenance overhaul carried out at the end of each cycle.

The proposed modifications will comply with all relevant legislation, including (but not limited to) the Occupational Health & Safety Act, 1988 and the Environmental Protection Act, 1986. They will also be subject to the stringent six stage safety review procedure including the Hazop study.

The Refinery will commission Technica Ltd. to review and update the BP Refinery Kwinana database and analysis for the Kwinana Industrial Area Cumulative Risk Analysis Study to verify that risk levels have not increased as a result of the proposed Feed Flexibility Project.

CHAPTER 6

ENVIRONMENTAL MANAGEMENT AND MONITORING

6.1 INTRODUCTION

Over the past thirty-five years BP Refinery Kwinana has been progressively upgraded to reflect technological changes and changes to environmental controls. The Refinery has a good safety record and has an ongoing commitment to the safety and protection of the workforce, local community and the environment.

The principles for management and monitoring of the emissions and risks associated with the Feed Flexibility Project are reviewed in this chapter.

6.2 MANAGEMENT OF EMISSIONS

6.2.1 Atmospheric and Liquid Emissions

Normal Operations

Management of emissions during normal operations is by the following means:

a) Liquid Emissions

Aqueous liquid waste is initially managed by source control. Any excess drainings are directed to either the gravity main if they are oil free or the oily water sewer if there is any possibility of traces of oil or solids being present.

The gravity main is one of the three salt cooling water collection mains and discharges its water into the North and South circular separators. These two circular separators provide a reservoir for temperature reduction and removal of any traces of free oil or solid matter from the cooling water prior to discharge from the Refinery via the outfalls into Cockburn Sound.

The oily water sewer is a partly enclosed network of collection mains running through each of the refinery process plants. It has a series of sewer boxes throughout the network which trap the majority of the oil which is in turn removed periodically as slops for reprocessing in the Crude Distillation units. The water then flows to API Separator No.1 where further clarification takes place before discharge to Cockburn Sound.

Additional control of aqueous liquid waste from the process units will be via the new Refinery Sour Water Stripper, which will remove any odorous volatile material from the accumulated water, and the existing refinery blowdown systems. Each blowdown system consists of a vessel with facilities for separation of oil and water plus an elongated chimney stack for dispersal of vented gases, generally nitrogen. Oil separated from the water in the blowdown drum is transferred to the dry oil system and the water is drained to the oily water sewer.

All hydrocarbon drainings from the process units will be segregated in the existing refinery dry oil system (DOS). This system is a closed network of pipes running through every process unit which collects essentially water free hydrocarbon oil. This "dry oil" is accumulated in the refinery slop tanks prior to reprocessing in the Crude Distillation units.

b) Particulate Emissions

The major source of particulate emissions is from the Residue Cracker stack. Control is exercised by the regenerator cyclones on the unit which remove the catalyst fines to a low level. The addition of new secondary cyclones will reduce particulate emissions to well below that required by present regulations.

c) Odours

Odorous emissions are minimised on the Refinery through the use of completely closed systems and a high proportion of fixed and floating roof tanks. All floating roof tanks are fitted with roof seals to minimise the escape of hydrocarbon and odorous vapours. In addition, the proposed new Refinery Sour Water Stripper; the two new Minalk units and the new Propane Production Unit No.1 Merox Unit will all further reduce possible odorous emissions.

d) Sulphur Dioxide Emissions

Management of sulphur dioxide emissions comes from the existing Sulphur Recovery Unit and the proposed new Sulphur Recovery Unit. Secondary control comes from the choice of refinery feedstocks which are tailored to run below a certain sulphur content.

e) Other Atmospheric Emissions

Other gases include hydrogen sulphide, ammonia and oxides of nitrogen (NO_X). Emissions are controlled at the Refinery by a combination of equipment design and operating techniques. Methods include contacting the gaseous streams with caustic soda solution to remove hydrogen sulphide; directing sour water to the refinery Sour Water Stripper; adjusting the operating conditions on the Sulphur Recovery Unit to maximise conversion of ammonia to nitrogen gas and burning of natural gas in the Refinery as opposed to fuel oil.

Unit Start-ups

Start-up of the new and modified units, either initially or following a maintenance turnaround, will necessitate flushing of all equipment and piping with fresh process water, after which the drainings are sent to the oily water sewer. This will be followed by a nitrogen purge to remove oxygen from the system. The gases will be directed to the refinery's existing blowdown system where any purged liquid is trapped and nitrogen is vented to atmosphere from the blowdown drum. When the unit is oxygen free it will be isolated from the blowdown system and the normal start-up procedure commenced to establish hydrocarbon inventory and begin process operations.

Routine Unit Shutdowns

Refinery process units are normally shutdown for a routine maintenance turnaround on a four year cycle. At this turnaround the unit is completely gas freed and opened up for legislative and mechanical inspection. When shutting down a process unit for maintenance the following general steps are followed:

- liquid levels in all vessels and towers are reduced to a minimum.

- all gas and vapours are vented to the Refinery fuel gas system and/or the flare system, and the remaining liquid drained to the dry oil system for reprocessing as slops in the Crude Distillation units.

- vessels, towers and pipework are steamed out to the Refinery flare system to remove all volatile hydrocarbons from the process unit.

- vessels, towers and pipework are flushed with process water and drained to the oily water sewer.

- gas testing is carried out to check for the presence of hydrocarbons, and if safe, the unit is opened up for inspection. If traces of hydrocarbon are present the steaming and flushing operations are repeated.

Hydrofiner Regeneration

At the routine turnaround catalyst regenerations and/or replacement of the catalyst generally take place. However, the new Hydrofiner will require at least one catalyst regeneration per year in order to restore catalyst activity. This operation will involve draining off the hydrocarbons to the dry oil system and venting gases from the unit to the flare system. Catalyst regeneration would be carried out using nitrogen/air mixtures.

During catalyst regeneration, the nitrogen rich gas stream is recirculated by the recycle gas compressor on the unit. It is continuously scrubbed with weak caustic soda solution to remove all sulphur oxides and carbon dioxide. A small purge gas stream is sent to atmosphere which contains mainly nitrogen. Spent caustic is sent to the Refinery spent caustic system for deodorisation.

Non-Routine Unit Shutdowns

Typically, unit shutdowns at other times between the routine maintenance turnarounds (eg. because of equipment failure or a planned production shutdown) do not necessitate complete gas freeing of the unit or draining of the hydrocarbon inventory unless it would be unsafe not to do so. If depressurisation of the plant is necessary this will take place to the Refinery fuel gas and flare systems. There will, therefore, be minimal impact on the environment as a result of this particular type of shutdown.

Emergency Shutdowns

In the event of an emergency shutdown the new units will follow similar procedures to the existing refinery units. All heat will be immediately taken off the unit, relief valves will vent to the refinery flare system and everything possible will be done to render the unit safe and minimise any impacts on the environment. The emergency shutdown systems will be engineered to render the unit safe.

Sulphur Recovery Unit

If a Sulphur Recovery unit suffers an unplanned shutdown, hydrogen sulphide rich gas will be directed to the other Sulphur Recovery unit with any excess gas initially sent to the refinery fuel gas main. Refinery process unit throughputs will be then be adjusted in order to meet the EPA licence conditions.

Shutdowns will be planned to coincide with those of the Hydrofiner and Residue Cracking units, the major sources of hydrogen sulphide, in order to minimise hydrogen sulphide in the refinery fuel gas main and hence sulphur dioxide emissions.

New Sour Water Stripper

With the commissioning of the new Sour Water Stripper, the present Residue Cracking unit sour water stripper will be shutdown, but not dismantled. The old unit will be maintained in case of failure of the new unit. The Refinery's process unit throughputs would be reduced to meet the capacity of the old unit and EPA licence conditions. Shutdowns of the Sour Water Stripper will be planned to coincide with those of the Hydrofiner and Residue Cracking units which are the major sources of sour water.

New Straight Run Gasolene and Catalytic Cracked Spirit Minalk units and the Propane Production Unit No.1 Merox Unit

Being liquid extraction units operating at essentially ambient temperatures, shutdown and start-up of these units does not present any problem either from a safety or environmental aspect. Unit shutdowns will always be planned to coincide with that of the major plant feeding the Merox and Minalk units, namely the Crude Distillation units and the Residue Cracking Unit.

New Hydrofiner

Kwinana Refinery has over thirty five years operating experience with a Hydrofiner and is therefore adept at shutting down and starting up a Hydrofiner without problems. Depressurising the unit to the refinery flare systems will have minimal effect on the environment as the majority of the gas within the unit is hydrogen with small quantities of methane and propane. Hydrogen sulphide will be sent to the flare system in only trace quantities, as the amine absorber will remove this in the unit itself.

Modifications to the Residue Cracking Unit

The modifications to the gas recovery section and the reduction in particulate emissions by means of additional secondary regenerator cyclones will have little bearing on the present start-up and shutdown procedures and will cause no additional impacts on the environment.

6.2.2 Groundwater

The Refinery's ongoing groundwater remediation strategy will be periodically reviewed to ensure that technological advances in groundwater treatment, if appropriate, can be implemented. Future requirements will depend on results from the current groundwater monitoring program.

The Feed Flexibility Project will not impact on groundwater quality.

6.2.3 Solid Waste

All solid waste will be disposed in accordance with the requirements of the Health Department of WA and be to the satisfaction of the Environmental Protection Authority.

The Refinery waste minimisation program will be periodically reviewed to identify and evaluate refinery emissions for the potential to reduce waste generation by source reduction, recycling, reuse, reprocessing and treatment.

6.2.4 Noise

All new plant will be designed to ensure that noise levels do not exceed 85 dB(A) at a distance of 1 metre. During commissioning, noise level measurements will be performed to confirm the noise specification has been achieved. The noise specification for all new units will ensure that noise levels satisfy statutory requirements outside the Refinery boundary.

A Noise Management Committee has been formed at the Refinery. The function of this committee is to overview all new projects with regard to meeting the current noise specifications and to investigate methods to reduce noise levels associated with existing equipment. In addition, a noise management program is underway to ensure that all employees are protected from noise hazards according to the Refinery noise control policy.

6.3 MONITORING

At present, a monitoring programme is in place at BP Refinery Kwinana. The monitoring programme involves regular sampling and testing of all wastewater discharges, sulphur dioxide and particulate emissions from the Residue Cracker stack, groundwater quality, solid waste quality, and noise levels to assess compliance with BP standards and EPA licence conditions.

The specific methodologies for these monitoring programmes is determined in consultation with the appropriate authorities. All monitoring is administered by fully qualified BP personnel or by specialist consultants. All monitoring results are reported to the EPA at regular intervals or as required by other relevant regulatory authorities, such as the Water Authority and the Department of Occupational Health, Safety and Welfare.

Upgrading of BP Refinery Kwinana's monitoring programme is planned in the near future, and any additional monitoring, if required by the regulatory authorities, could be incorporated into the existing monitoring programme.

6.4 AUDITS

Safety and environmental audits, already a regular feature of Refinery operations, would be conducted to monitor the effectiveness of BP Refinery Kwinana's commitments to protect people, property and the environment, and to ensure that they were being competently and fully executed. Internal audits would be supplemented by external audits to identify means by which even higher safety and environmental standards could be achieved.

BP Refinery Kwinana's health and safety policy would be regularly audited by the ongoing International Safety Rating System programme. A further recent management commitment by BP Refinery Kwinana is to introduce a policy of Total Loss Control to refinery operations. A full-time Total Loss Control Officer has been appointed to oversee the implementation of this policy.

6.5 RISKS & HAZARDS

6.5.1 Hazard Management Process

The Hazard Management Process at the Refinery consists of 3 elements:

- the formal Safety Review
- Refinery Permit System
- Refinery Management Systems

These are described below.

All new projects at BP Refinery Kwinana since 1978 have undergone formal Safety Review procedures which vary from four to six stages depending on the magnitude and complexity of the project. It is BP policy to ensure that potential health and safety factors and environmental effects are assessed for all new projects.

The six stages of the formal Safety Review are as follows:

Stage	Project Phase	Type of Review
1	Pre-project study.	Typical hazards & environmental problems.
2	Process design.	Check design covers safety & environmental hazards.
3	Detailed engineering.	HAZOP design.
4	Construction.	Check actions from HAZOP are implemented.
5	Pre-commissioning.	Check safety standards are met.
6	Post start-up check.	Check on operation.

Stages 1 & 2 of the Safety Review for all aspects of the Feed Flexibility Project have already been completed. Stages 3-6 will be completed following project approvals. The HAZOP studies and Piping and Instrument Diagrams would be made available to EPA.

All mechanical work carried out on the Refinery is subject to a strictly enforced permit system. Prior to commencement of work a specific site or refinery permit must be obtained and verified by the Head Operator on shift to ensure that all work conditions and safety precautions are met. Similarly, after completion of the work all conditions must be satisfied before recommissioning takes place. The permit system also encompasses refinery permits to cover special work and project situations of longer duration. The permit itself specifies the safety precautions necessary to avoid hazardous situations.

The following Refinery Management Systems will be developed prior to commissioning the units constructed or modified as part of the Feed Flexibility Project:

- manual of hazardous material data sheets,
- written operating procedures,
- routine maintenance, startup and shutdown, and emergency procedures,
- training for employees in the operation, maintenance and safety of the units,
- incident reporting/investigation systems,
- equipment testing/inspection schedules,
- alarm and trip testing procedures and schedules,
- periodic auditing programme.

The Hazards Management Process applied to the Feed Flexibility Project will be consistent with guidelines established by the Safety Coordinator, Explosives and Dangerous Goods Division, Department of Mines.

6.5.2 Reporting and Documentation.

All stages of the formal Safety Review are documented in the project files and are copied to BP's Head Office in London. Internal auditing takes place during stage six of the Safety Review procedure with documentation sent to BP London and also filed in the project files held at Kwinana Refinery. Being part of an International organisation, the Refinery has access to equivalent information and associated expert experience from other refineries and affiliates worldwide on which to base our Safety and Environmental strategy.

6.5.3 Regulatory Responsibility.

Presently reporting is to BP's Head Office in London for consideration and review by BP London senior safety experts. Consultation with the West Australian Department of Mines takes place on relevant safety issues.

CHAPTER 7

ENVIRONMENTAL MANAGEMENT COMMITMENTS

7.1 INTRODUCTION

A number of commitments have been made directly or inferred during preceding sections. This chapter presents a summary of all commitments made by BP Refinery Kwinana. Each commitment has been individually numbered to facilitate their transfer into Ministerial conditions which are legally enforceable under the Environmental Protection Act 1986.

7.2 GENERAL

(1) BP Refinery Kwinana will adhere to the Project as assessed by the Environmental Protection Authority and will fulfil the commitments made below.

(2) The modifications will be constructed and operated according to relevant Government statutes and agencies requirements, including those of the following:

- Environmental Protection Authority
- Water Authority of WA
- Health Department of WA
- Department of Occupational Health, Safety and Welfare
- Town of Kwinana

(3) The Hazard Management Process applied to the project will be consistent with guidelines established by the Safety Coordinator, Explosives and Dangerous Goods Division, Department of Mines.

7.3 CONSTRUCTION

(4) All construction materials and practices will be in accordance with the relevant Australian standards and/or BP Codes of Engineering Practice, whichever is the most stringent.

(5) Noise levels will comply with the requirements of the Department of Occupational Health, Safety and Welfare, as they relate to the construction workforce and the public, and with the requirements of the Environmental Protection Authority.

(6) Dust suppression watering practices will be adopted to minimise dust generated during construction activities. Dust levels will comply with the requirements of the Department of Occupational Health, Safety and Welfare and the Environmental Protection Authority.

(7) Close liaison will be maintained with local authorities to ensure that noise, dust and traffic impacts are minimised.

(8) BP Refinery Kwinana will update emergency procedures and response plans prior to commissioning. These procedures and response plans will be consistent with Department of Mines guidelines and be available for review by the Environmental Protection Authority and Department of Mines.

(9) An Audit of the Hazards Management Process carried out in accordance with guidelines agreed with the Safety Coordinator, Department of Mines; will be completed prior to commissioning and made available to the Department of Mines.

(10) Upon completion HAZOP studies and Piping and Instrument Diagrams will be made available to the Environmental Protection Authority and the Department of Mines.

7.4 OPERATIONAL

(11) BP Refinery Kwinana will design and operate the plant so as to control noise generation and noise levels at the boundary of the Refinery at all times to the satisfaction of the Environmental Protection Authority.

(12) Ongoing control of dust will be implemented to ensure that dust levels do not affect the workforce or the public, and satisfy the Department of Occupational Health, Safety and Welfare and the Environmental Protection Authority.

(13) The Refinery will undergo regular preventative maintenance to minimise unplanned shutdowns due to plant failure.

(14) All solid waste will be disposed of in accordance with the statutory requirements of the Health Department of WA and be to the satisfaction of the Environmental Protection Authority.

(15) All employees will be trained in the safe work practices and emergency procedures appropriate to their role in the operation of the Refinery and the handling of associated materials.

(16) If a Sulphur Recovery Unit suffers an unplanned shutdown, hydrogen sulphide rich gas will be directed to the other Sulphur Recovery Unit with any excess gas initially sent to the Refinery fuel gas main. Refinery process unit throughputs will then be adjusted, as quickly as is practicable, in order to meet Environmental Protection Authority licence conditions.

(17) BP Refinery Kwinana will ensure that, should emissions of sulphur dioxide from the Refinery occur, or be likely to occur, which exceed the requirements of the Draft Environmental Protection Policy for Sulphur Dioxide and Dust in the Kwinana region, then all appropriate operational and management steps will be taken to ensure that sulphur dioxide emissions are reduced to levels acceptable to the Environmental Protection Authority.

(18) Routine shutdowns of the Sulphur Recovery units will be planned to coincide with those of the Hydrofiners and Residue Cracker units, the major sources of hydrogen sulphide, in order to minimise sulphur dioxide emissions and meet Environmental Protection Authority licence conditions.

(19) In the advent of an unplanned shutdown of the new Refinery Sour Water Stripper, sour water will be directed to the existing Sour Water Stripper and process unit throughputs adjusted, as quickly as is practicable, to meet the reduced capacity of the old unit and Environmental Protection Authority licence conditions.

7.5 OTHER COMMITMENTS

(20) BP Refinery Kwinana will modify its pollution control operations so that environmental impacts are reduced to a level acceptable to the Environmental Protection Authority.

(21) BP Refinery Kwinana will co-operate with the Environmental Protection Authority to assist in achieving the air quality standards and limits as proposed in the Draft Environmental Protection Policy for Sulphur Dioxide and Dust in the Kwinana region.

(22) BP Refinery Kwinana will submit reports as required to the Environmental Protection Authority documenting the results of monitoring programmes, and will immediately advise the Environmental Protection Authority of any unplanned events, as they occur, that may adversely impact upon the surrounding environment.

(23) BP Refinery Kwinana will engage Technica Ltd to update the Refinery database for the Kwinana Cumulative Risk Analysis within 12 months of approval of this Project and provide the results to the government agency responsible for the cumulative risk study.

(24) BP Refinery Kwinana will continue to participate in and contribute to the development of the Kwinana Integrated Emergency Management System.

(25) Regular internal safety and environmental audits will be conducted to assess the effectiveness of BP Refinery Kwinana's commitments to safeguard and protect the workforce, public and the environment.

(26) BP Refinery (Kwinana) Pty Ltd will, within two years of the issue of Works Approval for this Project, submit to the Environmental Protection Authority a modernisation plan to substantially upgrade the Refinery wastewater treatment system.

(27) The following management systems will be developed prior to commissioning the units constructed or modified as part of this Project:

- manual of hazardous material data sheets
- written operating procedures
- routine maintenance, startup and shutdown, and emergency procedures
- incident reporting/investigation systems
- equipment testing/inspection schedules
- alarm and trip testing procedures and schedules
- periodic auditing programme.

(28) BP Refinery (Kwinana) Pty Ltd will provide an accurate annual estimate of greenhouse gas emissions to the Environmental Protection Authority each year.

(29) Reports will be provided to the Environmental Protection Authority quarterly on progress of the development of the Project and annually on the operation of the new plant after commissioning. Reporting will include advice to the Environmental Protection Authority on the fulfilment of any Ministerial Conditions; and commitments given by BP Refinery (Kwinana) Pty Ltd.

(30) BP Refinery (Kwinana) Pty Ltd will be responsible for decommissioning the Refinery and rehabilitating the site and its environment, to the satisfaction of the Environmental Protection Authority.

(31) BP Refinery (Kwinana) Pty Ltd will, at least six months prior to decommissioning, prepare a decommissioning and rehabilitation plan to the satisfaction of the Environmental Protection Authority.

CHAPTER 8

CONCLUSIONS

The proposed Feed Flexibility Project does not involve any significant additional environmental impacts or risks not already associated with current BP Refinery Kwinana operations. The Project will not generate any additional gaseous, liquid or solid wastes that cannot be safely disposed of in an environmentally sensitive manner. The Feed Flexibility Project will significantly improve the quality of wastewater discharged to Cockburn Sound and reduce atmospheric emissions of particulates and odorous mercaptans. The proposed Project will also significantly reduce the likelihood of high sulphur dioxide emissions as a second Sulphur Recovery Unit will be constructed.

An extensive set of management commitments has been outlined, encompassing shutdown procedures, safety features, hazard and risk management, operational philosophies and monitoring. BP Refinery Kwinana is committed to ensuring that the Refinery complies with all statutory requirements and minimises impacts on the surrounding communities and the environment.

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APPENDIX A

EPA GUIDELINES

GUIDELINES FOR THE PUBLIC ENVIRONMENTAL REPORT ON THE FEED FLEXIBILITY PROJECT, BP OIL REFINERY, KWINANA

These guidelines identify issues that should be addressed within the Public Environmental Review (PER). They are not intended to be exhaustive and the proponent may consider that other issues should also be included in the document.

The PER should facilitate public review of the key environmental issues. 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 may be appropriate to include ancillary or lengthy information in technical appendices.

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

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 programs, 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 PER.

3. NEED FOR THE PROPOSAL

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.

4. EVALUATION OF PERFORMANCE OF EXISTING PLANT

A brief discussion on the environmental history and performance of the existing plant should be given. Emphasis should be given to remedial action the company has taken to control gas emissions and odours in the past. Additionally, there should be details provided on the history of managing hazards and risks at the plant.

5. LOCATION

This section can be very brief as the proposal is to carry out engineering work on an existing site. This section is necessary however so that the reader can quickly put the location of the plant into a regional context.

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;
- location of discharges to Cockburn Sound; and
- provision of services, including drainage.

6. PROCESS DESCRIPTION

There should be a clear description of the process and existing plant associated with the proposal using diagrams where appropriate. An indication of the ultimate proposed capacity of the plant should be provided. Changes (at a later date) to the ultimate capacity as stated in the PER, may require additional assessment. Operational times should also be outlined.

7. GASEOUS EMISSIONS, WASTEWATER AND SOLID WASTE TREATMENT AND DISPOSAL

The PER should discuss the treatment and disposal of waste gases, solids and effluent associated with this development.

The PER should include:

- compliance with the requirements of the Environmental Protection Authority letter dated 28 September 1990 on "AIR MODELLING FOR FEED FLEXIBILITY PER" (attached);
- a description of gaseous emissions, volumes, composition and points of emission (eg. stack heights and diameter, exit velocity of gases, etc.);
- a statement on the greenhouse gases to be emitted;
- a description of the nature of any other waste including source, volume, composition;
- a description of the treatment of the wastes (solids and gases) generated as a result of this development, leading to the rationale for the selected option;
- a brief explanation of BP's two year plan to modernise its complete wastewater treatment system and how it fits into this proposal;
- a review of alternative waste disposal methods (where relevant) and strategies considered for treating wastes generated as a result of this development, leading to the rationale for the selected option;
- a description of the method of disposal of waste including the frequency of disposal, location of disposal and composition of effluent at final treatment;
- an indication of the ultimate volume of waste and effluent to be treated and disposed;
- an indication of the extent to which waste will be recycled;

- an outline of any backup treatment and disposal system; and

- disposal of solid waste on and off site. This would include sludge buildup in the wastewater treatment tanks and storage of spent chemicals.

8. SITE AND EFFLUENT IMPACTS AND MANAGEMENT

This section should describe, briefly, the overall effect on the environment of the Refinery with its proposed modification. 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.

The PER should also indicate approaches that will be adopted to ameliorate and manage the identified impacts. Issues that should be addressed include:

- impact of the gaseous emissions, odour, dust and effluent on the receiving environment as a result of this development;

- procedures to be adopted in the event of plant or waste disposal system breakdown;

- procedures used to ensure that the waste treatment system operates efficiently and effectively;

- consideration of related site management, such as stormwater disposal etc.; and

- risks and hazards.

It should be noted that air emissions and wastewater discharge to Cockburn Sound are two of the key issues and the impacts of this development on air emissions and wastewater discharge should be addressed in considerable detail.

9. MONITORING

The air emissions and wastewater treatment and disposal system will require monitoring to ensure that they are operating efficiently. The specification of the monitoring systems should be given and responsibility for the operation of that system should be assigned.

10. 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 is responsible for the commitment and who will do the work, b) what is the nature of the work, c) when the work will be carried out, d) where will the work be carried out (if relevant) and e) to whose satisfaction the work will be carried out.

In addition, a standard commitment regarding decommissioning the plant is requested by the Authority. The substance of the commitment can be seen in the recommendations of recent Environmental Protection Authority assessment reports. A set of well written commitments covering the key environmental issues of the proposal will help to expedite the proposal.

As the wastewater issue above is part of the much larger issue of wastewater from the plant in general, the Authority requests the proponent to make the following commitment:

> The proponent, as part of its five year company strategy, will within two years of publication of this report, submit to the Environmental Protection Authority for assessment, modernisation plan to substantially upgrade the wastewater treatment system.

Similarly, for risk and hazards, the PER should cover the points as set out in your letter of 21 September 1990. In particular, your commitment to a Hazard Management Programme should be detailed and be to the satisfaction of the Environmental Protection Authority on advice of the Department of Mines.

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

EPA

AN ENVIRONMENT WORTH PROTECTION

Dr Rod Lukatelich
Environmental Manager
BP Refinery (Kwinana) Pty Ltd
PO Box 131
KWINANA WA 6167

Your ref:
Our ref:
Enquiries Dr Ken Rayner
Fax: 221 2147

Dear Dr Lukatelich

AIR QUALITY MODELLING FOR FEED FLEXIBILITY PER

This letter follows a conversation with Mr John Yates on 27 September 1990, in which we outlined our requirements for air quality modelling in the PER. A summary of our requirements is as follows.

It will be necessary for BP to employ the services of a consultant who has access to the computer model DISPMOD which accounts for the complex dispersion patterns within onshore flow, unless a suitable alternative model can be found which performs as well to the EPA's satisfaction.

Model simulations will need to include best estimates of all known sources of sulphur dioxide in the Kwinana area in order to give representative predictions of cumulative ambient concentrations. We will provide to a consultant of your choice an emissions data file for the model DISPMOD. These data will reflect our best understanding of current emissions from various industries, erring on the side of conservatism to offset uncertainty. We will provide these data on the understanding that they are not to be published or otherwise released. In the event that the modeling results prove to be unfavourable you should feel free to request discussions with us to review the emissions data.

The modelling results which we wish to see in the PER are as follows:

The highest estimates of refinery sulphur dioxide emissions (excluding plant failure) should be included with the emissions of other industries to produce contour maps of the 99.9 percentile and maximum concentrations, which should be compared to the Kwinana EPP standards and limits respectively. The 99.9 percentile results are the most credible. This modelling work should take account of the points raised in my letter to Mr John Yates dated 27 September 1990 (copy attached).

It will also be necessary to present an analysis, possibly verbal, of the impact of high sulphur dioxide emissions accompanying plant failure (eg, loss of one of the sulphur recovery units). The appropriate procedures to achieve this for each identified failure case are as follows:

1. estimate the probability of the high emissions occuring (number of hours per year),

2. do a model run with the failure case emissions held constant for the whole year, together with emissions from all other Kwinana industry but excluding any emergency emissions from these other industries, and generate results for the number of exceedences, at each model grid point, of the relevant standard and limit (this is a standard output of DISPMOD),

Environmental Protection Authority

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3. select the highest exceedence frequency in each policy zone and multiply it by the plant failure probability in order to give a representative estimate of the frequency of exceedence in each policy zone of the standard and limit. To be acceptable to the EPA, these frequencies would need to be very much smaller than once per year in relation to limits and nine times per year in relation to standards.

In relation to other gases or particulate emissions, the PER should address any proposed changes to emissions and, if increases are to occur, assess these relative to NHMRC emission limits and whatever information is available from ambient monitoring. Modelling should be conducted if it is apparent that increases in emissions may cause ambient concentrations to reach a sizable fraction of normally acceptable standards (eg. Victorian EPA standards).

The meteorological data file employed in our EPP modeling work is the best available and should be used for all model runs.

Please contact Dr Ken Rayner on 222 7102 if you have any further queries.

Yours sincerely

Peter Browne-Cooper
DIRECTOR
POLLUTION CONTROL DIVISION

28 September 1990

Att.

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APPENDIX B

ABBREVIATIONS

AND

SYMBOLS

MEASUREMENTS

Technical units of measurement in this report are based on the International System of Units (SI) wherever possible. The technical units may be broadly grouped as prefixes and measurements. A prefix applies to the unit of measurement that immediately follows it - for example microgram is abbreviated as μg. Superscripts ^{2} and ^{3} following a linear unit indicate area and volume - for example m^2 (square metres) and m^3 (cubic metres). Different units are combined by a full stop (.) to differentiate units of the same exponential sign, and a solidus (/) to indicate 'per'. For example, megalitres per day is abbreviated as ML/day.

The prefixes used in this report are:

M	mega	1,000,000
k	kilo	1,000
m	milli	0.001
μ	micro	0.000001

Units of measurement which have been used are:

D	day
dBA	decibel, frequency weighting network A
°C	degrees Celsius
g	gram
ha	hectare
l	litre
t	tonne
TPD	tonnes per day
Pa	pascal (100 kPa = 1 atmosphere of pressure)
KTA	kilotonnes per annum
ppm	parts per million by volume
ppb	parts per billion by volume
pH	degree of alkalinity/acidity
m	metre
s	second
Leq	equivalent sound power level
%	percent

MISCELLANEOUS

API#1	American Petroleum Institute Standard Design Separator No.1 (fuels)
API#2	American Petroleum Institute Standard Design Separator No.2 (lubes)
CDU1	Crude Distillation Unit No.1
CDU2	Crude Distillation Unit No.2
CPU	Catalytic Polymerisation Unit
CR1	Catalytic Reformer No.1 (demolished)
CR2	Catalytic Reformer No.2
DOS	Dry Oil System
FCCU	Fluid Catalytic Cracking Unit (now converted to a Residue Cracking Unit)
GRU	Gas Recovery Unit
MEROX	A licensed UOP Sweetening or Extraction process for conversion of odorous mercaptan sulphur to non-odorous disulphide.
MINALK	Minimum Alkalinity Unit; a UOP licensed sweetening process for conversion of mercaptan sulphur using minimum strength caustic solution.
OWS	Oily Water Sewer
PDA	Propane Deasphalting Unit
PPU1	Propane Production Unit No.1
PPU2	Propane Production Unit No.2
R1	Residue Cracking Unit Regenerator No.1
R2	Residue Cracking Unit Regenerator No.2
RCU	Residue Cracking Unit
SGA	Steam Generation Plan
SRU	Sulphur Recovery Unit
SWS	Sour Water Stripper
VDU1	Vacuum Distillation Unit No.1 (demolished)
VDU2	Vacuum Distillation Unit No.2

AMINE	Diethanolamine
CCS	Catalytic Cracked Spirit
CO_2	Carbon Dioxide
DEA	Diethanolamine
H_2S	Hydrogen Sulphide
HF	Hydrogen Fluoride
HGO	Heavy Gas Oil
LCO	Light Cycle Oil
LGO	Light Gas Oil
LPG	Liquified Petroleum Gas
N_2	Nitrogen Gas
NaOH	Sodium Hydroxide (Caustic Soda)

NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
O_2	Oxygen Gas
SO_2	Sulphur Dioxide
SO_x	Oxides of Sulphur
SRG	Straight Run Gasoline

ANZEC	Australian and New Zealand Environmental Council
DCE	Department of Conservation & Environment
DISPMOD	Plume Dispersion Model
EPA	Environmental Protection Authority
EPP	Environmental Protection Policy
ISRS	International Safety Rating System
KAMS	Kwinana Air Modelling Study
KIA	Kwinana Industrial Area
KIEMS	Kwinana Integrated Emergency Management System
KTC	Kwinana Town Council.
NH & MRC	National Health and Medical Research Council
OCTEL	The Associated Octel Company Ltd. An international group of companies specialising in the supply transportation and handling of organic lead compounds.
PER	Public Environmental Review
SECWA	State Energy Commission of Western Australia
SES	State Emergency Service
SWEC	Stone & Webster Engineering Corporation (RCU Licensor)
TIBL	Thermal Internal Boundary Layer
TK3	Tank Number 3
UOP	Universal Oil Products Ltd
USEPA	United States of America Environmental Protection Agency
VEPA	Victorian Environment Protection Authority
WA	Western Australia
WHO	World Health Organisation

APPENDIX C

GLOSSARY

GLOSSARY

ALKYLATE	A high octane motor gasoline blending component produced from the Hydrogen Fluoride Alkylation Unit.
ATMOSPHERIC RESIDUE	The highest boiling fraction of crude oil which leaves the bottom of the Crude Oil Distillation Unit after processing.
BARREL (Bbl)	Typical volume unit of measurement equivalent to 42 US gallons or 159 litres.
BLEED GASES	Gas removed from the system to prevent a build up of contaminants in the recycle circuit.
CATALYST	A substance that aids a reaction to take place, but remains unaffected by the reaction.
CONDENSATE	Lower boiling range hydrocarbons condensed at the Well Head and supplied to refineries as a source of light crude oil.
CONDENSATE (STEAM)	Hot water resulting from the condensation of steam used for heating purposes.
CRACKING	The refinery process used to reduce high boiling point fuel oil components to lower boiling point motor gasoline and diesel blending components.
CYCLONE	Device used for the separation of solid particles (eg catalyst) from a gas stream.
FERROFINING	Refining process used to stabilise the colour of the final lubricating base oil component.
FIXED BED CATALYST	Catalyst is supported in the reactor by means of permanent grids which prevent migration and movement of the catalyst.
FURFURAL	Chemical compound made from corn husks used to extract undesirable aromatic compounds in refining lubricating oils.
JET	Refined kerosine used as fuel for all aeroplanes fitted with Jet engines.
MERCAPTANS	Low boiling sulphur compounds naturally present in crude oil which are characterised by their unpleasant odour.

OFFGAS	Gas vented from a refinery process unit or vessel and directed to the fuel gas collection main or flare system.
ONCE THROUGH SALT COOLING WATER	Sea water pumped from Cockburn Sound, used for cooling purposes and then returned to the Sound.
OVERHEAD GAS	Uncondensed gas leaving the top of the collection vessel after cooling in the overhead condensers. The overhead stream is the lowest boiling portion of the crude oil and leaves the Crude Distillation Column at the topmost exit.
PRIMARY SEPARATION	Initial gravity separation of solid particles from a liquid.
PYROPHORIC SCALE	Scale which will spontaneously ignite or emit sparks if dry and put in contact with air or oxygen.
REFORMATE	High octane motor gasoline blending component produced from the Catalytic Reforming process.
RESIDUE	That portion of crude oil remaining after distillation or evaporation of the lower boiling fractions. Generally the higher boiling fractions which are directed to the Residue Catalytic Cracking Unit for conversion from fuel oil components to motor gasoline and diesel blending components.
SLACK WAX	The high melting point paraffin waxes removed in the refining of lubricating oils.
SOLVENT	Chemical compounds used in the refining of lubricating oils for precipitation of the paraffin waxes or slack wax from the lubricating oil stream.
SOLUTISER	Equipment used for removal of sulphur compounds, chiefly hydrogen sulphide and mercaptans, from the low boiling fractions distilled in the Crude Distillation Unit.
SOUR WATER	Fresh water which has been contaminated with sulphur (hydrogen sulphide) or nitrogen (ammonia) compounds and has an offensive odour.
SPENT CAUSTIC	Caustic Soda (Sodium hydroxide) solution which has been used to remove sulphur compounds, chiefly hydrogen sulphide and mercaptans, from various hydrocarbon streams. It can contain varying degrees of sulphides and mercaptides as well as phenolic compounds.

STEAMING OUT	The process by which steam is used to vaporise and remove traces of hydrocarbons in process vessels prior to opening the vessels for entry or inspection.
STENCHING	The dosing of liquified petroleum gas (LPG) with minute quantities of ethyl mercaptan in order to provide a means of identifying leaking equipment by the unpleasant smell.
SWEETENING	The process of converting the odorous mercaptans in the lower boiling fractions to non-odorous sulphur compounds (eg disulphides).
VISCOSITY	The measurement of the property of a fluid to resist changes in shape when a force is applied.