Increase in Tiwest pigment plant production capacity to 80,000 tonnes per annum

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Tiwest Joint Venture

Report and recommendations
of the Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
Bulletin 778
May1995

FDR

THE PURPOSE OF THIS REPORT

This report contains the Environmental Protection Authority's environmental assessment and recommendations to the Minister for the Environment on the environmental acceptability of a proposal.

Immediately following the release of the report there is a 14-day period when anyone may appeal to the Minister against the Environmental Protection Authority's report.

After the appeal period, and determination of any appeals, the Minister consults with the other relevant ministers and agencies and then issues his decision about whether the proposal may or may not proceed. The Minister also announces the legally binding environmental conditions which might apply to any approval.

APPEALS

If you disagree with any of the contents of the assessment report or recommendations you may appeal in writing to the Minister for the Environment outlining the environmental reasons for your concern and enclosing the appeal fee of $10.

It is important that you clearly indicate the part of the report you disagree with and the reasons for your concern so that the grounds of your appeal can be properly considered by the Minister for the Environment.

ADDRESS

Hon Minister for the Environment
12th Floor, Dumas House
2 Havelock Street
WEST PERTH WA 6005

CLOSING DATE

Your appeal (with the $10 fee) must reach the Minister's office no later than 5.00 pm on **25 May 1995**.

Environmental Impact Assessment (EIA)

Process Timelines in weeks

Date	Timeline commences after receipt of full details of proposal from the proponent	Time (weeks)
17/8/94	Proponent Document Released for Public Comment	4
14/9/94	Public Comment Period Closed	
11/10/94	Issues Raised During Public Comment Period Summarised by EPA and Forwarded to the Proponent	4
4/1/95	Proponent's response to issues raised received	12
25/5/95	EPA reported to the Minister for the Environment	13

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Summary and recommendations

The Tiwest Joint Venture (TJV), the proponent, proposes to increase the production of finished titanium dioxide pigment at its Kwinana Pigment Plant from 64,000 to 80,000 tonnes per annum (tpa) by undertaking a "debottlenecking" process.

The TJV proposal was received by the Environmental Protection Authority (EPA) in April 1994. The EPA set the level of assessment at Consultative Environmental Review (CER).

The major environmental issues identified during the assessment of the titanium dioxide pigment plant debottlenecking project were:

- atmospheric discharges of sulphur dioxide (SO_2), other reduced sulphur compounds such as hydrogen sulphide (H_2S) and carbon oxy-sulphide (COS), and nitrogen oxides (NO_x);
- marine impacts from wastewater discharges to Cockburn Sound;
- noise emissions;
- radiation; and
- the individual risk of fatality from the plant to the surrounding area.

The proponent's commitments (Section 6) address many of the environmental issues associated with the debottlenecking proposal. The EPA has recommended further Environmental Conditions relating to wastewater re-use, noise and risks and hazards.

The EPA is aware that from time to time odorous gaseous emissions occur. The EPA considers that the proponent should maintain optimum scrubbing efficiency on caustic scrubbing equipment on the existing and proposed Waste Gas Incinerators, to the requirements of the Department of Environmental Protection, except in cases such as planned maintenance operations. As this issue can be managed through Part V of the EP act 1986 (licensing), the EPA has not made a recommendation on the issue.

Following examination of the CER and additional information supplied by the proponent, and conducting its own investigations into various aspects of the proposal, the EPA considers that it is environmentally acceptable to debottleneck the existing Kwinana Pigment Plant to a production capacity of 80,000 tpa of finished titanium dioxide pigment subject to the proponent's commitments and the Environmental Protection Authority's recommendations in this assessment report.

The EPA understands that Tiwest may be considering further expansions to the Kwinana Pigment Plant in the near future. To avoid unnecessary referrals and to alleviate the need for assessment at every stage of expansion the EPA has commented on an approach regarding future expansions (Section 4.8).

Recommendation Number	Summary of recommendations
1	The Environmental Protection Authority has considered the proposal by the Tiwest Joint Venture to increase the production capacity of the Kwinana Pigment Plant from 64,000 tpa to 80,000 tpa of finished titanium dioxide pigment via a de-bottlenecking process. The Environmental Protection Authority recommends that the proposal be considered environmentally acceptable, subject to: • the Environmental Protection Authority's recommendations in this report (Section 4); and • the proponent's consolidated list of environmental management commitments (Section 6).
2	The Environmental Protection Authority recommends that the Recommended Environmental Conditions (Section 6) be the sole conditions for the proposal by the Tiwest Joint Venture to increase the production capacity of the Kwinana Pigment Plant from 64,000 tpa to 80,000 tpa, and that they supersede all previous Ministerial Environmental conditions for the project.
3	The proponent should examine methods of reducing water consumption, including wastewater re-use and recycling, and on-site treatment and re-use, at the pigment plant. To this end, the proponent should submit a report of this examination to the Environmental Protection Authority and the Water Authority of Western Australia for their approval, within six months of any approval of the 80,000 tpa upgrade.

4	To meet the risk criteria established by the Environmental Protection Authority in Bulletin 627, the proponent should ensure that the recommendations (1.3.1 to 1.3.3) contained in the VRJ (1994) hazard and risk assessment are implemented. These are: 1. A testing program for all critical trip systems should be introduced to the plant. The introduction of this system would lead to a further reduction in risk levels for the plant. 2. In addition to recommendation 1.3.1, a hazard and demand frequency (trip testing) review should be undertaken. This, together with the results of this hazard and risk analysis, will assist in determining a priority procedure for critical trips throughout the plant. 3. The six LPG vessels are considered to be a high risk area. Their alignment is towards the plant which is considered to be an unacceptable exposure. VRJ believe that these vessels should be replaced with a storage configuration utilising larger vessels. Any alteration should first be evaluated within the context of this hazard and risk analysis study before proceeding. Aspects of the Total Hazard Control Plan for the Tiwest pigment plant that relate to off-site releases should also include the adjacent chlor-alkali plant, such that both plants will have a co-ordinated emergency response in the event of an off-site release. The emergency response procedures that relate to both the Tiwest Pigment Plant and the adjacent chlor-alkali plant should be to the requirements of the Department of Environmental Protection and the Department of Minerals and Energy.

1. Introduction and background

1.1 Background information

The Tiwest Joint Venture (TJV), the proponent, formerly known as the Cooljarloo Joint Venture, is a joint venture between Kerr-McGee Chemical Corporation and Ticor Resources Pty Ltd (formerly Minproc Resources Pty Ltd). The joint venture has developed a fully vertically integrated titanium minerals processing project in Western Australia based on mineral sands extracted from the Cooljarloo mine near Cataby. The project consists of:

- a mineral sands mine at Cooljarloo, 170kms north of Perth;
- a dry separation and synthetic rutile plant at Chandala, 60kms north of Perth; and
- a titanium dioxide pigment plant at Kwinana, 40kms south of Perth (Figure 1).

Each of the above operations has been subject to a previous formal assessment by the Environmental Protection Authority (EPA). The titanium dioxide pigment plant was assessed in 1989 (EPA Bulletin 373) and 1994 (EPA Bulletin 742).

The TJV integrated mineral sands mining and processing project is subject to a State Agreement in the "Western Australian Government Mineral Sands (Cooljarloo) Mining and Processing Agreement Act, No. 68 of 1988".

An Environmental Review and Management Programme (ERMP) was released for the Kwinana Pigment Plant in July 1988. The ERMP was assessed by the EPA in its report and recommendations on the proposal (EPA Bulletin 373, 1989). In April 1989, the Minister for the Environment issued a Ministerial Statement that the proposal by the TJV to construct and operate a 54,000 tonnes per annum (tpa) Titanium Dioxide Pigment Plant at Kwinana, could be implemented (Appendix 1). A works approval, and subsequently a licence, were issued to the proponent to construct and operate the works. Operations at Kwinana commenced in 1991.

In January 1994 the TJV submitted a proposal to increase production from 54,000 tpa to 64,000 tpa by "debottlenecking" certain areas of the Pigment Plant. This proposal required a Section 46 amendment to Condition 1 of the Ministerial Condition Statement of 26 April 1989, which restricted the original plant to 54,000 tonnes per annum, as assessed by the Environmental Protection Authority in Bulletin 373.

In accordance with Section 46(1) of the Environmental Protection Act, the EPA issued its report and recommendations to the Minister for the Environment (EPA Bulletin 742) in June 1994. Amended Environmental Conditions were published on 19 August 1994 (Appendix 2).

1.2 The proposal

The proponent now proposes to undertake a further "debottlenecking" proposal so that the plant can be up-rated from 64,000 tonnes to 80,000 tonnes per annum of finished titanium dioxide pigment.

The Environmental Protection Authority set the level of assessment for this debottlenecking proposal at Consultative Environmental Review (CER).

2. Summary description of proposal

2.1 Overall debottlenecking concept

The Tiwest Joint Venture has proposed a debottlenecking programme so that the plant can produce 80,000 tpa of finished titanium dioxide pigment.

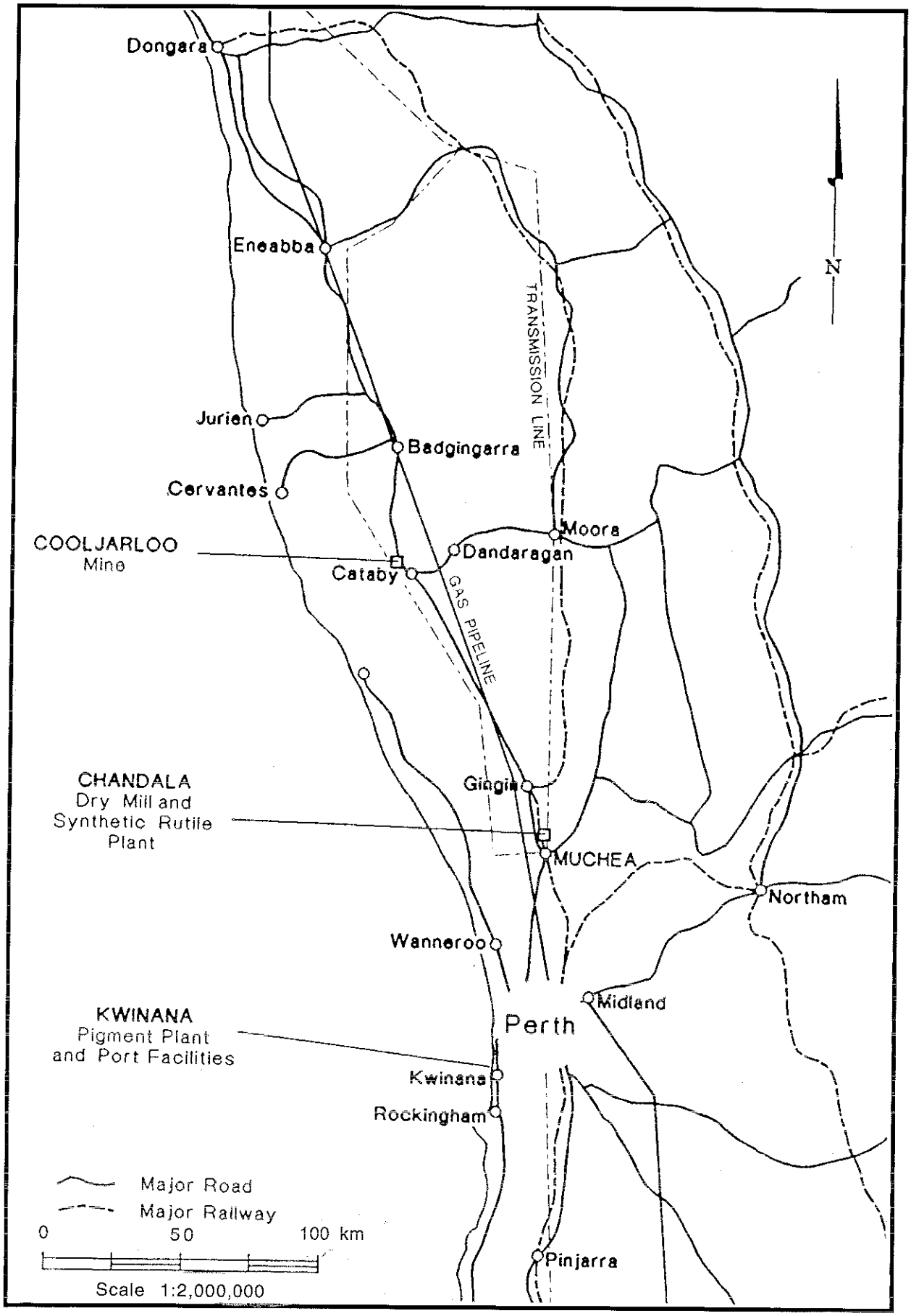

Figure 1: Cooljarloo, Chandala and Kwinana locality map.

The debottlenecking proposal calls for upgrading and modifications to various areas of the plant. The aim of the project is to streamline areas of the existing production process which presently inhibit production. These inhibiting areas are associated with a number of prevailing process conditions (Tiwest Joint Venture, 1994), and include the following:

- blockages of the chlorinator beds ;
- frequency of maintenance. Plant items such as the methanol chillers require a high degree of maintenance and it is proposed to remove these chillers, reducing downtime. It is proposed to modify the chlorinator bed and distributor plate to reduce maintenance. Maintenance will also be reduced by increasing the diameter of pipework to the titanium tetrachloride superheaters and pigment treatment tanks.
- throughput capacity. Additional capacity is required for titanium tetrachloride storage and pumping as well as the heat exchanger system to reduce pressure drops through the condensation system;
- ancillary process inputs. A second aluminium chloride mixing tank is required. The pumps and pipework to the titanium dioxide pigment treatment tanks require upgrading as well as the capacity of the plant air compressor circuit; and
- waste management. Extra capacity is required to handle the increased volumes of waste process gases as well as liquid and solid wastes.

Table 1 summarises the modifications that are proposed as part of the project (Tiwest Joint Venture, 1994).

TABLE 1 PROPOSED MODIFICATIONS FOR DEBOTTLENECKING PROJECT

Location	*Description of Works*
Unit 100	SYNTHETIC RUTILE AND COKE HANDLING
	° No change.
Unit 200	CHLORINATION, CONDENSATION AND PURIFICATION
	° Install second waste gas incinerator and waste heat boiler.
	° Modify chlorinator.
	° Upgrade condensing recirculation pumps.
	° Install additional heat exchangers.
	° Install fourth $TiCl_4$ storage tank.
	° Install spare hydrochloric acid scrubber with bypass pipework.
Unit 300	OXIDATION
	° Install second aluminium chloride mixing tank.
	° Replace chillers with larger heat exchanger.
	° Increase pipe diameter to superheaters.
	° Install fourth vaporiser.
	° Install additional chlorine gas compressor.
	° Install second sulphuric acid scrubber with pipework and valves
	° Install third demister element.
	° Install spare aluminium chloride bag hoist.
Unit 400	FINISHING
	° Upgrade treatment tank feed and discharge pumps.
	° Install second fines cyclone cluster.
	° Redesign course cyclone cluster.
	° Install duplicate bucket elevator.
	° Upgrade bagging capacity.
Unit 500	UTILITIES AND CHEMICAL STORAGE
	° Install third plant air compressor.
	° Upgrade capacity of cooling utilities.
Unit 600	WASTE TREATMENT
	° Install four additional filtration units.
	° Increase capacity of ocean outfall pump.
Unit 700	OTHER
	° Upgrade Capacity of Distributed Control System.
	° Upgrade motor control centres.

Figure 2 illustrates the locations of these proposed modifications on the Pigment Plant site.

The major plant modifications that have the potential for significant environmental impact are discussed in sections 2.2 to 2.3, below. Other proposed plant modifications detailed in the CER (Tiwest, 1994) required for the 80,000 tpa upgrade, are summarised in Appendix 3.

2.2 Unit 200 - Chlorination, condensation and purification

In Unit 200 synthetic rutile and chlorine gas are reacted together to produce titanium tetrachloride ($TiCl_4$). The processes involved in Unit 200 are chlorination of the synthetic rutile and condensing and purification of liquid $TiCl_4$. The proposed modifications to Unit 200 are given below.

Installation of a second Waste Gas Incinerator and Waste Heat Boiler

Under normal plant operating conditions, all chlorinator process waste gases pass through the primary Waste Gas Incinerator (WGI), the waste heat boiler, venturi scrubber and sulphur dioxide scrubber before venting to the atmosphere via the main stack.

Under certain current plant operating conditions, the steam capacity of the waste heat boiler may be exceeded, and under these conditions it is necessary to "load share". Under the load sharing arrangement, part of the waste gas stream is diverted to the Standby Thermal Oxidiser (STO) before venting to the atmosphere. The STO does not have a venturi or sulphur dioxide scrubber, hence sulphur dioxide discharges increase during load sharing.

The existing waste gas incineration system and waste heat boiler is unable to accommodate production levels to 80,000 tpa.

It is proposed to install a second Waste Gas Incinerator (WGI) with venturi scrubber, sulphur dioxide scrubber, demister, stack and waste heat boiler. The combined capacity of the existing and proposed WGI's will accommodate a production rate greater than 130,000 tpa.

Normally, both WGI's will be operated together. When one WGI trips out or is shut down for planned maintenance, the other WGI will be used in conjunction with the STO. The implications are, that under most foreseeable situations, there will be no need to use the emergency stack.

Tables 5.3 and 5.4 of the CER show a comparison of maximum theoretical emissions under various operation conditions for the 64,000 tpa and 80,000 tpa production rates respectively.

Installation of a fourth $TiCl_4$ storage tank

On-site storage of $TiCl_4$ provides a buffer for continued operation of the oxidation section and allows maximum use to be made of the Nufarm-Coogee chlor-alkali plant capacity. It is proposed to increase $TiCl_4$ storage from three to four tanks to accommodate the 80,000 tpa upgrade. This modification will enable continued operation of the oxidation section for up to three days while the chlorination section is shutdown. Increased $TiCl_4$ storage will allow the chlor-alkali plant to be operated at maximum capacity for longer periods, thus optimising its performance while maintaining minimum inventories of liquid chlorine.

2.3 Unit 600 - Waste treatment

Unit 600 consists of the wastewater treatment plant, waste gas incinerators, sulphur dioxide scrubber and demister, and solid waste disposal area. Modifications proposed for Unit 600 are given below.

Installation of four additional filtration units

The capacity of the existing wastewater treatment filtration circuit is insufficient to accommodate production to 80,000 tpa. It is proposed to install four additional filtration units to meet the increased production rate.

Increase capacity of ocean outfall pump

The increased volumes of wastewater generated from the proposed plant upgrade will require an improvement in pumping capacity to discharge this effluent to the ocean (Cockburn Sound). It is proposed to increase pumping capacity by installing a larger motor and impeller on the existing pump.

The wastewater volumes discharged to Cockburn Sound are expected to increase from an average of 6.4 megalitres per day in 1994 (Tiwest *pers. comm.*, 1995) to approximately 9 megalitres per day for the proposed upgrade. The concentrations of metals in the wastewater discharge is not expected to increase. This is discussed further in Section 4.4.

3. Environmental impact assessment method

3.1 General

The proposal was referred to the EPA in April 1994, and has been assessed under the provisions of Part IV of the Environmental Protection Act 1986.

The environmental impact assessment for this proposal followed the *Environmental impact assessment administrative procedures 1993* (Department of Environmental Protection, 1993a).

The proponent's Consultative Environmental Review (CER) was released for a four week public review period from 17 August 1994 to 17 September 1994.

The Department of Environmental Protection (which administers the environmental impact assessment process for the EPA) reviewed all submissions made on this proposal and prepared a list of environmental issues raised in submissions. A list of submitters is provided in Appendix 7. The TJV has provided a response to the environmental issues raised in submissions (Appendix 4), and a consolidated list of environmental management commitments for the Tiwest Kwinana Pigment Plant (Section 6).

Limitation

This evaluation has been undertaken using information currently available. The information has been provided by the proponent through preparation of the environmental review document (in response to guidelines prepared by the DEP), by DEP officers utilising their own expertise and reference material, by utilising experience and information from other State Government agencies, and by contribution from Environmental Protection Authority members.

The Environmental Protection Authority recognises that further studies and research may affect the conclusions. Accordingly, the EPA considers that if the proposal has not been substantially commenced within five years of the date of this report, then such approval should lapse. After that time, further consideration of the proposal should occur only following a new referral to the EPA.

3.2 Public submissions

The proponent's CER document was available for public comment for a period of four weeks between 17 August 1994 and 14 September 1994. Comments were sought on the proposal from the public, community groups and local and State Government Authorities.

There were four submissions received (Appendix 7). The environmental issues of concern in the submissions related to:

- atmospheric discharges including standby stack emissions (sulphur dioxide), emergency stack usage and emergency stack emissions (carbon oxy-sulphide and hydrogen sulphide);
- emissions of nitrogen oxides (NO_X);

- effluent pond management and wastewater discharges to Cockburn Sound;
- noise;
- radiation levels and radiation management, and
- risks and hazards.

The EPA has considered the submissions received and the proponent's response as part of the assessment of the proposal.

4. Evaluation

The EPA has evaluated all the potential environmental issues identified in this report based on existing information. The principal environmental issues relate to:

- gaseous discharges (sulphur dioxide, reduced sulphur compounds and nitrogen oxides);
- effluent pond management and marine impacts;
- noise;
- radiation management; and
- risks and hazards.

The major proposed modifications to the plant have been discussed in sections 2.1 to 2.3 and a full listing of the proposed work is given in Table 1. A further description of proposed modifications is given in Appendix 3.

General evaluation framework principles

In assessing the acceptability of waste discharges to the atmosphere or water bodies, the EPA uses two complementary criteria.

First, discharges of waste must not cause an environmental impact beyond an environmentally acceptable limit. An unacceptable environmental impact is pollution, and pollution of the environment must be prevented or abated. Discharges of waste cause pollution only when their impact on the surrounding environment exceeds an acceptable limit. The limit may be defined as a concentration level in the environment, an accumulation of contaminants to an unacceptable level, or an undesirable change to the environment. This principle is provided for in Section 49 of the Environmental Protection Act, 1986.

Atmospheric environmental impacts are normally assessed via computer modelling which relies heavily on meteorological data and needs to be verified against measurements (monitoring data) of the respective air pollutants. The EPA regularly utilises guidelines from bodies such as the Australian Environment Council and National Health and Medical Research Council (AEC and NH & MRC, 1986), and the Victorian EPA, as a starting point in its assessment of ambient air quality impacts.

Guidelines from the Australian and New Zealand Environment and Conservation Council (ANZECC, 1992) are regularly used as a basis in determining potential impacts on fresh and marine waters.

Second, all reasonable and practicable measures should be taken to minimise the discharge of waste into the environment, irrespective of the magnitude of the environmental impact. Waste minimisation is central to ensuring the long term protection of the environment while preventing individual emitters from unnecessarily utilising the environment's capacity to disperse waste thereby limiting future opportunities which may be considered desirable by the community. This principle is provided for in Section 51 of the Environmental Protection Act, 1986.

4.1 Sulphur dioxide discharges

4.1.1 Objective

The Environmental Protection Authority's objective is to ensure that the ambient air quality objectives in the Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1992 are met, and the maximum permissible quantities of sulphur dioxide (SO_2) emitted by Tiwest (EPA Bulletin 644, 1992) are not exceeded.

4.1.2 Evaluation framework

The Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1992 (referred to in this report as the EPP) provides a basis for the establishment of ambient air quality objectives to protect the environment (including human health) in the municipalities of Cockburn, Kwinana and Rockingham. The EPP also provides a mechanism for effective achievement of those objectives. EPA Bulletin 644 (1992) defines the air quality objectives and associated regulations for sulphur dioxide and particulates (with the opportunity for other pollutants to be added at a later date). EPA Bulletin 644 states the maximum permissible emission of sulphur dioxide, in grams per second, for industries in the Kwinana Industrial Area, including Tiwest. Bulletin 644 has since been updated (DEP correspondence of 18 January 1995 to Kwinana Industries).

The maximum permissible emission of SO_2 from Tiwest is 77.0 grams/second from the Bypass Incinerator Stack (also known as the Standby Thermal Oxidiser, STO).

The following have been utilised to assess the impacts of sulphur dioxide impacts:

- The Environmental Protection (Kwinana) (Atmospheric Wastes) Policy (1992a);
- EPA Bulletin 644 (1992b); Development of an environmental protection policy for air quality at Kwinana;
- technical information submitted by the proponent in the CER, particularly Section 5;
- sulphur dioxide monitoring data submitted by the proponent as a requirement of licence conditions (EPP reporting requirements); and
- response to submissions raised during the formal assessment process.

4.1.3 Public submissions

Submissions related to the efficiency of the sulphur dioxide scrubber and design details of the second proposed SO_2 scrubber.

The Town of Kwinana stated that its support for the proponent's debottlenecking project was conditional on the proponent operating the plant within the parameters of the Kwinana EPP and "increasing the capacity of the waste gas incineration system so that process gases are not vented directly through the emergency stack without scrubbing".

An issue raised by the DEP relating to the efficiency of sulphur dioxide scrubbers stated:

> "The original Environmental Management Programme (Tiwest, 1989) stated that the SO_2 scrubber efficiency is 99% for a gaseous design flow rates of 22500 m^3/h and a liquid design flow rate of 90 m^3/h. Appendix B of the CER indicates that emissions from the main stack are in excess of 5 g/sec for less than 1.3 % of the time (over four days per year), indicating a scrubber efficiency as low as 72% on occasions. What are the limitations to scrubber efficiency and/or reliability that result in less than 99% SO_2 removal? Could Tiwest provide a commitment to ensure that scrubber efficiency is maintained at 99% for both the existing and proposed SO_2 scrubbers? What management procedures would be

implemented to ensure that scrubber efficiency is maintained at 99% and how would this be monitored?"

The company was asked to submit design details to the DEP of the second SO_2 scrubber in terms of engineering design parameters, process control details and maintenance schedules to confirm that best practice SO_2 removal is proposed.

4.1.4 Proponent's response

Tiwest made the following response to the submission relating to SO_2 scrubber efficiency.

> "Appendix B of the CER shows that for the period 01/12/93 to 30/06/94, the main stack emissions were less than 5 grams/second for 98.7% of the time. Calculations of the emissions rates less than 5 g/sec are imprecise, although a study currently being conducted by Dames and Moore into calibration of monitoring equipment may enable closer definition of low level emissions". The study has confirmed (Tiwest, Dames and Moore, pers. comm's., 1995) that emission rates down to 0.5 g/sec of SO_2 are now able to be measured with a higher degree of accuracy and confidence than previously determined .
>
> "Tiwest currently ensures that main stack SO_2 emissions are less than 5 g/sec, apart from short periods for system maintenance. Tiwest will operate the current and proposed scrubbing systems to ensure that this level of SO_2 removal from the main stack is maintained in an effective and economic manner. The controls on scrubber liquor chemistry that are now in place to effectively control SO_2 emission levels will be continued".

In response to questions relating to details of the second SO_2 scrubber, Tiwest commented,

> "...Tiwest plans to install a new additional scrubber with equivalent efficiency to the existing unit, with a combined joint capacity to handle production levels of 130,000 tpa. Once scrubber design is finalised, details will be reviewed with DEP prior to installation".

Commitments made by the proponent

The proponent has made commitments regarding the use of the STO in the event that both WGI's fail (Commitment 7, Section 6):

> "The existing Standby Thermal oxidiser (STO) is designed to accommodate a plant production rate of 80,000 tonnes per annum. In the event that both Waste Gas Incinerators (WGI) fail, the Proponent commits to scaling back plant production, as necessary, to ensure that all process waste gases pass through the STO, without load sharing to the Emergency Stack".

4.1.5 Evaluation

The EPA is concerned that the previously determined SO_2 emission rates less than 5 g/sec, were imprecise. However, the proponent has indicated that emission rates down to 0.5 g/sec of SO_2 are now able to be measured with a higher degree of accuracy and confidence than previously determined .

The EPA considers that more accurate determination of SO_2 levels should now enable Tiwest plant operators to maintain the operation of caustic scrubbers on the existing and proposed Waste Gas Incinerators to achieve optimum scrubbing efficiency.

Table 5.4 of the CER shows a comparison of maximum theoretical emissions under various operational conditions, at the projected production rate of 80,000 tpa. This table indicates that the maximum theoretical emission from the STO is 80.3 g/sec of SO_2, which is higher than the maximum permissible quantity of 77.0 g/sec in the EPP. This figure of 80.3 g/sec is a maximum based on the sulphur content of raw materials and is also based on the unlikely event that both WGI's have tripped out and all process gases are diverted through the STO.

Whilst it appears theoretically possible for Tiwest to exceed the maximum permissible quantity of 77.0 g/sec in the EPP, the company is bound by the legal requirements of the EPP. Tiwest have also made a commitment (Commitment 5, Section 6) to maintain atmospheric emissions to levels and standards agreed with the EPA and DEP.

The STO does not have a SO_2 scrubber system unlike the existing and proposed WGI's, and as a result produces the highest emissions of SO_2 at the Tiwest plant. Only the maximum permissible quantity of SO_2 from the Standby Thermal Oxidiser (77.0 g/sec) is defined in Bulletin 644 for the EPP. For the existing and proposed WGI to be included in the EPP, a redetermination of the maximum permissible quantities of SO_2 from the Tiwest plant would have to be undertaken.

The EPA considers that, in the event that the Department of Environmental Protection conducts a redetermination, under the provisions of the EPP, of the maximum permissible quantity of sulphur dioxide from the Standby Thermal Oxidiser, this redetermination should also include maximum permissible quantities for the existing and proposed Waste Gas Incinerators.

Until a redetermination is completed, and sulphur dioxide maximum permissible quantities are allocated for the Standby Thermal Oxidiser and existing and proposed Waste Gas Incinerators, the Department of Environmental Protection should set interim licence limits for the existing and proposed Waste Gas Incinerators.

4.2 Emergency stack usage and emissions of reduced sulphur compounds

4.2.1 Objective

The Environmental Protection Authority's objective is to ensure that the emergency stack is only used for emergency situations and that ambient ground level concentrations of reduced sulphur compounds do not cause unacceptable health or odour impacts during use of the emergency stack.

4.2.2 Evaluation framework

The following information was used to evaluate the impact of emissions from the emergency stack:

- emergency stack concentrations of reduced sulphur compounds as predicted in the ERMP for the Pigment Plant (Maunsell and Partners Pty Ltd, 1988);
- monitoring reports of emergency stack emissions;
- technical information submitted by the proponent in the CER;
- guidelines for odour threshold concentrations of reduced sulphur compounds; and
- responses to submissions raised during the formal assessment process.

Licence requirements, under the Environmental Protection Act, for the Kwinana Pigment Plant state that the emergency stack should only be used for one hour at a time, after which the plant should commence shutdown procedures, unless otherwise approved by the Director (Pollution Prevention Division). Emissions of reduced sulphur compounds (carbon oxy-sulphide (COS) and hydrogen sulphide (H_2S)) are emitted from the emergency stack when it is in operation. These gases have the potential to produce odours outside the boundary of the plant, if ground level odour threshold concentrations are exceeded.

The EPA has also received advice from the DEP that there have been occasions when Tiwest have used their emergency stack for events other than emergencies. These are not covered in licence conditions and include:

- "purging" the chlorinators. When chlorinators go off-line they may be purged with nitrogen gas to keep the beds fluidised. This allows the chlorinators to be brought back on-line quickly, reducing down time; and
- for maintenance operations.

These are discussed further in Section 4.2.5.

4.2.3 Public Submissions

Submissions related to the use of the emergency stack, emergency shutdown procedures, emergency stack emissions of carbon oxy-sulphide (COS) and hydrogen sulphide (H_2S).

Issues raised by the DEP stated:

> "Are there any other circumstances (besides total power outage) that may result in use of the emergency stack? These should be presented in a Fault Tree analysis along with frequency data".
>
> "In the absence of relevant information relating directly to COS, it is recommended that H_2S be used as a guideline. The recommended ground level concentrations for H_2S range from 0.14µg/m^3 (3 minute average, Victorian EPA) to 2.5 µg/m^3 (99.5 percentile for one hour; Dutch standard). Is the 60 minute allowable operating time still appropriate given the increased ground level concentrations of carbon disulphide (CS_2), carbon oxy-sulphide (COS) and hydrogen sulphide (H_2S)? What are the cumulative impacts of these reduced sulphur compounds? Dispersion modelling and an analysis of the cumulative effects of COS, CS_2 and H_2S emissions on the environment is required to confirm if the 60 minute allowable operating time is appropriate".

4.2.4 Proponent's response

The proponent has stated that the emergency stack has been used when power failures or power surges have caused temporary loss of the main or standby stack systems. The proponent has stated:

> "It is remotely possible that during maintenance of one of the main units, a fault could develop necessitating use of the emergency stack. If the plant is undergoing maintenance and one WGI becomes inoperative, the alternative WGI and STO would continue in use. If the second WGI became inoperative, the emergency stack would then be used. Tiwest considers the probability of such a situation developing to be extremely low... It is not Tiwest's intention to deliberately plan to use the emergency stack during maintenance".

Tiwest have further stated that:

> "There is no potential for deleterious environmental discharge at startup following an emergency shutdown".
>
> "The odour threshold for COS is 89 µg/m^3 (33 parts per billion, Centre for Waste Water Treatment Odour Research Laboratory Report 30 June 1994). Thus Tiwest does not anticipate any odour related problems outside the plant boundary".
>
> "The use of H_2S as a guideline is not considered appropriate in light of the report from the Centre for Waste Water Treatment Odour Research Laboratory".
>
> "Stack testing of emergency stack discharges during 1994 did not identify the presence of H_2S. The ground level concentration of COS at the plant boundary is expected to be 85.3 µg/m^3 (99.9 percentile), below the odour threshold of 89 µg/m^3 (33 parts per billion, Centre for Waste Water Treatment Odour Research Laboratory Report 30/06/94) thus Tiwest does not anticipate any odour related problems outside the plant boundary".

"There is no technical evidence to suggest that odour related complaints should occur as a result of use of the emergency stack. If an odour related complaint was received, Tiwest would immediately investigate ambient air for odour at both the plant boundary and adjacent industrial premises".

Since the response to the submissions were received (January 1995), the proponent has submitted further information (March 1995) regarding modelling of emissions from the emergency stack. The proponent has stated that there were significant errors in the original modelling of the emissions scenario:

"The predicted ground level concentrations are too low, and the conclusions are unfounded".

The proponent has proposed a works programme to address these errors.

"As part of a programme to evaluate the impact of emissions from the emergency stack, Tiwest proposes to engage Dames & Moore to undertake the following scope of works:

1. Review air dispersion modelling reports provided by Tiwest along with stack test results previously performed.
2. Take samples from the emergency stack gas stream and have them analysed to quantify all emission constituents. The gases that samples will be analysed for include, but will not be limited to CO, CO_2, N_2, O_2, SO_2, H_2S, COS and CS_2, and emissions flow rates measured under a range of plant operating conditions.
3. Conduct a modelling exercise for worst case emissions scenarios.
4. Verify the odour threshold level for carbon oxy sulphide (COS).
5. Prepare a report for Tiwest to allow a comprehensive discussion of results and options with DEP.

Further, Tiwest will undertake a search internationally for documented research on COS, particularly as it may relate to the setting of standards and licence levels".

Commitments made by the proponent

The proponent has made the following commitments (Commitments 5 and 8, Section 6) in relation to the emergency stack:

Commitment 5

"Atmospheric emissions will be maintained to levels and standards agreed with the EPA and DEP".

Commitment 8

"The proponent commits to implementing an agreed quarterly reporting procedure with the Department of Environmental Protection that will provide comprehensive detail of Emergency Stack usage including time of occurrence, frequency, duration, reason for use and estimated composition of emitted gases".

4.2.5 Evaluation

The EPA considers that, given the lack of available literature, potential odour problems can be evaluated using information submitted by Tiwest for the odour threshold values of COS.

The EPA is concerned that the latest correspondence submitted by Tiwest (10 March 1995) highlights significant errors in the initial modelling of the emissions from the emergency stack.

However, the EPA is satisfied that the issues associated with the use of the emergency stack can be managed given the proposed scope of works to be undertaken and the commitments made by the proponent. The EPA considers that the above commitments made by the proponent, and Commitment 1 (Section 6) to conduct an environmental audit prior to commissioning at the 80,000 tpa level, are adequate.

Emergency stack emissions and potential odour problems beyond the plant boundary and nearby premises during use of the emergency stack can be determined as part of the audit (Commitment 1, Section 6). The company has given the commitment to the implememtation of audit action items.

The use of the emergency stack and licence conditions should then be reviewed in consultation with the Department of Environmental Protection.

The EPA has considered advice from the DEP that there have been occasions when Tiwest have used their emergency stack for events other than emergencies, such as "purging" of the chlorinators and maintenance operations.

Discussions with Tiwest (Tiwest, pers. comm., 1995) indicate that use of the emergency stack during purging of the chlorinators when they are off-line is unavoidable.

The EPA considers that the emergency stack should only be used for emergency operations, or for the purposes of shutting down the plant. Production waste gases should only be discharged through the emergency stack for a limited period during emergencies and plant shutdowns. This limited period should be determined between discussions between the DEP and Tiwest and should be set under the licence conditions for the plant. The proponent has also made a commitment to implementing quarterly reporting that will provide comprehensive details of Emergency Stack usage (Commitment 8).

4.3 Discharges of nitrogen oxides

4.3.1. Objective

The objectives are to ensure that emissions of nitrogen oxides (NO_x) do not cause an environmental or human health problem and that all reasonable and practicable measures are taken to prevent or minimise the discharge of nitrogen oxides.

4.3.2 Evaluation framework

The DEP has advised the EPA on this issue after comparing NO_x discharges from the Tiwest plant to other industries in the Kwinana industrial area.

4.3.3 Public submissions

An issue raised by the DEP stated:

> "Throughout the CER, waste streams are generally estimated to increase by 25%, however nitrogen oxides (NO_x) emissions increase by 48%. These sources should be listed and quantified, where possible. Is the WGI, or any other fuel combustion equipment, to be installed with low NO_x technology designs?".

4.3.4 Proponent's response

The proponent has listed the sources of nitrogen oxides at the plant and has estimated total NO_x emissions as 67.8 tonnes per year which equates to an average discharge rate of 2.15 grams per second. The proponent has stated that, "Tiwest does not plan to equip the WGI or other fuel combustion equipment with low NO_x technology design".

4.3.5 Evaluation

The Tiwest plant has many low level sources of NO_x, mainly arising from the combustion of natural gas. The plant is not considered to be a significant producer of nitrogen oxides in the Kwinana industrial area. However, the EPA considers that Tiwest should investigate the use of low NO_x technology burner equipment for future upgrades and equipment replacements.

4.4 Marine impacts and effluent pond management

4.4.1 Objective

Cockburn Sound is used for a wide variety of uses including commercial fishing, recreation and industrial uses. The main objectives are to:

- **protect the beneficial uses and amenity of Cockburn Sound;**
- **ensure that sediment quality is maintained or improved such that there is no detrimental build-up of toxicants in the sediments; and**
- **ensure the proper management of the wastewater treatment plant and effluent storage ponds such that final effluent discharge quality is acceptable for discharge to Cockburn Sound.**

4.4.2 Evaluation framework

Monitoring data provided by Tiwest for wastewater discharges, and marine sediment and mussel sampling, as a requirement of licence conditions, were evaluated against water quality guidelines and existing data for Cockburn Sound. The following were used in the evaluation:

- Draft Western Australian Water Quality Guidelines for Fresh and Marine Waters (EPA Bulletin 711, 1993a);
- Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 1992);
- results of marine surveys conducted by the DEP and information from the Southern Metropolitan Coastal Waters Study (DEP, draft 1995); and
- a report by Kinhill Engineers Pty Ltd (December 1994) entitled, "Ocean Outfall - Comparison of three years of post-commissioning monitoring with baseline data".

Final effluent quality, as discharged to Cockburn Sound, and the potential effect of effluent on sediments and mussels was assessed.

Final effluent quality

Tiwest wastewater discharge monitoring data for the period 1993 to 1994 were evaluated against the guidelines for the protection of aquatic ecosystems (for the production of edible fish, crustacea and shellfish, Bulletin 711) and Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 1992). Where no standards were available, discharge concentrations were compared to sea water concentrations. These comparisons are presented in Appendix 5.

Sediments

Kinhill Engineers Pty Ltd (1994) conducted a comparison of baseline data and the last three years of post-commissioning sediment metal levels, as background levels are not available for the area. This is discussed further in Section 4.4.5.

Mussels

Tiwest monitoring data for metal levels in mussels for the period 1992 to 1994 (Tiwest, 1995) were compared to other studies of heavy metals in mussels conducted as part of the Southern Metropolitan Coastal Waters Study (Burt and Scrimshaw, 1993; and EPA, draft 1995).

Burt and Scrimshaw (EPA Technical Series Number 56, 1993) present the results of a comparative mussel survey conducted in 1977 and 1989 and the EPA (draft, 1995) present the results of surveys conducted in 1994.

Levels of iron, manganese and chromium were compared as these metals were common to the Tiwest monitoring data and the EPA studies (Appendix 6).

4.4.3 Public submissions

Submissions related to the quality of effluent discharged to Cockburn Sound and effluent pond management.

The proponent was asked what management practices could be implemented to reduce the Total Suspended Solids (TSS) in treated wastewater discharged to Cockburn Sound. Tiwest was asked to provide an estimate of the residence time for waste water in the effluent ponds at 80,000 tpa, and quantify the resultant change in TSS expected as a result of any decrease in the residence time.

Submissions stated that effluent pond management practices as well as methods to test for effluent pond liner integrity and procedures for liner repairs, should be included in the Environmental Management Programme.

One question related to the pH of the wastewater prior to discharge to Cockburn Sound:

> "Tiwest have previously highlighted that the pH in the 'clean water pond' tends to go acidic over a period of time due to bacterial activity. Will this still be a problem during the 80,000 tpa upgrade? What happens if the clean pond is "off spec" with respect to pH and the "dirty pond" is close to capacity? Is this scenario valid, if so how often would it be expected to occur and how would it be managed? It is understood that Tiwest are undertaking studies to determine the cause of pH variations in the clean pond caused by bacterial activity. What are the outcome of these studies and can the findings be implemented such that these fluctuations are minimised? Can Tiwest provide regular updates on the study into identifying and controlling the bacteria present in the effluent ponds?"

In relation to discharges to Cockburn Sound an issue raised by the DEP asked how the concentrations of waste water parameters (Table 5.5 in the CER) compared to the Draft Western Australian Water Quality Guidelines for Fresh and Marine Waters (EPA Bulletin 711, 1993a) and Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 1992).

Another question related to the use of mussels at the Tiwest outfall for use as bio monitors as an indicator of water quality. Mussels are an appropriate choice for the biological monitoring of heavy metals in marine waters as they obtain the heavy metals predominantly from their food supply with minor proportions being obtained by ingestion of particulate matter and by direct uptake from solution (Ritz *et al*, 1980).

4.4.4 Proponent's response

The proponent made the following comments in relation to Total Suspended Solids, effluent residence times, and effluent pond liner integrity.

> "Future planned dredging programmes similar to the operation currently underway will ensure Tiwest remains within licence limits. The Environmental Management Programme will address this issue. A diver regularly checks silt build-up level in the ponds. Tiwest will continue to monitor silt build-up and monitor TSS concentrations of water being discharged. The ponds will be managed to ensure that licence limits for TSS are not exceeded".
>
> "It is anticipated that residence time in the waste water ponds will reduce to 8 days at the 80,000 tpa production level. The effect of this reduced residence time will be offset by the additional pond capacity available as the dredging programme proceeds. Tiwest will manage the pond system to ensure that TSS licence limits on waste water discharge are met".

"Groundwater monitoring bores have been installed adjacent to the ponds specifically to check for signs of liner leakage. During the dredging programme, special precautions are taken to protect the liner integrity, and Tiwest is confident damage will not occur".

The proponent made the following comments in relation to effluent pH.

"Changes in pond management techniques have improved maintenance of waste water pH within licence conditions. Tiwest is confident that changes in pond management have solved the low pH problem. There is no reason to expect that the problem will recur when plant production increases to 80,000 tpa".

Recent discussions with Tiwest (Tiwest, *pers. comm.*, 1995) indicate that pH variations in the effluent discharge are now maintained within licence limits due to the additional dosing of treated wastewater with sodium hydroxide (caustic soda).

"The studies currently being undertaken to determine the cause of pH variations in the clean pond are incomplete, but will continue. The final report and proposed corrective actions will be discussed with DEP".

In relation to discharges to Cockburn Sound and mussels, the proponent made the following response.

"The concentrations of materials in the wastewater discharge will not change as a result of the 80,000 tpa project. Only the volume of wastewater discharge will increase", and, "historic concentrations of materials in the wastewater compare favourably with those listed in the guidelines for aquatic environments".

"Mussels are collected annually from a sampling set grid pattern adjacent to the Tiwest outfall and monitored for accumulation of metals. To date there have been no indications of heavy metal accumulation in the mussels sampled. Physiological examination of mussels does not appear warranted".

4.4.5 Evaluation

The EPA is concerned over the variation in pH and Total Suspended Solids of the final effluent discharged to Cockburn Sound. The EPA notes that in the Company's triennial report 1992-4 that its effluent has ranged outside licence conditions with respect to pH and Total Dissolved Solids. However, the EPA considers that management procedures are now in place to reduce these variations and maintain effluent quality within licence limits. These issues are to be fully addressed in the revised Environmental Management Programme for the plant.

Another issue of concern to the EPA is the volumes of scheme water used by Tiwest at the Pigment Plant. The Tiwest Kwinana Pigment Plant is one of the largest users of scheme water in Western Australia. Approximately 6 million litres of water is used daily and is discharged to Cockburn Sound. With the upgrade to 80,000 tpa this figure is expected to rise to about 9 million litres per day. This water is a resource which should, if possible, be recycled or re-used for other purposes, other than being discharged into Cockburn Sound.

It was a requirement of an Environmental Condition placed upon the original Tiwest Kwinana proposal by the Minister for the Environment (Appendix 1, Condition 7) that Tiwest should investigate methods of water recycling. The EPA again considers that this would be an appropriate condition to be placed upon the present proposal and has made a recommendation accordingly (Recommendation 4, Section 5)

The EPA has evaluated the impact of wastewaters discharges on water quality, sediments and mussels in Cockburn Sound.

Final effluent quality

The comparison (Appendix 5) of wastewater discharge monitoring data for the period 1993 to 1994 against the guidelines for the protection of aquatic ecosystems (Bulletin 711, 1993b) and Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 1992) indicates that the discharge concentration of manganese is greater than the guideline value for the protection of human consumers of fish and other aquatic organisms.

The comparison also indicates that discharge concentrations of titanium, calcium, iron, aluminium and tin are greater than seawater concentrations. After the initial 120-fold dilution within the mixing zone, these concentrations are similar to seawater concentrations.

A study undertaken by Kinhill Engineers Pty Ltd (1994) for Tiwest, has shown that the concentrations of certain metals (aluminium oxide, chromium, niobium and zirconium) in the waters surrounding the outfall have shown increases above those of the baseline data. However, no clear spatial pattern was detected to indicate a plume effect of the wastewater. The study recommended that monitoring of the surface waters around the outfall should continue in order to assess any further increase in levels.

Sediments

Kinhill Engineers Pty Ltd (1994) have conducted a comparison of baseline and post-commissioning sediment metal levels, as background levels are not available for the area.

The Kinhill study states:

> "Certain metals (chromium, iron oxide, manganese, titanium and vanadium) indicate a possible plume effect at stations to the west and north of the outfall. The elevation of titanium (a potential marker for the wastewater discharge) above the baseline data at stations to the north, south and west confirm the spatial extent of enrichment due to the outfall".
>
> "Radionuclide levels in the sediments surrounding the outfall do not show a consistent pattern with outfall enrichment. Further monitoring is required in order to ascertain whether there is a pattern in the radionuclide data".

Mussels

There are no health standards for manganese, chromium, or iron in food (National Food Authority, 1992).

The Kinhill (1994) study states;

> "Data from the third year of monitoring (ie. 1994) clearly show a relationship between elevated levels of chromium, manganese, titanium and vanadium in the sediments surrounding the outfall and tissue levels of the same metals in mussels".

Appendix 6 shows the increase in manganese levels described in the Kinhill (1994) study.

> "Manganese levels measured in the third year, however, are substantially higher than pre-commissioning values reported by Burt and Scrimshaw (1993)".
>
> "At present there are no criteria for these metals; however, the mussels appear to be healthy and it is unlikely that these levels would be detrimental to their survival. The possible effect of biomagnification of metals in animals that consume these mussels is unclear".

Mussel deformities are an indicator of potential heavy metal contamination and may highlight areas that are susceptible to metal build-up. The EPA considers that useful information can be gained from the cursory physiological examination of mussels either during or after sampling of the mussels at the outfall. This requirement is able to be dealt with in discussions with the DEP or as an addition to licence monitoring conditions.

The Kinhill (1994) study makes conclusions and recommendations relating to monitoring of various metals in the effluent, sediments and mussels. The study recommends that some analyses be deleted from Tiwest's monitoring programme. The EPA considers that the findings of the Kinhill study should be evaluated more closely by the DEP prior to any changes to the monitoring programme.

The EPA considers that discharge concentrations of metals in the water column, after dilution within the mixing zone, are unlikely to cause a detrimental impact on Cockburn Sound. However, the EPA concurs with the Kinhill (1994) study that monitoring should continue to determine if there are any increasing trends in the levels of metals.

The EPA also considers that elevated levels of metals in the sediments surrounding the outfall, and in the tissues of mussels, need to be monitored further to assess whether the trend is likely to continue. Other potential sources of these metals, from nearby industries, should also be investigated.

4.5 Noise

4.5.1 Objective

The Environmental Protection Authority's objective is to ensure that the health and amenity of Kwinana and Rockingham residents is not adversely affected by noise from the Tiwest Kwinana Pigment Plant.

The proposal for expansion involves the installation of mechanical equipment, which will contribute to the overall noise output of the Tiwest plant. The objective is to ensure that the noise emissions meet the requirements of the current Noise Abatement (Neighbourhood Annoyance) Regulations, 1979. A comparison has also been made with the draft Environmental Protection (Noise) Regulations 1995.

4.5.2 Evaluation framework

In 1989, the EPA (Bulletin 373) considered the impacts of noise from the Tiwest plant acceptable due to the distance from the nearest residence.

Noise measurements and modelling of existing noise emissions and predictions for the proposed upgrade was undertaken by an independent consultant (Herring Storer Acoustics, 1994). The Herring Storer Acoustics (HSA) report uses the well accepted ENM noise prediction method to compute noise levels from the Tiwest plant likely to be received at the nearest residences 2.5 km away.

HSA conducted noise monitoring around the site boundaries of the Tiwest plant, the results of which indicated levels ranging between 61 and 67 dB(A). These results showed no identifiable tonal components.

The HSA report states that if the major plant items for the upgrade were engineered, where practicable, to achieve compliance with the Occupational Health, Safety and Welfare Regulations 1988, resulting in maximum levels of 85 dB (A) at 1 metre, the overall noise level on the eastern boundary would increase by 3 dB(A). This would result in an increase in the noise contribution from Tiwest of 3 dB(A), to 23 dB(A), at the nearest residence 2.5 km from the site.

The DEP has reviewed the modelling results and conclusions, and provided comment to the EPA on this issue.

In evaluating the noise issue, the EPA has also considered the proponent's acceptable management of plant noise since the commissioning of the pigment plant in 1991.

4.5.3 Public submissions

Submissions related to existing noise emissions and to the predicted increases in noise emissions as a result of the upgrade. The proponent was asked to identify tonal characteristics which could be sourced to the plant and comment on appropriate management practices to ensure that predicted noise levels are consistent with: achieving Licence Conditions; minimising "creeping noise"; and maintaining a noise environment free of annoying characteristics.

The proponent was asked if they were committed to a noise management and monitoring programme and the ability of the programme to address unacceptable off site impacts due to excessive noise or tonal components that may be caused by certain equipment or plant processes.

4.5.4 Proponent's response

In response to the above submissions, the proponent made the following comments.

> "It is impossible to predict accurately the noise emission levels that may result from the Debottlenecking project. However most of the proposed changes will be made to existing equipment, only a small proportion of which is 'noise generating'. Little increase in noise emission levels is expected".
>
> "A follow up survey will be undertaken within three months of the completion of the expansion programme to assess changes in noise emission levels".
>
> "Existing predicted levels under worst case conditions at the Kwinana residential area (2500m from the plant) are 20 dB(A). Predicted levels on completion of the expansion will increase to 23 dB(A). Both predicted levels are below normal background residential neighbourhood noise levels. Plant noise emissions are not a contributing factor to residential noise levels".
>
> "Predicted existing night time levels (calm conditions) at 2500m from the eastern boundary of the plant are 13 dB(A). This is below background residential neighbourhood noise levels and the plant noise emissions are not a contributing factor. There are no identifiable tones that can be attributed to the plant".
>
> "The annual surveys Tiwest now undertakes at the plant boundary and within the plant will be continued".
>
> "These surveys will include a component for tonal analysis to monitor for the presence of, or increase in annoying characteristics".
>
> "A comparison of annual noise emission levels (in plant and at the boundary) will identify any "creep" in emissions over time".
>
> "From the noise survey data, predictions of noise levels in residential areas (2500m east of the plant boundary) will be made to confirm compliance with licence conditions".

Tiwest has committed (in the Environmental Management Programme) to conduct regular noise monitoring and will conduct a further noise monitoring programme within three months of the completion of the expansion programme to assess changes in noise emission levels.

In response to the ability of the programme to address unacceptable off site impacts due to excessive noise or tonal components that may be caused by certain equipment or plant processes, the proponent responded:

> "Unacceptable off site impacts due to excessive noise or tonal components will be identified by the annual noise monitoring programme. If a problem is identified, appropriate engineering modifications will be made. However, given the predicted low levels of noise emissions from the plant, it is extremely unlikely that noise levels or tonal components will become an issue".

4.5.5 Evaluation

The predictions of noise from the proposed upgrade indicate that noise is unlikely to be an issue, provided the noise emissions of new plant items are controlled within set limits.

The EPA has reviewed the noise modelling data and predictions made by HSA, and notes their conclusions. The modelling data indicates a noise contribution level of 20 dB(A) resulting from the existing plant under worst case conditions, increasing to 23 dB(A) after the upgrade. These results are accepted as representative of the overall impact of the proposal. They are well within the most stringent noise criteria of 35 dB(A) between the hours of 2200 to 0700 hours (Noise Abatement (Neighbourhood Annoyance) Regulations, 1979) and are consistent with minimisation of "creeping noise". The measured noise levels of 60-67 dB(A) at the site boundaries are also in compliance with the Assigned Outdoor Neighbourhood Noise level of 70 dB(A) for a heavy industrial area (Neighbourhood Annoyance Regulations, 1979). A

comparison of current noise levels with predicted noise levels for the 80,000 tpa upgrade is shown in Table 3.

Table 3 Comparison of current noise levels with predicted noise levels for the 80,000 tpa upgrade

Criteria	Current maximum noise level (down wind conditions)	Predicted maximum level for 80,000 tpa upgrade (down wind conditions)	Noise regulation (Neighbourhood Annoyance Regulations, 1979)
Noise at nearest residential area	20 dB(A)	23 dB(A)	35 dB(A) (2200 - 0700 hrs)
Noise at eastern boundary of plant	67 dB(A)	70 dB(A)	70 dB(A)

As a worst case, the highest of these noise levels (ie 67 dB(A)) may increase to be equal to the 70 dB(A) assigned level as a result of the proposed upgrade. This level would be in excess of the proposed Maximum Allowable Noise Level of 65 dB(A) under the proposed draft Environmental Protection (Noise) Regulations 1995. The proponent should monitor the progress of the draft noise regulations with a view to achieving compliance through appropriate design measures if necessary.

The EPA notes that the predicted noise levels both at the boundary and at the nearest residence are based on the assumption (Herring Storer Acoustics, 1994), that major plant items for the upgrade are engineered, where practicable, to achieve a sound level of 85 dB (A) at 1 metre for occupational health and safety reasons. The EPA considers that this approach is acceptable.

To ensure that the overall noise impact from the pigment plant on residential areas and other industrial premises is acceptable, major plant items for the proposed upgrade should be engineered to result in noise levels, at the boundary of the premises, that are acceptable to the Department of Environmental Protection.

4.6 Radiation

4.6.1 Objective

The Environmental Protection Authority's objective is to ensure that radioactive material is disposed of in an environmentally acceptable manner.

4.6.2 Evaluation framework

The EPA relies on other government departments, namely the Radiological Council of the Health Department of Western Australia and the Mines Radiation Sub-Committee of the Department of Minerals and Energy to provide advice on radiation issues.

A Radiation Management Plan (RMP) to address the potential radiological impact of the disposal of solid and liquid wastes was produced by TJV in 1989, as an original Ministerial requirement (Environmental Condition 18, Appendix 1) prior to commissioning of the pigment plant.

4.6.3 Public submissions

The Town of Kwinana stated that its support for the proponent's debottlenecking project was conditional on the proponent revising the existing Environmental Management Plan, to include a radiation management plan.

The Radiological Council provided the majority of questions relating to radiation. Their submission related to exposure pathways and the increase in radiation levels due to increases in feedstock usage and the build up of radioactive material over time in certain areas of the plant, such as the chlorinator bed. A recommendation was made for a suitably qualified professional with radiation protection expertise to review the proponent's RMP.

Further questions from the Radiological Council related to the likelihood of ingestion of dust from dried solid waste storage areas and the typical gamma radiation levels.

The proponent was asked to provide a commitment that transportation of solid wastes and other potentially radioactive waste material (eg chlorinator bricks, contaminated filters and pipes) will comply with the Code of Practice for the "Safe Transport of Radioactive Substances (1990)" as published by the Department of the Arts, Sport, the Environment, Tourism and Territories under the Environmental Protection (Nuclear Codes) Act (1978).

The proponent was asked to consider the use of the National Health and Medical Research Council (NH&MRC) guidelines for radionuclides in drinking water as a basis for waste water discharges.

4.6.4 Proponent's response

In response to the radiation submissions, the proponent made the following comments.

> "As a result of the planned increase in production, no further concentration of radioactive materials will occur above current levels".
>
> "Transport and disposal of solid waste now occurs in accordance with the approved Radiation Management Plan. This plan is currently under review, but any amendments will be approved by the regulatory authorities prior to adoption by Tiwest".
>
> "The residue from the chlorinator beds is checked daily for uranium and thorium content. The average value (cumulative) can range from 200 - 550 parts per million. This level is not critical for (chlorinator) bed dumping, but is part of the standard assaying routine"
>
> "Gamma activity of the chlorinator bed material is checked regularly....a person would need to remain within one metre of the chlorinator bed for 8 hours per day, 5 days per week, 50 weeks per year, to receive a dose of 1.5 mSv (milli Sieverts). This dose level is very low".
>
> "The waste material is stored in a shed where it has a short storage time before transport to the Cooljarloo minesite for disposal. The filter cake waste has a nominal moisture content of 25%. Water sprays can be utilised if necessary to further minimise dust".
>
> "Gamma level surveys have shown very low activity...a person who remained in the waste materials shed 1 metre from the waste stockpile for 8 hours per day, 5 days per week, 50 weeks per year, would receive a dose of 1.8 mSv. Tiwest personnel visit the solid waste shed only sporadically".
>
> "Tiwest transports all solid process wastes from the Pigment Plant to the Cooljarloo mine for disposal. This transportation and disposal is in strict accordance with licence requirements, Ministerial requirements and the commitments given in the current Radiation Management Plan. The Pigment Plant solid wastes are not classified as radioactive materials".
>
> "There will be no increase in radiation levels. Existing exposure pathways will remain unchanged".
>
> "Guidelines for radionuclides in drinking water have been compared as a basis for waste water discharges into the marine environment. The drinking water standards for Gross alpha and Gross beta levels are both set at 100 mBq/L (Western Australian Water Quality

Guidelines, 1993), which suggests the Tiwest radionuclides values (Section 5.4.3) are satisfactory".

Commitments made by the proponent

The proponent has made commitments (Commitments 16, 17 and 18, Section 6) relating to the reviewing of the existing Radiation Management Plan (RMP) and the disposal and transport of solid wastes.

The proponent has stated (commitment 16):

"Within three months of approval of the 80,000 tpa project, the proponent will review the existing Radiation Management Plan (RMP) to the requirements of the Radiological Council of WA, Department of Minerals and Energy and the DEP".

Commitment 18 states:

"The proponent will develop transport and disposal methods for the plant solid wastes for the approval of the authorities and will detail the methods to be used in the EMP (Environmental Management Programme).

4.6.5 Evaluation

The acceptable occupational radiation dose is 100 mSv over a period of five years, with a maximum dose of 50 mSv in one year, and the dosage for a member of the public is 1 mSv per year, above background levels (Health Department of Western Australia, *pers. comm.*, 1995). Considering the long continuous exposure time required to receive a dosage of 1.5 mSv per year from chlorinator bed material, the EPA considers that there is a minimal radiation threat to members of the public. Members of the public are also not exposed to waste material from the Tiwest plant.

The EPA considers that radiation issues are manageable given the commitments made by the proponent to review the Radiation Management Plan to the requirements of the Radiological Council of WA, Department of Minerals and Energy and the DEP.

4.7 Risks and hazards

4.7.1 Objective

The Environmental Protection Authority's objective is to ensure that surrounding industries and residents are not exposed to any undue risks from the Tiwest plant.

4.7.2 Evaluation framework

The EPA sought advice from the Explosives and Dangerous Goods Division of the Department of Minerals and Energy in relation to risks and hazards.

Bulletins 611 and 627 (EPA, 1992) outline the EPA's criteria for the assessment of the fatality risk acceptability of proposed hazardous industrial developments. The Bulletins state the individual fatality risks acceptable to the EPA for residential, non-industrial activities located in buffer zones, and sensitive developments such as hospitals and schools.

The risk criteria specified in Bulletin 611 and 627 are as follows:

(i) A risk level in residential areas of one chance in a million per year (1×10^{-6}/yr), or less.

(ii) A risk level in "sensitive developments", such as hospitals, schools, child care centres and aged care housing of between one half and one in a million per year (0.5×10^{-6}/yr to 1×10^{-6}/yr).

(iii) Risk levels from industrial facilities should not exceed a target of fifty in a million per year (50 x 10^{-6}/yr) at the site boundary for each individual facility, and the cumulative risk level imposed upon an industry should not exceed a target of one hundred in a million per year (100 x 10^{-6}/yr).

(iv) A risk level for any non-industrial activity located in buffer zone between industrial facilities and residential zones of ten in a million per year or lower (10 x 10^{-6}/yr).

As a part of the 80,000 tpa upgrade, Tiwest were required to complete a Quantitative Risk Analysis (QRA) to evaluate possible hazardous events which could produce risk at the plant boundary and beyond. These hazardous events include releases of titanium tetrachloride, chlorine and Liquefied Petroleum Gas (LPG). The QRA was conducted for Tiwest by VRJ Risk Engineers Pty Ltd (1994).

The VRJ (1994) report presents the individual risk criteria for the 80,000 tpa upgrade. The report highlights significant differences from a previous study (IRM, 1992). These differences are largely attributed to more refined methods of modelling and Tiwest's ability to contain and control titanium tetrachloride spillages. The report states:

> "The revised results show the 50 x 10^{-6}/yr industrial individual risk contour is within the plant boundary. The 1 x 10^{-6}/yr individual risk contour extends further than the previous study results. However, all individual risk contour results calculated comply with the EPA risk criteria".

Advice received from the Explosives and Dangerous Goods Division of the Department of Minerals and Energy (DME) indicates that the 50 x 10^{-6}/yr risk contours actually extend into the Nufarm-Coogee chlor-alkali plant. The Nufarm-Coogee chlor-alkali plant is a dedicated chlorine supplier to the pigment plant and chlorine delivery lines go directly from it to the Tiwest plant.

The DME advice states:

> "The (VRJ) report is silent on the impact on their dedicated chlorine supplier, Nufarm-Coogee, due to its special operating status. On the basis of the submitted data, the risks as determined in the QRA will meet the EPA criteria, other than at the Nufarm-Coogee site. This is provided Tiwest address the recommendations arising out of the risk analysis (Section 1.3)".

The appropriate recommendations from the VRJ (1994) report are:

> "1.3.1 A testing program for all critical trip systems should be introduced to the plant. The introduction of this system would lead to a further reduction in risk levels for the plant.
>
> 1.3.2 In addition to recommendation 1.3.1, a hazard and demand frequency (trip testing) review should be undertaken. This, together with the results of this hazard and risk analysis, will assist in determining a priority procedure for critical trips throughout the plant.
>
> 1.3.3 The six LPG vessels are considered to be a high risk area. Their alignment is towards the plant which is considered to be an unacceptable exposure. VRJ believe that these vessels should be replaced with a storage configuration utilising larger vessels. Any alteration should first be evaluated within the context of this hazard and risk analysis study before proceeding".

The DME (DME, pers. comm., 1995) has stated that the location of the Nufarm-Coogee plant necessitates a special co-ordinated emergency response system. At present however, the Total Hazard Control Plan (THCP) for the Tiwest plant does not include the Nufarm-Coogee plant as the delineated boundary of the THCP only includes the chlorine line where it leaves the Nufarm-Coogee boundary (Tiwest Pigment Total hazard Control Plan, 1994). For both plants to be considered integrally (with respect to off-site risk) emergency response aspects of the THCP that deal with off-site releases for both plants, should be co-ordinated.

Commitments made by the proponent

The proponent has made a commitment (Commitment 20, Section 6) relating to risk from the Pigment Plant.

The commitment states:

> "The proponent commits to achieving all appropriate risk criteria for the Pigment Plant as defined in EPA Bulletin 627 through implementation of risk mitigation measures where appropriate".

4.7.3 Evaluation

The EPA has considered the advice from the DME, the recommendations in the VRJ (1994) report and the commitment made by the proponent.

The EPA considers that, with respect to off-site risk, both the adjacent chlor-alkali and the Tiwest plants should be considered integrally as the chlorine pipeline is shared between them. This is consistent with the approach taken in the original assessment of the pigment plant and chlor-alkali plant (Bulletin 373, 1989). The EPA has made a recommendation accordingly (Recommendation 5).

4.8 Future expansions of the Tiwest Kwinana Pigment Plant

As stated in Section 1, the EPA has conducted three different assessments for the Tiwest Kwinana Pigment Plant.

The EPA understands that Tiwest may be considering further expansions (Tiwest, pers. comm., 1995).

The EPA considers that, in order to streamline the approvals process, and to avoid unnecessary future referrals, Tiwest should conduct an analysis to determine the maximum capacity of the pigment plant that will satisfy all environmental requirements. Subsequently the proponent should submit all information supporting an expansion up to that level, assuming that this expansion was not inconsistent with the company's expectations. This will invariably avoid unnecessary referrals, leading to a better utilisation of resources, and at the same time will ensure that there is a technically sound basis for the EPA to make a thorough assessment of the proposal.

The EPA concludes that the proponent should undertake a thorough analysis to determine the maximum capacity of the pigment plant that will comply with all environmental requirements. This analysis and supporting information would then be submitted to the Environmental Protection Authority for assessment.

The EPA considers that it would be appropriate to conduct this analysis after the completion of the environmental audit as stated in Commitment 1 of the attached schedule of proponent's environmental management commitments (Section 6).

4.9 Proposed changes to environmental conditions and commitments

In order to provide a single Statement of Environment Conditions from which the environmental performance of this proposal can be managed and assessed, the DEP has reviewed the statements issued in 1989 and 1994 (Appendix 1 and 2).

Some conditions are recommended for deletion as they are no longer relevant to the proposal, others have been updated and replaced. Where a condition has been fully met by the proponent, this condition is also recommended to be deleted.

The Recommended Environmental Conditions in Section 6 of this report are a result of this review exercise, and assessment of the proposed pigment plant debottlenecking by the EPA.

At the same time as the DEP was reviewing the Environmental Conditions set on this proposal, the Tiwest Joint Venture was asked to review its commitments and provide a single set of up to date commitments. The proponent's revised set of Environmental Management Commitments (April 1995) for the Tiwest Kwinana Pigment Plant is provided as an attached schedule to the Recommended Environmental Conditions in Section 6.

The proponent has identified three management commitments in the CER. These commitments relate to the revision of the Environmental Management Programme (Commitment 2 of the schedule of proponent's environmental commitments, Section 6); the review of the Radiation Management Plan for the Pigment Plant (Commitment 16) and the commitment to achieving all appropriate risk criteria (Commitment 20).

The EPA considers that Commitment 1 is particularly worthy of note. Commitment 1 states:

> "The proponent commits to an environmental audit of its Pigment Plant at the proposed 80,000 tpa production rate by an external auditor who is acceptable to the Proponent and the Department of Environmental Protection. The audit scope will be set in consultation and agreement with both parties and include such issues as compliance with environmental licence, ministerial conditions and Proponent's commitments, risk assessment, environmental operating procedures, continuous improvement and comparison with industry best practice. The Proponent commits to implementation of audit action items agreed by the DEP prior to commissioning of the 80,000 tonne per annum project".

5. Conclusions and Recommendations

The EPA considers that, with the commitment to undertake a comprehensive audit and to implement audit action items together with the EPA's recommendations and proponent's commitments, the proposed de-bottlenecking expansion of the existing Kwinana Pigment Plant can be managed within acceptable environmental levels.

Notwithstanding the above, the proponent should maintain optimum scrubbing efficiency on caustic scrubbing equipment on the existing and proposed Waste Gas Incinerators, to the requirements of the Department of Environmental Protection, except in cases such as planned maintenance operations.

Following consideration of environmental issues evaluated in Section 4 of this report, the EPA's review of the previous conditions set on this proposal, the implementation of those conditions and the commitments given by the proponent, the Environmental Protection Authority considers that the proposed de-bottlenecking of the Tiwest Kwinana Pigment Plant from 64,000 tpa to 80,000 tpa is environmentally acceptable and could proceed.

Recommendation 1

The Environmental Protection Authority has considered the proposal by the Tiwest Joint Venture to increase the production capacity of the Kwinana Pigment Plant from 64,000 tpa to 80,000 tpa of finished titanium dioxide pigment via a de-bottlenecking process.

The Environmental Protection Authority recommends that the proposal be considered environmentally acceptable, subject to:

- **the Environmental Protection Authority's recommendations in this report (Section 4); and**
- **the proponent's consolidated list of environmental management commitments (Section 6).**

Recommendation 2

The Environmental Protection Authority recommends that the Recommended Environmental Conditions (Section 6) be the sole conditions for the proposal by the Tiwest Joint Venture to increase the production capacity of the Kwinana Pigment Plant from 64,000 tpa to 80,000 tpa, and that they supersede all previous Ministerial Environmental conditions for the project.

Recommendation 3

The proponent should examine methods of reducing water consumption, including wastewater re-use and recycling, and on-site treatment and re-use, at the pigment plant. To this end, the proponent should submit a report of this examination to the Environmental Protection Authority and the Water Authority of Western Australia for their approval, within six months of any approval of the 80,000 tpa upgrade.

Recommendation 4

To meet the risk criteria established by the Environmental Protection Authority in Bulletin 627, the proponent should ensure that the recommendations (1.3.1 to 1.3.3) contained in the VRJ (1994) hazard and risk assessment are implemented. These are:

1. **A testing program for all critical trip systems should be introduced to the plant. The introduction of this system would lead to a further reduction in risk levels for the plant.**
2. **In addition to recommendation 1.3.1, a hazard and demand frequency (trip testing) review should be undertaken. This, together with the results of this hazard and risk analysis, will assist in determining a priority procedure for critical trips throughout the plant.**
3. **The six LPG vessels are considered to be a high risk area. Their alignment is towards the plant which is considered to be an unacceptable exposure. VRJ believe that these vessels should be replaced with a storage configuration utilising larger vessels. Any alteration should first be evaluated within the context of this hazard and risk analysis study before proceeding.**

Aspects of the Total Hazard Control Plan for the Tiwest pigment plant that relate to off-site releases should also include the adjacent chlor-alkali plant, such that both plants will have a co-ordinated emergency response in the event of an off-site release. The emergency response procedures that relate to both the Tiwest Pigment Plant and the adjacent chlor-alkali plant shall be to the requirements of the Department of Environmental Protection and the Department of Minerals and Energy.

6. Recommended environmental conditions

Based on its assessment of this proposal and recommendations in this report, the Environmental Protection Authority considers that the following Recommended Environmental Conditions are appropriate.

TITANIUM DIOXIDE PIGMENT PLANT, INCREASE IN PRODUCTION CAPACITY TO 80,000 TPA, KWINANA

1 Proponent Commitments

The proponent has made a number of environmental management commitments in order to protect the environment.

1-1 In implementing the proposal, the proponent shall fulfil the commitments made in the Consultative Environmental Review, in response to issues raised following public submissions, and in correspondence of 2 March 1995; provided that the commitments are not inconsistent with the conditions or procedures contained in this statement.

A schedule of environmental management commitments (April 1995) which will be audited by the Department of Environmental Protection is included in Environmental protection Authority Bulletin 77X, and a copy is attached.

2 Implementation

Changes to the proposal which are not substantial may be carried out with the approval of the Minister for the Environment.

2-1 Subject to these conditions, the manner of detailed implementation of the proposal shall conform in substance with that set out in any designs, specifications, plans or other technical material submitted by the proponent to the Environmental Protection Authority with the proposal. Where, in the course of that detailed implementation, the proponent seeks to change those designs, specifications, plans or other technical material in any way that the Minister for the Environment determines on the advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

3 Environmental Management Programme

A practical operational plan is needed to implement good environmental management.

3-1 Within three months of the formal authority issued to the decision making authorities under Section 45(7) of the Environmental protection Act 1986, the proponent shall revise the Environmental Management Programme required by the Ministerial Statement of 26 April 1989 for the pigment plant. This programme shall include the requirement for submission of brief annual and comprehensive triennial reports to the Department of Environmental Protection, and shall address, but not be limited to:

(1) air quality monitoring and quality control procedures;
(2) effluent pond management;
(3) noise level measurement, frequency and control;
(4) detection and management of leaks; and
(5) radiation monitoring and management (see condition 7).

3-2 The proponent shall implement the Environmental Management Programme required by Condition 3-1.

4 Atmospheric Emissions

4-1 From operation to decommissioning, the proponent shall maintain the process equipment, instrumentation and alarm systems consistent with the safety and reliability assessment of the plant; to the requirements of the Department of Environmental Protection on advice of the Chief Inspector, Explosives and Dangerous Goods Division of the Department of Minerals and Energy.

4-2 From operation to decommissioning, the proponent shall maintain very high integrity instrumentation for the control of the plant and for the detection of and response to any unplanned releases, to the requirements of the Department of Environmental Protection on advice of the Chief Inspector, Explosives and Dangerous Goods Division of the Department of Minerals and Energy.

4-3 The proponent shall design and operate the plant in a manner which ensures that there is no odour of reduced sulphur compounds from the plant detectable in the nearest residential areas.

5 Wastewater Discharges

5-1 The proponent shall only discharge wastewaters into Cockburn Sound which permit the maintenance of the beneficial uses of the receiving waters, outside the defined mixing zones.

5-2 The proponent shall refer any proposal for wastewater discharge through the Cape Peron Ocean outfall to the Environmental Protection Authority.

6 Water reduction, re-use and recycling

6-1 Within six months of the formal authority issued to decision making authorities under Section 45(7) of the Environmental Protection Act, the proponent shall report on methods of reducing water consumption, including wastewater re-use and recycling, and on-site wastewater treatment and re-use, at the Pigment Plant.

6-2 The proponent shall implement the methods of water reduction, re-use and recycling required by condition 6-1 to the requirements of the Department of Environmental Protection on advice of the Water Authority of Western Australia.

6-3 In the event of a major water recycling project commencing in the Kwinana area, the proponent shall utilise the recycled water produced to the requirements of the Ministers for Environment, and Water Resources and the Minister administering the Mineral Sands (Cooljarloo) Mining and Processing Act 1988.

7 Radiation Management

7-1 The proponent shall safely manage radiation within the plant site and its environs. throughout the plant and shall also monitor and manage the potential effects of radiation arising from the discharge of liquid effluent and the disposal of solid wastes. During operation, the proponent shall maintain a radiation management programme for the pigment plant and for the disposal of liquid and solid wastes. This programme shall be to the satisfaction of the Radiological Council of WA , the Department of Minerals and Energy and the Department of Environmental Protection.

7-2 Within six months of the formal authority issued to decision making authorities under Section 45(7) of the Environmental Protection Act, and to achieve the objectives of condition 7-1, the proponent shall prepare a revised radiation management programme for the pigment plant and for the disposal of liquid and solid wastes to the requirements of the Department of Environmental Protection on advice of the Radiological Council of WA and the Department of Minerals and Energy.

7-3 The proponent shall implement the radiation management plan required by condition 8-2.

8 Risks and Hazards and Emergency Response

8-1 The proponent shall maintain and revise the plant emergency plan to take into account all relevant emergency events, including "plant upset" conditions, to the requirements of the Department of Environmental Protection on advice of the Chief Inspector, Explosives and Dangerous Goods Division of the Department of Minerals and Energy.

Note:
This plan should be fully integrated with the requirements of other neighbouring Kwinana industries.

8-2 To meet the risk criteria published in EPA Bulletin 627 (1992) the proponent shall implement the recommendations contained in the VRJ (1994) hazard and risk assessment to the requirements of the Department of Environmental Protection on advice of the Department of Minerals and Energy. (A copy of these recommendations, 1.3.1 to 1.3.3, is attached).

Note:
It would be a Department of Environmental Protection requirement that under Commitment 1, the proponent would require that an audit of risk compliance be undertaken prior to commissioning of the 80,000 tonnes per annum project.

8-3 Within six months of the formal authority issued to decision making authorities under Section 45(7) of the Environmental Protection Act, the proponent shall prepare a co-ordinated emergency response plan to be implemented with the proponent of the adjacent chlor-alkali plant to the requirements of the Department of Environmental Protection on advice of the Chief Inspector, Explosives and Dangerous Goods Division of the Department of Minerals and Energy.

9 Decommissioning

9-1 The proponent shall achieve the satisfactory decommissioning and rehabilitation of the site and its environs.

9-2 At least six months prior to decommissioning, the proponent shall prepare a decommissioning and rehabilitation plan to achieve the objectives of condition 9-1.

9-3 The proponent shall implement the plan required by condition 9-2.

10 Proponent

These conditions legally apply to the nominated proponent.

10-1 No transfer of ownership, control or management of the project which would give rise to a need for the replacement of the proponent shall take place until the Minister for the Environment has advised the proponent that approval has been given for the nomination of a replacement proponent. Any request for the exercise of that power of the Minister shall be accompanied by a copy of this statement endorsed with an undertaking by the proposed replacement proponent to carry out the project in accordance with the conditions and procedures set out in the statement.

11 Time Limit on Approval

The environmental approval for the proposal is limited.

11-1 If the proponent has not substantially commenced the project within three years of the date of this statement, then the approval to implement the proposal as granted in this statement shall lapse and be void. The Minister for the Environment shall determine any question as to whether the project has been substantially commenced.

Any application to extend the period of three years referred to in this condition shall be made before expiration of that period, to the Minister for the Environment by way of a request for a change in the condition under Section 46 of the Environmental Protection Act. (On expiration of the three year period, further consideration of the matter can only occur following a new referral to the Environmental Protection Authority).

12 Compliance Auditing

To help determine environmental performance, periodic reports on progress in implementation of the proposal are required.

12-1 The proponent shall submit periodic Progress and Compliance Reports, in accordance with an audit programme prepared by the Department of Environmental Protection in consultation with the proponent.

Procedure

1 Unless otherwise specified, the Department of Environmental Protection is responsible for assessing compliance with the conditions contained in this statement and for issuing formal clearance of conditions.

2 Where compliance with any condition is in dispute, the matter will be determined by the Minister for the Environment.

Notes

1 The proponent is required to hold a licence under the provisions of Part V of the Environmental Protection Act.

Schedule of proponent's environmental management commitments to be audited by the Department of Environmental Protection

Environmental audit

1. The proponent commits to an environmental audit of its Pigment Plant at the proposed 80,000 tpa production rate by an external auditor who is acceptable to the Proponent and the Department of Environmental Protection. The audit scope will be set in consultation and agreement with both parties and include such issues as compliance with environmental licence, ministerial conditions and Proponent's commitments, risk assessment, environmental operating procedures, continuous improvement and comparison with industry best practice. The Proponent commits to implementation of audit action items agreed by the DEP prior to commissioning of the 80,000 tonne per annum project.

Environmental Management Programme

2. Within three months of approval of the 80,000 tpa debottlenecking project, the proponent will submit a revised Environmental Management Plan (EMP) for the Pigment Plant to the Minister for the Environment.

3. The proponent will implement the EMP for the Pigment Plant site. The EMP will be reviewed and updated as necessary in consultation with the Department of Environmental Protection (DEP).

Emergency Response Procedures

4. The proponent will continually review and modify as necessary its plant emergency procedures plan. The proponent will maintain a strong and active association with the Kwinana Industries Mutual Aid group.

Atmospheric Emissions

5. Atmospheric emissions will be maintained to levels and standards agreed with the EPA and the DEP.

6. The approved system of primary waste gas incinerators and associated scrubbing equipment and back up combustion chamber will be operated and maintained to reduce emissions of contaminants from the main and by-pass stacks.

7. The existing Standby Thermal oxidiser (STO) is designed to accommodate a plant production rate of 80,000 tonnes per annum. In the event that both Waste Gas Incinerators (WGI) fail, the Proponent commits to scaling back plant production, as necessary, to ensure that all process waste gases pass through the STO, without load sharing to the Emergency Stack.

8 The proponent commits to implementing an agreed quarterly reporting procedure with the Department of Environmental Protection that will provide comprehensive detail of Emergency Stack usage including time of occurrence, frequency, duration, reason for use and estimated composition of emitted gases.

9. Fugitive emissions of Titanium Tetrachloride will be collected by a vacuum pick up system connected to a scrubber system.

Water Usage

10. Where possible, the proponent will minimise water usage within the plant areas where water usage can be reduced or recycled, and have a potential to impact on the environment, will be discussed with the DEP prior to implementation.

Plant Spillages

11. Water circulation systems will, generally, be located over concrete pads or hardstand with collection areas and sumps. Spills will be collected and routed to a neutralisation system to join the plant effluent stream.

Stormwater

12. Contaminated stormwater collected in hardstand areas with collection areas and sumps will be routed through the waste water treatment plant. Uncontaminated stormwater will be directed to stormwater sumps at the site.

Effluent Storage Ponds

13. The settling ponds will be lined to prevent leaching of liquids into the groundwater. The proponent will monitor a set of ground water bores adjacent to the ponds to ensure that the integrity of the liners is maintained.

    Details of pond designs, and mitigation procedures in the event of pond leakage will be included in the EMP.

Ground Water

14. The proponent will conduct an on-going ground water monitoring and reporting programme.

Liquid Effluent

15. The proponent will dispose of liquid effluents by either discharge into Cock burn Sound or into the Western Australian Water Authority's Cape Peron sewerage disposal system, or an alternative system approved by the EPA.

Radiation & Solid Waste

16. Within three months of approval of the 80,000 tpa project, the proponent will review the existing Radiation Management Plan (RMP) to the requirements of the Radiological Council of WA, Department of Minerals and Energy and the DEP.

17. The proponent will implement the RMP for the Pigment Plant site. The RMP will be reviewed and updated as necessary in consultation with the Radiological Council of WA, Department of Minerals and Energy and the DEP.

18. The proponent will develop transport and disposal methods for the plant solid wastes for the approval of the authorities and will detail the methods to be used in the EMP.

Noise

19. The proponent is committed to remaining within the EPA guidelines for noise emissions and undertaking an on-going noise monitoring programme.

Risk

20. The proponent commits to achieving all appropriate risk criteria for the Pigment Plant as defined in EPA Bulletin 627 through implementation of risk mitigation measures where appropriate.

21. The capacity of the SNAKE system scrubbers will be sufficient to deal with all possible releases directed to the SNAKE system.

Decommissioning

22. When operations cease and no further use for the site facilities can be identified, buildings and equipment will be dismantled, sold or disposed of. The general plant area will then be cleaned up to a tidy condition.

Equipment used in the titanium dioxide plant will be checked for radioactivity, and where necessary, decontaminated prior to sale or disposal.

Proposals for clean up procedures will be submitted to the EPA for approval prior to decommissioning.

7. References

ANZECC (1992), *Australian Water Quality Guidelines for Fresh and Marine Waters* , Australia and New Zealand Environment and Conservation Council, Australia.

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Tiwest Joint Venture (1995), Triennial Report 1992-1994, Pigment Plant, Tiwest Joint Venture.

Appendix 1

Minister's statement of 26 April 1989 including the proponent's commitments

MINISTER FOR EN...

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

Titanium Dioxide Pigment Plant, Kwinana
(excluding the Chlor-alkali Plant and
the Air Separation Plant)

Cooljarloo Joint Venture

This proposal may be implemented subject to the following conditions:

1. The proponent shall adhere to the proposal as assessed by the Environmental Protection Authority and shall fulfil those commitments applicable to the Pigment Plant made and listed in appendix 2 of EPA Bulletin 373 (copy of commitments attached).

2. The proponent shall include in the Environmental Management Programme required under condition 20, a plan to minimise construction stage impacts, including noise, dust from site works and site run-off, to the satisfaction of the Environmental Protection Authority before construction begins.

3. The proponent shall not allow any unacceptable environmental impacts resulting from, for example, air emissions or effluent discharge, during start-up of the plant. The proponent shall include in the Environmental Management Programme details of management provisions which will be used to minimise start-up impacts. This programme shall be to the satisfaction of the Environmental Protection Authority before commissioning.

4. The proponent shall include in the Environmental Management Programme a comprehensive hazard identification and risk management programme to the satisfaction of the Environmental Protection Authority on advice from the Department of Mines.

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The comprehensive hazard identification and risk management programme shall include, but shall not be limited to, the following:

(1) safety engineering design;

(2) quantified risk assessments;

(3) hazard and operability studies (HAZOP) of the facilities;

(4) implementation systems; and

(5) safety reviews during the life of the plant.

The on-going results shall be forwarded to the Environmental Protection Authority for assessment and to the Department of Mines.

In the event that the Environmental Protection Authority finds that the results of the programme are unacceptable, the proponent shall modify the process and/or operations as required.

5. From design to decommissioning the proponent shall:

(1) maintain the process equipment, instrumentation and alarm systems consistent with the safety and reliability assessment of the plant; and

(2) install very high integrity instrumentation for the control of the plant and for the detection of and response to any unplanned releases;

to the satisfaction of the Environmental Protection Authority on advice from the Department of Mines.

6. Prior to commissioning, the proponent shall develop and implement, to the satisfaction of the Environmental Protection Authority and other relevant agencies, a plant emergency plan which takes into account all relevant events, including "plant upset" conditions. This plan shall be fully integrated with the requirements of the Kwinana Integrated Emergency Management System (KIEMS).

7. During the detailed design stage, the proponent shall examine ways of reducing water consumption and shall submit a report of this examination to the Environmental Protection Authority and the Water Authority of WA for their assessment, prior to commissioning of the plant. In the event of a major water recycling project commencing in the Kwinana area, the proponent shall utilise the recycled water produced if required to do so by the Ministers for Environment and Water Resources and the Minister administering the Mineral Sands (Cooljarloo) Mining and Processing Act 1988.

8. The proponent shall treat and dispose of effluents in a manner and to the extent that ensures the protection of the beneficial uses of the receiving waters outside the defined mixing zones, and to the satisfaction of the Environmental Protection Authority. Currently the criteria for this protection are those contained in "Water Quality Criteria for Marine and Estuarine Waters of Western Australia". (Department of Conservation and Environment, Bulletin 103, April 1981).

9. At least six months prior to commissioning, the proponent shall prepare and implement a monitoring programme of physical, chemical and biological parameters of the effluent and the receiving waters. This monitoring programme shall include regular reporting of results to the Environmental Protection Authority and shall be to the satisfaction of the Environmental Protection Authority.

   If there is any change in the receiving water quality, unacceptable to the Environmental Protection Authority, the proponent shall modify the plant to the satisfaction of the Environmental Protection Authority.

10. Any proposal for discharge via the Cape Peron outfall shall be the subject of assessment by the Environmental Protection Authority.

11. The proponent shall design the plant so that it can be connected into a scheme for integrated management and disposal of liquid effluents from the Kwinana area at a later date, if required to do so by the Minister for Environment.

12. The proponent shall ensure that the quality of groundwater at the proponent's Cooljarloo minesite is protected and that the rehabilitation of the mine is not jeopardised by disposal of solid waste. The proponent shall make a full and detailed assessment of the disposal of the solid residue, paying particular attention to the amount and fate of the dissolved solids in the residue. As part of the Environmental Management Programme, the proponent shall prepare a report on the disposal of the solid residue, to the satisfaction of the Environmental Protection Authority, at least six months prior to commissioning.

    As part of the Environmental Management Programme, the proponent shall report on the performance of the solid residue disposal, and in the event of unacceptable impacts on the groundwater or vegetation rehabilitation, the proponent shall modify disposal practices to the satisfaction of the Environmental Protection Authority.

13. The proponent shall design and operate the plant in a manner which ensures that there shall be no odour of reduced sulphur compounds from the plant detectable in residential areas.

14. As part of the Environmental Management Programme, the proponent shall prepare a fault tree analysis of conditions leading to emissions which may occur during plant upset (notably via emergency vents), to the satisfaction of the Environmental Protection Authority.

If the fault tree analysis indicates that potentially unacceptable emissions may occur, the Environmental Protection Authority may require the proponent to undertake further dispersion analysis of the emissions and subsequently make modifications to the plant.

15. Prior to commissioning and as part of the Environmental Management Programme, the proponent shall submit a report describing the procedures for leak detection and repair within the pigment plant, to the satisfaction of the Environmental Protection Authority.

16. During the detailed design stage, the proponent shall provide details of:

    (1) the characteristics of emitted gas streams;

    (2) the emission control devices; and

    (3) the final emission stack heights and design,

    to the satisfaction of the Environmental Protection Authority.

17. At least 6 months prior to commissioning the pigment plant, the proponent shall prepare and implement the monitoring programme for gaseous emissions and the ambient air environment around the plant, to the satisfaction of the Environmental Protection Authority.

18. The proponent shall monitor radiation throughout the plant and shall also monitor and manage the potential effects of radiation arising from the discharge of liquid effluent and the disposal of solid wastes. Prior to commissioning, the proponent shall prepare a radiation management programme for the proposed plant and for the disposal of liquid and solid wastes. This programme shall be to the satisfaction of the Radiological Council of WA and the State Mining Engineer.

19. To achieve acceptable noise levels the proponent shall:

    (1) incorporate noise control as a fundamental criterion in the design of the plant, and shall ensure that all attenuation measures considered necessary to address the tonality of the plant noise emissions and to meet the noise levels deemed acceptable by the Environmental Protection Authority are incorporated during construction;

    (2) prior to commissioning, include a noise level monitoring programme in the Environmental Management Programme, to the satisfaction of the Environmental Protection Authority; and

    (3) after commissioning, undertake monitoring to determine the effectiveness of the attenuation measures designed and built into the plant, to the satisfaction of the Environmental Protection Authority.

20. The proponent shall prepare, in stages as appropriate, an Environmental Management Programme which deals with specific aspects of the proposal including, but not limited to:

(1) construction and commissioning impacts (see conditions 2 and 3);

(2) reduction in water use (see condition 7);

(3) monitoring of solid waste disposal at the Cooljarloo mine site (see condition 12);

(4) monitoring of the liquid effluent and receiving waters (see condition (9);

(5) detection of leaks in the pigment plant (see condition 15);

(6) air emissions and air quality monitoring (see conditions 14, 16 and 17);

(7) radiation monitoring (see condition 18); and

(8) noise level measurement and control (see condition 19).

The Environmental Management Programme shall include the requirement for submission of brief annual and comprehensive triennial reports to the Environmental Protection Authority and shall be to the satisfaction of the Environmental Protection Authority.

21. The proponent shall be responsible for decommissioning the plant and rehabilitating the site and its environs to the satisfaction of the Environmental Protection Authority.

22. The proponent shall, at least six months prior to decommissioning, prepare a decommissioning and rehabilitation plan to the satisfaction of the Environmental Protection Authority.

23. No transfer of ownership, control or management of the project which would give rise to a need for the replacement of the proponent shall take place until the Minister has advised the proponent that approval has been given for the nomination of a replacement proponent. Any request for the exercise of that power of the Minister shall be accompanied by a copy of this statement endorsed with an undertaking by the proposed replacement proponent to carry out the project in accordance with the conditions and procedures set out in the statement.

Bob Pearce, MLA
MINISTER FOR ENVIRONMENT

26 APR 1989

COOLJARLOO JOINT VENTURE

TITANIUM DIOXIDE PIGMENT PLANT

COMMITMENTS

INTRODUCTION

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   The EMP will include a Hazard and Operability Study (HAZOP) and a Total Hazard Control Plan (THCP). The EMP will be completed and submitted to the Environmental Protection Authority (EPA) prior to the commissioning of the plant.

2. The proponent will prepare a plant emergency procedures plan which will be prepared in conjunction with and, co-ordinated into the proposed Kwinana Emergency Plan. The plan will be prepared and submitted to EPA prior to plant commissioning.

LANDSCAPING

3. The proponent will prepare a landscape and planting programme for the site.

PLANT EMISSIONS

4. The proponent will engage the services of a Manager, Environmental, Health and Safety Affairs, to manage the environmental health and safety concerns of the site.

ATMOSPHERIC EMISSIONS

5. Atmospheric emissions will be maintained to levels and standards agreed with the EPA.

6. An incinerator with a back up combustion chamber will be installed to reduce atmospheric emission of contaminants from the main process vent stack.

7. Fugitive emissions of $TiCl_4$ will be collected by a vacuum pick up system connected to a scrubber system.

WATER

8. Programmes will be established to minimise water usage, including where feasible, recycling of water within the plant circuit.

9. Water circulation systems will, generally, be located over concrete pads or hardstand with collection areas and sumps. Spills will be collected and routed to a neutralisation system to join the plant effluent stream.

10. Stormwater run off will be collected in a surface drain system and disposed of off site.

11. The settling ponds will be lined to prevent leaching of liquids into the groundwater. The ponds will be fitted with an under pond drainage system to intercept any leakage through the lining that may occur.

    Details of the pond design will be included in the EMP.

12. A groundwater sampling and reporting procedure will be detailed in the EMP and submitted to the EPA prior to plant commissioning.

LIQUID EFFLUENT

13. The disposal of liquid effluents may be by either discharge into Cockburn Sound or into the Western Australian Water Authorities, Cape Peron sewerage disposal system.

    The system selected will be to the approval of the appropriate authority and detailed in the EMP.

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14. Details of the mine rehabilitation plan, including details for the disposal of the pigment plant solid waste products will be outlined in the mine site EMP to be submitted to the EPA prior to the operation of the Pigment Plant.

15. The proponent will develop transport and disposal methods for the plant solid wastes to the approval of the authorities and will detail the methods to be used in the EMP.

NOISE

16. The proponent is committed to remain within the EPA guidelines for noise emissions. Monitoring of noise levels, during construction and operations will be undertaken on site and off site.

    The results of the monitoring will be reported to the EPA.

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RADIATION

17. Regular checking and reporting to the appropriate authority to ensure that the EPA's guideline levels for radiation levels of uranium and thorium in feedstock, solid wastes, liquid effluent and product are met and maintained.

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CHEMICAL STORAGE

18. The bunded area for the pure $TiCl_4$ tanks will be designed to hold 100% capacity of the $TiCl_4$ tanks.

19. The design specification for the $TiCl_4$ tanks will be submitted to the appropriate authorities for approval prior to construction.

20. The capacity of the emergency scrubbers will be sufficient to deal with all possible gaseous leaks from the storage vessels.

DECOMMISSIONING

21. When operations cease and no further use for the site facilities can be identified, buildings and equipment will be dismantled, sold or disposed of. The general plant area will then be cleaned up to a tidy condition.

    Equipment used in the titanium dioxide plant will be checked for radioactivity, and where necessary decontaminated prior to sale or disposal. Cleanup procedures upon project completion date are detailed in the ERMP.

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COOLJARLOO JOINT VENTURE

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7 MAR 19[illegible]

186/85/2

2nd March, 1989

Ref: 629RDS1
File No: E03:017

Mr P. Skitmore
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

Dear Mr Skitmore,

COOLJARLOO MINERAL SAND PROJECT
KWINANA PIGMENT PLANT

The Titanium Dioxide Pigment Plant ERMP which has been assessed by the EPA and reported on in Bulletin 373 contains information on Chlor-alkali and Air-seperation plants which form part of the total complex.

To enable management flexibility to be maintained, applications for individual works approvals for the Chlor-alkali and Air Seperation Plants have been lodged with the EPA.

A review of the commitments submitted to the EPA and contained in Bulletin 373 has been undertaken and commitments relevant to each plant identified to enable a set of commitments for each plant to be produced.

A copy of the commitments for each plant is attached hereto and we confirm that there are no ommissions from the list of commitments made in the supporting documents.

Your sincerely
COOLJARLOO JOINT VENTURE

G. Newman

G. Newman
GENERAL MANAGER - OPERATIONS

024[illegible]

Noted. Action taken via IOM conditions. [illegible] 9/3/89

Appendix 2

Amended Minister's statement of 19 August 1994 including the proponent's commitments

WESTERN AUSTRALIA

MINISTER FOR THE ENVIRONMENT

STATEMENT TO AMEND CONDITIONS APPLYING TO A PROPOSAL (PURSUANT TO THE PROVISIONS OF SECTION 46 OF THE ENVIRONMENTAL PROTECTION ACT 1986)

PROPOSAL:	TITANIUM DIOXIDE PIGMENT PLANT, KWINANA (EXCLUDING THE CHLOR-ALKALI PLANT AND THE AIR SEPARATION PLANT) (175A / 867)
CURRENT PROPONENT:	TIWEST JOINT VENTURE
CONDITIONS SET ON:	26 APRIL 1989

Condition 1 is amended to read as follows:

1A Proponent Commitments

The proponent has made a number of environmental management commitments in order to protect the environment.

In implementing the proposal, including the modification to allow an increase in production to 64,000 tpa of finished titanium dioxide pigment, as reported on in Environmental Protection Authority Bulletin 742, the proponent shall fulfil those commitments applicable to the Pigment Plant made and listed in Appendix 2 of Environmental Protection Authority Bulletin 373; provided that the commitments are not inconsistent with the conditions or procedures contained in this statement. (A copy of the commitments is attached).

1B Implementation

Changes to the proposal which are not substantial may be carried out with the approval of the Minister for the Environment.

Subject to the conditions in this amended statement, the manner of detailed implementation of the proposal shall conform in substance with that set out in any designs, specifications, plans or other technical material submitted by the proponent to the Environmental Protection Authority with the proposal. Where, in the course of that detailed implementation, the proponent seeks to change those designs, specifications, plans or other technical material in any way that the Minister for the Environment determines, on the advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

The following condition and procedure are inserted after condition 23:

24 Compliance Auditing

In order to ensure that environmental conditions and commitments are met, an audit system is required.

Published on

19 AUG 1994

24-1 To help verify environmental performance, the proponent shall prepare periodic Progress and Compliance Reports in consultation with the Department of Environmental Protection.

Procedure

1 The Department of Environmental Protection is responsible for verifying compliance with the conditions contained in this statement, with the exception of conditions stating that the proponent shall meet the requirements of either the Minister for the Environment or any other government agency.

2 If the Department of Environmental Protection, other government agency or proponent is in dispute concerning compliance with the conditions contained in this statement, that dispute will be determined by the Minister for the Environment.

Kevin Minson MLA
MINISTER FOR THE ENVIRONMENT

Proponent's Commitments

TITANIUM DIOXIDE PIGMENT PLANT, KWINANA
(EXCLUDING THE CHLOR-ALKALI PLANT AND THE AIR SEPARATION PLANT) (175A / 867)

TIWEST JOINT VENTURE

COOLJARLOO JOINT VENTURE

TITANIUM DIOXIDE PIGMENT PLANT

COMMITMENTS

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LANDSCAPING

3. The proponent will prepare a landscape and planting programme for the site.

PLANT EMISSIONS

4. The proponent will engage the services of a Manager, Environmental, Health and Safety Affairs, to manage the environmental health and safety concerns of the site.

ATMOSPHERIC EMISSIONS

5. Atmospheric emissions will be maintained to levels and standards agreed with the EPA.

6. An incinerator with a back up combustion chamber will be installed to reduce atmospheric emission of contaminants from the main process vent stack.

7. Fugitive emissions of $TiCl_4$ will be collected by a vacuum pick up system connected to a scrubber system.

WATER

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13. The disposal of liquid effluents may be by either discharge into Cockburn Sound or into the Western Australian Water Authorities, Cape Peron sewerage disposal system.

    The system selected will be to the approval of the appropriate authority and detailed in the EMP.

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15. The proponent will develop transport and disposal methods for the plant solid wastes to the approval of the authorities and will detail the methods to be used in the EMP.

NOISE

16. The proponent is committed to remain within the EPA guidelines for noise emissions. Monitoring of noise levels, during construction and operations will be undertaken on site and off site.

    The results of the monitoring will be reported to the EPA.

    The noise monitoring programme will be developed in consultation with the EPA and detailed in the EMP.

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20. The capacity of the emergency scrubbers will be sufficient to deal with all possible gaseous leaks from the storage vessels.

DECOMMISSIONING

21. When operations cease and no further use for the site facilities can be identified, buildings and equipment will be dismantled, sold or disposed of. The general plant area will then be cleaned up to a tidy condition.

    Equipment used in the titanium dioxide plant will be checked for radioactivity, and where necessary decontaminated prior to sale or disposal. Cleanup procedures upon project completion date are detailed in the ERMP.

ASS # 1750

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State # 065

MINISTER FOR EN...

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

Titanium Dioxide Pigment Plant, Kwinana
(excluding the Chlor-alkali Plant and
the Air Separation Plant)

Cooljarloo Joint Venture

This proposal may be implemented subject to the following conditions:

1. The proponent shall adhere to the proposal as assessed by the Environmental Protection Authority and shall fulfil those commitments applicable to the Pigment Plant made and listed in appendix 2 of EPA Bulletin 373 (copy of commitments attached).

2. The proponent shall include in the Environmental Management Programme required under condition 20, a plan to minimise construction stage impacts, including noise, dust from site works and site run-off, to the satisfaction of the Environmental Protection Authority before construction begins.

3. The proponent shall not allow any unacceptable environmental impacts resulting from, for example, air emissions or effluent discharge, during start-up of the plant. The proponent shall include in the Environmental Management Programme details of management provisions which will be used to minimise start-up impacts. This programme shall be to the satisfaction of the Environmental Protection Authority before commissioning.

4. The proponent shall include in the Environmental Management Programme a comprehensive hazard identification and risk management programme to the satisfaction of the Environmental Protection Authority on advice from the Department of Mines.

Published on

26 APR 1989

7th Floor, May Holman Centre,
32 ST. GEORGE'S TERRACE, PERTH, 6000, WESTERN AUSTRALIA
Phone (09) 325 4133

The comprehensive hazard identification and risk management programme shall include, but shall not be limited to, the following:

(1) safety engineering design;

(2) quantified risk assessments;

(3) hazard and operability studies (HAZOP) of the facilities;

(4) implementation systems; and

(5) safety reviews during the life of the plant.

The on-going results shall be forwarded to the Environmental Protection Authority for assessment and to the Department of Mines.

In the event that the Environmental Protection Authority finds that the results of the programme are unacceptable, the proponent shall modify the process and/or operations as required.

5. From design to decommissioning the proponent shall:

(1) maintain the process equipment, instrumentation and alarm systems consistent with the safety and reliability assessment of the plant; and

(2) install very high integrity instrumentation for the control of the plant and for the detection of and response to any unplanned releases;

to the satisfaction of the Environmental Protection Authority on advice from the Department of Mines.

6. Prior to commissioning, the proponent shall develop and implement, to the satisfaction of the Environmental Protection Authority and other relevant agencies, a plant emergency plan which takes into account all relevant events, including "plant upset" conditions. This plan shall be fully integrated with the requirements of the Kwinana Integrated Emergency Management System (KIEMS).

7. During the detailed design stage, the proponent shall examine ways of reducing water consumption and shall submit a report of this examination to the Environmental Protection Authority and the Water Authority of WA for their assessment, prior to commissioning of the plant. In the event of a major water recycling project commencing in the Kwinana area, the proponent shall utilise the recycled water produced if required to do so by the Ministers for Environment and Water Resources and the Minister administering the Mineral Sands (Cooljarloo) Mining and Processing Act 1988.

8. The proponent shall treat and dispose of effluents in a manner and to the extent that ensures the protection of the beneficial uses of the receiving waters outside the defined mixing zones, and to the satisfaction of the Environmental Protection Authority. Currently the criteria for this protection are those contained in "Water Quality Criteria for Marine and Estuarine Waters of Western Australia". (Department of Conservation and Environment, Bulletin 103, April 1981).

9. At least six months prior to commissioning, the proponent shall prepare and implement a monitoring programme of physical, chemical and biological parameters of the effluent and the receiving waters. This monitoring programme shall include regular reporting of results to the Environmental Protection Authority and shall be to the satisfaction of the Environmental Protection Authority.

   If there is any change in the receiving water quality, unacceptable to the Environmental Protection Authority, the proponent shall modify the plant to the satisfaction of the Environmental Protection Authority.

10. Any proposal for discharge via the Cape Peron outfall shall be the subject of assessment by the Environmental Protection Authority.

11. The proponent shall design the plant so that it can be connected into a scheme for integrated management and disposal of liquid effluents from the Kwinana area at a later date, if required to do so by the Minister for Environment.

12. The proponent shall ensure that the quality of groundwater at the proponent's Cooljarloo minesite is protected and that the rehabilitation of the mine is not jeopardised by disposal of solid waste. The proponent shall make a full and detailed assessment of the disposal of the solid residue, paying particular attention to the amount and fate of the dissolved solids in the residue. As part of the Environmental Management Programme, the proponent shall prepare a report on the disposal of the solid residue, to the satisfaction of the Environmental Protection Authority, at least six months prior to commissioning.

    As part of the Environmental Management Programme, the proponent shall report on the performance of the solid residue disposal, and in the event of unacceptable impacts on the groundwater or vegetation rehabilitation, the proponent shall modify disposal practices to the satisfaction of the Environmental Protection Authority.

13. The proponent shall design and operate the plant in a manner which ensures that there shall be no odour of reduced sulphur compounds from the plant detectable in residential areas.

14. As part of the Environmental Management Programme, the proponent shall prepare a fault tree analysis of conditions leading to emissions which may occur during plant upset (notably via emergency vents), to the satisfaction of the Environmental Protection Authority.

If the fault tree analysis indicates that potentially unacceptable emissions may occur, the Environmental Protection Authority may require the proponent to undertake further dispersion analysis of the emissions and subsequently make modifications to the plant.

15. Prior to commissioning and as part of the Environmental Management Programme, the proponent shall submit a report describing the procedures for leak detection and repair within the pigment plant, to the satisfaction of the Environmental Protection Authority.

16. During the detailed design stage, the proponent shall provide details of:

    (1) the characteristics of emitted gas streams;

    (2) the emission control devices; and

    (3) the final emission stack heights and design,

    to the satisfaction of the Environmental Protection Authority.

17. At least 6 months prior to commissioning the pigment plant, the proponent shall prepare and implement the monitoring programme for gaseous emissions and the ambient air environment around the plant, to the satisfaction of the Environmental Protection Authority.

18. The proponent shall monitor radiation throughout the plant and shall also monitor and manage the potential effects of radiation arising from the discharge of liquid effluent and the disposal of solid wastes. Prior to commissioning, the proponent shall prepare a radiation management programme for the proposed plant and for the disposal of liquid and solid wastes. This programme shall be to the satisfaction of the Radiological Council of WA and the State Mining Engineer.

19. To achieve acceptable noise levels the proponent shall:

    (1) incorporate noise control as a fundamental criterion in the design of the plant, and shall ensure that all attenuation measures considered necessary to address the tonality of the plant noise emissions and to meet the noise levels deemed acceptable by the Environmental Protection Authority are incorporated during construction;

    (2) prior to commissioning, include a noise level monitoring programme in the Environmental Management Programme, to the satisfaction of the Environmental Protection Authority; and

    (3) after commissioning, undertake monitoring to determine the effectiveness of the attenuation measures designed and built into the plant, to the satisfaction of the Environmental Protection Authority.

20. The proponent shall prepare, in stages as appropriate, an Environmental Management Programme which deals with specific aspects of the proposal including, but not limited to:

(1) construction and commissioning impacts (see conditions 2 and 3);

(2) reduction in water use (see condition 7);

(3) monitoring of solid waste disposal at the Cooljarloo mine site (see condition 12);

(4) monitoring of the liquid effluent and receiving waters (see condition (9);

(5) detection of leaks in the pigment plant (see condition 15);

(6) air emissions and air quality monitoring (see conditions 14, 16 and 17);

(7) radiation monitoring (see condition 18); and

(8) noise level measurement and control (see condition 19).

The Environmental Management Programme shall include the requirement for submission of brief annual and comprehensive triennial reports to the Environmental Protection Authority and shall be to the satisfaction of the Environmental Protection Authority.

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26 APR 1989

COOLJARLOO JOINT VENTURE

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Operations Manager – KMM Australia International Pty Ltd

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2nd March, 1989

7 MAR

186/85/2

Ref: 629RDS1
File No: E03:017

Mr P. Skitmore
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

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KWINANA PIGMENT PLANT

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A copy of the commitments for each plant is attached hereto and we confirm that there are no ommissions from the list of commitments made in the supporting documents.

Your sincerely
COOLJARLOO JOINT VENTURE

G. Newman
GENERAL MANAGER – OPERATIONS

024133

Voted Action taken via L/M contacts 9/3/89

Appendix 3

Other proposed pigment plant modifications

Unit 200 - Chlorination, condensation and purification

Chlorinator modifications

At present the chlorinator bed and distributor plate are subject to occasional blockages, thus generating increased pressure and uneven bed fluidisation. This results in the need to change each distributor plate every three to six months. The procedure involves stopping the chlorine flow and purging each chlorinator with nitrogen for several hours. When the bed is cool, the bottom is unbolted and removed to enable the distributor plate to be removed. A new plate is then prepared to replace the existing plate.

It is proposed to replace the bottom of each of the three chlorinators in Unit 200 with a "roddable" bottom to improve efficiency. Roddable bottoms are designed to remove blockages occurring in each chlorinator's distributor plate. With the proposed roddable bottoms, it is expected that the distributor plate replacement procedure may only be necessary once every two years.

Upgrade condensing recirculation pumps

Additional circulation of titanium tetrachloride ($TiCl_4$) within Unit 200 is required to enable greater throughput of product. It is proposed to upgrade the condensing recirculation pumps by increasing the size and impeller diameter of each pump. This upgrade will increase circulation of raw $TiCl_4$ from the crude quench tank to the chlorinator crossover and then into the condensing column.

Installation of additional heat exchangers

Additional heat exchange capacity is required when operating at 80,000 tpa rates to reduce pressure drop through the condensation system. It is proposed to install a third heat exchanger to provide additional flow capacity for the condensation circuit and ensure that production is not restricted by pressure drop.

Installation of a fourth $TiCl_4$ storage tank

On-site storage of $TiCl_4$ provides a buffer for continued operation of the oxidation section and allows maximum use to be made of the chlor-alkali plant capacity. It is proposed to increase $TiCl_4$ storage from three to four tanks to accommodate the 80,000 tpa upgrade. This modification will enable continued operation of the oxidation section for up to three days while the chlorination section is shutdown. Increased $TiCl_4$ storage will allow the chlor-alkali plant to be operated at maximum capacity for longer periods, thus optimising its performance while maintaining minimum inventories of liquid chlorine.

Installation of a spare hydrochloric acid scrubber with bypass pipework

The waste gas scrubbing system is susceptible to blockage by solid build-up, which presently requires a complete Unit 200 shutdown for cleanout. It is proposed to install a second concentrated hydrochloric acid scrubber with bypass pipework that will allow either scrubber to be cleaned separately without shutdown of the process.

Unit 300 - Oxidation

Unit 300 converts pure $TiCl_4$ feed from Unit 200 into raw titanium dioxide product using a proprietary oxidation process. The following modifications are proposed for Unit 300.

Installation of second aluminium chloride mixing tank

An essential part of the process is to dissolve aluminium chloride into titanium tetrachloride under controlled conditions. A second mixing tank is required to increase capacity in Unit 300.

Replacement of methanol chillers with a larger heat exchanger

The existing facility uses three methanol chillers to remove the heat load in the sulphuric acid circuit. These chillers currently require a high degree of maintenance. Every two to three days

it is necessary to shutdown operations and replace a contaminated chiller with a clean chiller. This involves a down time of two to three hours. The removed chiller must then be serviced for later reuse.

It is proposed to remove the three chillers thereby reducing down time. The removal of the chillers will generate a heat load in the sulphuric acid circuit further down into the process. To offset this problem, a heat exchanger will be installed and cooled with cooling water to reduce the temperature of the sulphuric acid. The acid will then be directed to the sulphuric acid scrubber.

Increase pipe diameter to superheaters

At present the piping through the $TiCl_4$ superheaters in Unit 300 is subject to high pressure drops which limits throughput. It is proposed to increase the diameter of the piping which will result in a reduction in pressure loss through the piping and increase the throughput of vaporised $TiCl_4$ through the superheaters.

Installation of a fourth vaporiser

Fouling of the tube bundle in the vaporisers occurs regularly which requires down time of an oxidiser while the bundle is being replaced. It is proposed to install a fourth vaporiser unit that has the ability to act as a replacement spare for any of the three operating units. This will allow continued operation of the oxidation system while the tube bundle of the fouled unit is being replaced and increase the on-stream efficiency of Unit 300.

Installation of an additional chlorine gas compressor

Operation of the oxidation unit at the increased rates required for 80,000 tpa will result in a greater volume of recycle gas to be processed in Unit 300. It is proposed to install another chlorine gas compressor to ensure sufficient compressor capacity to meet requirements at increased production.

Installation of a second sulphuric acid scrubber with pipework and valves

Increased gas flows in Unit 300 at higher production rates (80,000 tpa) will lead to increased pressure drop through the sulphuric acid scrubber and result in a process bottleneck. It is proposed to install a second sulphuric acid scrubber that will reduce pressure drops at higher gas flows and ensure efficient scrubbing of the gas.

Installation of a third demister element

Increased gas flows in Unit 300 through the sulphuric acid scrubber and gas compressor will result in high pressure drops through the demister elements of the process. It is proposed to install a third demister element which will accommodate the increased gas flows at 80,000 tpa rates without pressure drops becoming a process bottleneck.

Installation of a spare aluminium chloride bag hoist

Aluminium chloride used in the process must be lifted in bags to the plant storage vessel. This essential raw material is currently hoisted by a single electric chain hoist. If this equipment fails, continued operation of the process is placed in jeopardy. It is proposed to install a spare aluminium chloride bag hoist which will ensure continuous supply of this raw material.

Unit 400 - Finishing

Unit 400 processes the pigment slurry from Unit 300 and packages dry titanium dioxide (TiO_2) product for sale. The processes used to achieve this are: milling and classification, chemical treatment, filtering and drying, micronisation (grinding) and bagging and storage. The proposed modifications to Unit 400 are discussed below.

Upgrade treatment tank feed and discharge pumps

The two treatment tanks in Unit 400 form a component which is concerned with pigment treatment, filtration and drying. In order to increase throughput, new pumps with bigger lines

and increased capacity will need to be installed. This will result in increased input of TiO_2 slurry into the treatment tank and increased output of pigment from the treatment tank into the filtration process.

Installation of second fines cyclone cluster

Capacity of the existing fines classifying cyclones limits production through Unit 400 to current levels. It is proposed to install a second fines cyclone cluster of identical design to accommodate production to 80,000 tpa.

Redesign of coarse cyclone cluster

The capacity of the existing coarse classifying cyclones is insufficient to accommodate production to 80,000 tpa. In addition, the flexibility of the existing units is insufficient to meet the wide range of operating conditions. It is proposed to redesign the coarse cyclones cluster to accommodate increased production and improve operational flexibility. However, essentially the same cyclone design will be used to ensure that classification performance is maintained.

Installation of duplicate bucket elevator

The bucket elevator is an essential piece of equipment in Unit 400. If this equipment breaks down, production through the unit must stop. It is proposed to install a duplicate bucket elevator with maintenance access via monorail which will improve the on-stream efficiency of Unit 400 and accommodate production to 80,000 tpa.

Upgrade bagging capacity

Final product is bagged in 25 kg paper bags and shipped in 1 tonne lots on wood pallets. The capacity of the existing bagging system is insufficient to accommodate production to 80,000 tpa. It is proposed to upgrade the bagging capacity by installing additional bagging machinery and improving the existing palletising equipment.

Unit 500 - Utilities and chemical storage

Unit 500 incorporates all services supplied to the plant, including water treatment, cooling water, compressed air, steam generation, snake scrubber system, chemical storage and refrigeration systems. The proposed modifications to Unit 500 are discussed below.

Installation of third plant air compressor

A frequently occurring problem in Unit 500 concerns insufficient air being produced to heat up the chlorinators in Unit 200. The problem arises when air is being simultaneously fed to Unit 400 for bagging operations and to the chlorinator as a conveying medium. Whilst nitrogen is used as the conveying medium to the chlorinators under normal operating conditions, air is periodically required to bring chlorinators back on-line from standby conditions. It is proposed to install a third plant air compressor to overcome this problem.

Upgrade capacity of cooling utilities

The cooling requirements of the process will increase as a result of the proposed increases in plant capacity. It is proposed to upgrade the capacity of the chilled water refrigeration package and the cooling water circuit by installing another chiller package and upgrading the cooling water circulation pumps.

Unit 600 - Waste treatment

Unit 600 consists of the wastewater treatment plant, waste gas incinerators, sulphur dioxide scrubber and demister, and solid waste disposal area. Modifications proposed for Unit 600 are discussed below.

Installation of four additional filtration units

The capacity of the existing wastewater treatment filtration circuit is insufficient to accommodate production to 80,000 tpa. It is proposed to install four additional filtration units to meet the increased production rate.

Increase capacity of ocean outfall pump

Increased volumes of wastewater generated from the proposed plant upgrade will require an improvement in pumping capacity to discharge this effluent to the ocean (Cockburn Sound). It is proposed to increase pumping capacity by installing a larger motor and impeller on the existing pump.

Other plant upgrades

Upgrade capacity of Distributed Control System

The proposed Pigment Plant upgrade will require installation of additional instrumentation and process control equipment and it will be necessary to upgrade the control capacity of the Distributed Control System (DCS).

Upgrade Motor Control Centres

Increasing production capacity will require installation of more motor drives. The capacity of the existing motor control centres will need to be upgraded to accommodate these additional electric motors. It is proposed to upgrade the Motor Control Centres by installing switchgear, distribution boards, motor protection panels and monitoring instruments.

Operational changes

The proposed modifications will require a pro rata increase in raw materials and utility services and generate a corresponding increase in by-products and waste products. Transportation requirements will also be increased. The effects of these increases are discussed below.

Transport

The Pigment Plant is situated on Mason Road, Kwinana. Traffic volumes along this local two lane road amount to approximately 3,800 vehicles per day (Dames & Moore, 1993a).

Rockingham Road (Bunbury Highway) is currently the major highway linking Perth and Fremantle to Kwinana, Rockingham and Mandurah. The road is a four lane, divided arterial road which carries approximately 39,500 vehicles per weekday (Dames & Moore, 1993a). The intersection of Mason Road/Rockingham Road/Mandurah Road is currently being investigated by the Main Roads with proposals being prepared to create a four-way signalised junction.

A number of industries in the Kwinana region are serviced by Westrail, including the Pigment Plant, the Alcoa alumina refinery, the SECWA power station, the CSBP fertiliser plant, the Western Mining nickel refinery and the AGR sodium cyanide plant. Due to the seasonal nature of some of the products transported, rail traffic is variable.

The nearest port facility to the site is at Cockburn Sound, a semi-enclosed marine embayment which has been developed to accommodate bulk cargo vessels of up to 80,000 tonne capacity. A major naval facility has been established at Garden Island, whilst nine cargo berths have been developed on the eastern foreshore for importing and exporting raw and processed materials. The Pigment Plant uses the BHP bulk handling port facilities for synthetic rutile storage and coke importing and storage. Pigment export is through the port of Fremantle.

Infrastructure and integration with Kwinana industries

The existing Pigment Plant uses utility services and infrastructure facilities located within the Kwinana Industrial Area. The plant is also integrated with several industrial establishments located nearby.

As an outcome of this proposal, demand for utilities/infrastructure and interaction between establishments will generally increase on a pro rata basis. Based on the existing rated capacity of 64,000 tpa the proposal represents an increase of 25 percent.

The following additional utilities and raw materials will be required:

Imported materials:

- petroleum coke.

Utilities:

- gas;
- electricity; and
- water.

Suppliers of locally purchased materials:

- Pinus radiata pallets;
- paper pigment bags;
- plastic sheet;
- bulk bags;
- dunnage bags (sea container pneumatic packing material);
- sand;
- caustic soda;
- chlorine;
- lime;
- nitrogen;
- oxygen;
- liquefied petroleum gas;
- sodium aluminate;
- sodium silicate;
- sulphuric acid; and
- synthetic rutile.

Increased demand for raw materials will most likely be met by the following industries:

- Nufarm Coogee (caustic soda and chlorine);
- CSBP & Farmers (sulphuric acid);
- Coogee Chemicals (sodium aluminate and sodium silicate);
- Liquid Air (oxygen and nitrogen);
- Wesfarmers LPG Plant (LPG bullets); and
- Cockburn Cement (lime).

The proposal will generate 5,000 tpa of anhydrous hydrochloric acid which will be either sold or neutralised through the wastewater treatment plant.

Discussions between Tiwest and its local raw material suppliers have indicated that existing facilities will be adequate to meet Tiwest's increased demand without major modifications or additions to installed equipment.

Appendix 4

Proponent's response to issues raised in submissions

TIWEST JOINT VENTURE
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4 January 1995

Director
Evaluation Division
Department Environmental Protection
Level 8
Westralia Square
141 St Georges Terrace
PERTH WA 6000

Dear Sir

Titanium Dioxide Pigment Plant at Kwinana
Production Debottlenecking to 80,000 tpa (882)
(Your Ref. 186/85/2 of 19 December 1994)

Attached are Tiwest's responses to your final list of questions. We trust the Environmental Protection Authority can now proceed with finalising its assessment.

Yours faithfully

D J CHARLES
Manager Corporate Services

CC S H Livingston - Kwinana
B J Montgomery - Bentley
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5194HR6

Sulphur Dioxide Discharges

1.1 SO_2 Scrubber

It is stated in the original EMP that the existing SO_2 scrubber efficiency is 99% for a gaseous design flow rates of 22 500 m^3/h and a liquid design flow rate of 90 m^3/h. The CER states the maximum theoretical SO_2 mass emission rate from the unscrubbed standby stack is equal to 64.5 g/sec from 64 000 tpa production, and hence it can be concluded the mass load the SO_2 scrubber handles will never exceed this value significantly. The SO_2 mass emission rate from the scrubber should therefore not exceed 0.64 g/sec.

Question

Appendix B of the CER indicates that emissions from the main stack are in excess of 5 g/sec for less than 1.3% of the time (over four days per year), indicating a scrubber efficiency as low as 72% on occasions. What are the limitations to scrubber efficiency and/or reliability that result in less than 99% SO_2 removal? Could Tiwest provide commitment to ensure that scrubber efficiency is maintained at 99% for both the existing and proposed SO_2 scrubbers? What management procedures would be implemented to ensure that scrubber efficiency is maintained at 99% and how would this be monitored?

Response

The existing SO_2 scrubber was designed to operate at 99% efficiency and this value is quoted in the Environmental Management Programme (EMP). Appendix B of the CER shows that for the period 01/12/93 - 30/06/94, the main stack emissions were less than 5 g/sec for 98.7% of the time. Calculations of emission rates less than 5g/sec are imprecise, although a study currently being conducted by Dames & Moore into calibration of monitoring equipment may enable closer definition of low level emissions.

Tiwest currently ensures that main stack SO_2 emissions are less than 5 g/sec, apart from short periods for system maintenance. The emissions data for the seven month period in Appendix B shows that this emission level is rarely exceeded. Tiwest will operate the current and proposed scrubbing systems to ensure that this level of SO_2 removal from the main stack waste gas stream is maintained in an effective and economic manner.

The controls on scrubber liquor chemistry that are now in place to effectively control SO_2 emissions level will be continued. Details of the proposed scrubbing system will be provided to DEP for review prior to installation.

1.2 Question

The Company is requested to submit design details to the DEP of the second SO_2 scrubber in terms of engineering design parameters, process control details and maintenance schedules to confirm the best practice SO_2 removal is proposed. Details of engineering design parameters should include :-

- height of packing;
- diameter of column;
- type and size of packing;
- inlet gas volumetric flow rate, SO_2 concentration and temperature
- inlet liquid volumetric flow rate, sodium hydroxide concentration and temperature;
- pressure;
- statement of significant assumptions made for design calculations; and
- any other essential information.

Response

The proposed SO_2 scrubber is still in the design stage and precise details are not yet available. However, Tiwest plans to install a new additional scrubber with equivalent efficiency to the existing unit, with a combined joint capacity to handle production levels of 130 000 tpa. Once scrubber design is finalised, details will be reviewed with DEP prior to installation.

Standby Stack Emissions

1.3 Question

Could Tiwest comment on the following waste minimisation/effluent reduction scheme for STO SO_2 emissions. The scheme is to divert all combustion product from the two Waste Gas Incinerators (WGI's) and the Standby Thermal Oxidiser (STO) to a common pipe header and then distribute appropriately to the duplicate Waste Heat Boilers, venturi scrubber, SO_2 and demister train prior to atmospheric discharge through a stack.

Are there any technical and/or economic factors which would prevent the scheme from being implemented as part of the 80 000 tpa upgrade?

Response

The proposed scheme is neither practically nor economically feasible for the small percentage of time proposed. An estimated cost of $7M would be required to implement the proposal.

Emergency Stack Usage

2.1 Question

There are not process upsets, apart from the total power outage, stated in the CER that would require the use of the emergency stack. Are there any other circumstances that may result in use of the emergency stack? These should be presented in a Fault Tree Analysis along with frequency data.

Response

To date, the majority of uses of the emergency stack has been when power outages or power surges have caused temporary loss of the main or standby stack systems.

The operating licence is clear on usage of the emergency stack and the protocols and reporting that must accompany its use. Tiwest has no recorded instances of the Plant operating outside the guidelines stipulated in the licence for emergency stack use.

It is remotely possible that during maintenance of one of the main units, a fault could develop necessitating use of the emergency stack. If such an instance arose, the licence requirements for emergency stack use would be followed.

If the plant is undergoing maintenance and one WGI becomes inoperative, the alternative WGI and STO would continue in use. If the second WGI became inoperative, the emergency stack would then be used. Tiwest considers the probability of such a situation developing to be extremely low and hence, a fault tree analysis appears unwarranted. It is not Tiwest's intention to deliberately plan to use the emergency stack during maintenance.

2.2 Question

The following information should be supplied so that the emergency shut-down process and consequences may be more fully understood. How is the controlled emergency shutdown procedure implemented once the emergency stack has been in use for one hour? What upstream process units are able to continue production? For what length of time can these upstream units store the products formed? What are the consequences for an emergency shutdown in terms of environmental discharge upon start-up? How long does the emergency shutdown procedure take from the time it is initiated to the time at which no atmospheric emissions result? How often are emergency shutdown procedures initiated and what is the cause of these shutdowns?

Response

Since the plant commenced operations there has not been an occasion when the controlled emergency shutdown procedure has had to be implemented as a result of emergency stack use for over one hour.

On rare occasions during plant startup , a failure in the WGI required use of the emergency stack for more than one hour. In those instances, Kwinana staff of the Department of Environmental Protection (DEP) were appraised of the circumstances within the plant, including likely delay to startup and prevailing weather conditions. Approval has always been granted for extended use of the emergency stack beyond the one hour licence limit.

If the emergency stack is shutdown, the chlorination and oxidation sections of the plant are unable to operate and must also shutdown. Following a shutdown of the chlorination section (the sole source of emission gas), all gases would be cleared within a maximum of two minutes.

Plant startup following an emergency shutdown is progressive and is preceded by being on line with the primary waste gas incinerator and the associated SO_2 scrubbing equipment. There is no potential for deleterious environmental discharge at startup following an emergency shutdown.

No deliberate emergency shutdowns have occurred since plant commissioning, apart from periodic critical shutdown tests. During the period 01/01/94 to 31/10/94, thirteen shutdowns have occurred, all due to power supply or power distribution faults. All shutdowns and startups have been uneventful.

Emergency Stack Emissions

Carbon Oxy Sulphide (COS) and Hydrogen Sulphide (H_2S)

It is recommended by Canadian Liquid Air Ltd, a manufacturer of COS, that the Time Weighted Average (TWA) should be considered similar to H_2S in relation to possible health impacts. In the absence of relevant information relating directly to COS, it is recommended that H_2S be used as a guideline. The recommended ground level concentrations for H_2S range from 0.14 $\mu g/m^3$ (3 minute average, Victorian EPA) to 2.5 $\mu g/m^3$ (99.5 percentile for one hour; Dutch standard).

3.1 Question

Tiwest's present licence allows them to operate the emergency stack for 60 minutes before commencing shutdown procedures or requiring approval from DEP to continue operation. Is the 60 minutes allowable operating time still appropriate given the increased ground level concentrations of carbon disulphide (CS_2),carbon oxy sulphide (COS) and hydrogen sulphide (H_2S)? What are the cumulative impacts of these reduced sulphur compounds? Dispersion modelling and an analysis of the cumulative effects of COS, CS_2 and H_2S emissions on the environment is required to confirm if the 60 minute allowable operating time is appropriate.

Response

Use of the emergency stack is strictly in accordance with licence requirements During the first three years of plant operation, there have been no odour related complaints from the surrounding industrial or residential community relating to the rare occasion of emergency stack use.

Modelled emissions of COS (at the 54 000 tpa production rate) show that the 99.9 percentile Ground Level Concentration (GLC) at 200 m 300 degree from the emergency stack is 58.6 $\mu g/m^3$. This point is outside the plant boundary. This GLC is well below the odour threshold level of 89 $\mu g/m^3$ (33 ppb) (Ref. Centre for Waste water Treatment Odour Research Laboratory Report, 30/06/94). The modelling predicts that there are unlikely to be COS induced odour related complaints (Ref. VRJ Report: Stack Emission Dispersion 07/11/94).

3.2 Question

The CER states a maximum 1 hour GLC of 2460 $\mu g/m^3$ for COS emissions from the emergency stack. How does Tiwest propose to reduce the GLC of COS so that ground level concentrations are reduced to acceptable international standards (using H_2S as a guideline)?

Response

The values quoted for COS in the CER were based on a preliminary model run using limited weather data. A re-run of this model using updated and more comprehensive weather information gave the following results: (VRJ Risk Engineers, 18/11/94 Report).

	99.9 Percentile GLC for COS μgm^3	*Distance from Source*	*Bearing of Receptor from Source (degree)*
54 000 tpa	*58.6*	*200*	*300*
80 000 tpa	*85.3*	*200*	*300*

The odour threshold level for COS is 89 μgm^3 (33ppB) (Ref. Centre for Waste Water Treatment Odour Research Laboratory Report, 30 June, 1994). Thus Tiwest does not anticipate any odour related problems outside the plant boundary.

The use of H_2S as a guideline is not considered appropriate in light of the report from the Centre for Waste Water Treatment Odour Research Laboratory.

3.3 Question

The CER states that the hydrogen sulphide stack discharge concentration is less than 16 mg/m^3 for a production capacity of 54 000 tpa. What is the stack concentration for the 80 000 tpa upgrade?

Response

The estimated hydrogen sulphide emergency stack discharge concentration for a production capacity of 80 000 tpa is expected to be approximately 24 mg/m^3.

3.4 Question

The recommended ground level concentration for H_2S is 0.14 µg/m^3 (3 minute average, Victorian EPA and DEPWA Air Quality Guidelines). What ground level concentrations of H_2S are likely to be experienced at the boundary of the plant? Are these concentrations likely to cause odour related problems?

Response

COS emissions from the stack (Question 3.1) have been modelled to provide a prediction for ground level concentrations. No separate modelling has been undertaken for H_2S. Stack testing of emergency stack discharges during 1994 did not identify the presence of hydrogen sulphide.

The ground level concentrations of COS at the plant boundary are expected to be 85.3 µg/m^3, below the odour threshold level of 89 µg/m^3. It is unlikely that the COS emissions will cause odour related problems, and the prediction is reinforced by the absence of odour complaints during the plant operation to date.

3.5 Question

What management strategy would be implemented by Tiwest should odour related complaints be received as a result of the use of the emergency stack?

Response

There is no technical evidence to suggest that odour related complaints should occur as a result of use of the emergency stack.

Tiwest handles all complaints related to plant operation by investigating the circumstances and responding as soon as possible. This commitment to dealing with community concerns in a timely and responsible manner is embodied in Kwinana Industries Council, Plastics and Chemical Industries Association, and Kwinana Industries Mutual Aid documents to which Tiwest is a signatory. If an odour related complaint was received, Tiwest would immediately investigate ambient air for odour at both the plant boundary and adjacent industrial premises.

3.6 Question

What is the feasibility of modifying at least one of the WGI's and its associated venturi scrubber to operate under emergency power such that emergency emissions can be oxidised and scrubbed prior to discharge from the emergency stack?

Response

The plant does not generate emergency power to operate one WGI and its associated venturi scrubber in the event of a mains power supply outage. It is not feasible to do so.

Waste Heat Boilers

4.1 Question

Tiwest operate backup conventional utility boilers when the waste heat from the WGI is unavailable. Is there to be any increase in capacity of utility boilers as part of the 80 000 tpa upgrade?

Response

No increase in capacity of utility boilers is planned as part of the 80 000 tpa upgrade.

NO_x Emissions

5.1 Question

Throughout the CER, waste streams are generally estimated to increase by 25%, however nitrogen oxides (NO_x) emissions increased by 48%. These sources should be listed and quantified, where possible. Is the WGI, or any other fuel combustion equipment, to be installed with low NO_x technology designs?

Response

The sources for nitrogen oxides (NO_x) emissions are given below :-

Source	*No.*	*Volume of Gas Consumed m^3/hr*	*Burner Rating*
Steam Superheater	*1*	*313*	*Industrial Rating*
Tunnel Dryers	*2*	*360*	*Industrial Rating*
Steam Generators	*2*	*680*	*Industrial Rating*
$TiCl_4$ Preheaters	*3*	*160*	*Commercial Rating*
Oxygen Preheaters	*3*	*140*	*Commercial Rating*
Main Stack (Waste Gas Incinerators)	*1*	*350*	*Industrial Rating*
Total Gas Consumed		*3643 m^3/hr*	

Emission factors used in the calculation are taken from USEPA AP42.

- *For industrial applications, 2240 kg NO_x as NO_2 per million cubic metres of natural gas combusted.*
- *For commercial applications, 1600 kg NO_x as NO_2 per million cubic metres of natural gas combusted.*

The estimated total NO_x generated from the plant is :-

-	*Industrial rating equipment*	=	*52 t/year*
-	*Commercial rating equipment*	=	*12 t/year*
i.e.	*Total NO_x as NO_2 emitted*	=	*64 t/year*

An equivalent natural gas volume to combusted carbon monoxide specific heat is calculated at commercial rating 2.1 t/year of NO_x. It is also estimated that 1.7 t/year of NO_x is produced during acid neutralisation.

In total, these emissions for NO_x equate to 67.8 t/year or 2.15 g/sec.

Tiwest does not plan to equip the WGI or other fuel combustion equipment with low NO_x technology design.

Waste Water Discharge to Cockburn Sound

Effluent Pond Desludging

6.1 Question

Monitoring data supplied by Tiwest indicates that Total Suspended Solids (TSS) concentrations being discharged are approaching licence limits. What management practices can Tiwest implement to ensure future operation will take appropriate remedial action, such as pond desludging, prior to the TSS concentrations reaching licence limits? These management practices should be included in the Environmental Management Programme for the site.

Response

Tiwest has maintained TSS within licence limits. Future planned dredging programmes similar to the operation currently underway will ensure Tiwest remains within licence limits. The Environmental Management Programme will address this issue.

A diver regularly checks silt build up level in the ponds.

Tiwest will continue to monitor silt build up and monitor TSS concentrations of water being discharged. The ponds will be managed to ensure that licence limits for TSS are not exceeded.

Effluent Pond Integrity

6.2 Question

As dredging operations of the ponds are estimated to be necessary every few years, Tiwest should include in the Environmental Management Programme a method to test for liner integrity and procedures for the implementation of liner repairs to adequately seal any identified leaking areas.

Response

Eight groundwater bores have been installed adjacent to the ponds and these bores are monitored quarterly, in accordance with licence requirements, specifically to check for signs of liner leakages.

During the dredging programme, special precautions are taken to protect the liner integrity, and Tiwest is confident damage will not occur.

If the groundwater analysis suggests that liner rupture has occurred, the matters will be investigated and repairs effected.

Effluent Total Suspended Solids (TSS) Concentration

6.3 Question

It is stated in the CER (Section 5.4.2) that there is approximately 10 days residence time of waste water in the ponds. Could Tiwest supply an estimate of the residence time for waste water effluent at 80 000 tpa and quantify the resultant change in TSS expected as a result of any decrease in the residence time?

Response

It is anticipated that residence time in the waste water ponds will reduce to 8 days at the 80 000 tpa production level.

The effect of this reduced residence time will be offset by the additional pond capacity available as the dredging programme proceeds.

Tiwest will manage the pond system to ensure that TSS licence limits on waste water discharge are met. No increase in TSS levels are expected as a result of the combined effect of shorter residence time and the silt dredging programme.

Effluent pH

6.4 Question

Tiwest have previously highlighted that the pH in the "clean water pond" tends to go acidic over a period of time due to bacterial activity. Will this still be a problem during the 80 000 tpa upgrade? What happens if the clean pond is "off spec" with respect to pH and the "dirty pond" is close to capacity? Is this scenario valid, if so, how often would it be expected to occur and how would it be managed?

Response

Changes in pond management techniques have improved maintenance of waste water pH within licence. Essentially, these techniques include modification of pH levels, plus the transfer of clean, treated, silt free water from the dirty water pond to the clean water pond as quickly as possible.

Tiwest is confident that the changes in pond management have solved the low pH problem. There is no reason to expect that the problem will recur when plant production increases to 80 000 tpa.

6.5 Question

It is understood that Tiwest are undertaking studies to determine the cause of pH variations in the clean pond caused by bacterial activity. What are the outcome of these studies and can the findings be implemented such that these fluctuations are minimised? Can Tiwest provide regular (e.g. quarterly) updates on the study into identifying and controlling the bacteria present in the effluent ponds?

Response

The studies currently being undertaken to determine the cause of pH variations in the clean pond are incomplete, but will continue. Once the work is complete, an assessment will be made to determine possible courses of action.

The final report and proposed corrective actions will be discussed with DEP.

Unit 600 Thickener Design

6.6 Question

What is the maximum design capacity of the thickener in terms of liquid effluent feed rate and overflow solids concentration? What is the overflow solids concentration achieved at present by the thickener?

Response

Tiwest has assurance from the thickener manufacturers that the current plant has adequate capacity to cope with the increased throughput resulting from the increase in production to 80 000 tpa.

The overflow solids concentration is not measured. All treated water is transferred to the first pond where residual solids settle out. Clean water is then decanted or pumped to the second pond prior to discharge. No discharge off site occurs unless treated water meets licence requirements.

6.7 Question

Can Tiwest provide further details of the investigation into the performance of the thickener referred to in the CER?

Response

Yes, details of correspondence with the thickener manufacturer can be provided.

Marine Impacts

Waste Water Discharge Quality

7.1 Question

How will the upgrade affect the concentrations of waste water parameters as listed in Table 5.5 of the CER? How do these concentrations compare to the water quality guidelines for aquatic environments as listed in the Draft Western Australian Water Quality Guidelines for Fresh & Marine Waters (EPA Bulletin 711) and the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 1992)?

Response

The concentrations of materials in the waste water discharge will not change as a result of the 80 000 tpa project. Only the volume of waste water discharged will increase.

Tiwest monitors the quality of treated water on a daily, monthly or quarterly basis for different parameters and, historic concentrations of materials in the waste water compare favourably with those listed in the guidelines for aquatic environments (Australian Water Quality Guidelines for Fresh and Marine Waters, ANZECC, 1992 and Draft Western Australian Water Quality Guidelines for Fresh and Marine Waters, EPA Bulletin 711).

Mussels - Physiological Examination

7.3 Question

Mussels in the vicinity of the Tiwest Outfall can be used as a useful bio-monitor. Can physiological examinations of mussels be included in the annual reporting of the sediment and mussel survey?

Response

Mussels are collected annually from a sampling set grid pattern adjacent to the treated water outfall in Cockburn Sound. These mussels are analysed for metal compounds that might be accumulating in their tissue as a result of the Tiwest plant marine waste water discharge.

To date, there have been no indications of heavy metal accumulation in the mussels sampled.

Physiological examination of mussels does not appear warranted.

Noise Impacts

The only data presented in the CER refers to a noise survey in January 1993, which found noise levels "in the order of 69dB(A) on the eastern boundary of the plant". The following further information is requested :-

8.1 Question

What is the noise emission of the existing plant (at the eastern boundary) at night?

Response

A recent noise survey determined that the noise emission of the existing plant (at the eastern boundary) at night is 62dB(A).

8.2 Question

By how much will this increase as a result of the proposed upgrade?

Response

It is impossible to predict accurately the noise emission levels that may result from the plant Debottlenecking project. However, most of the proposed changes will be made to existing equipment, only a small proportion of which is "noise generating". Little increase in noise emission levels is expected.

A follow up survey will be undertaken within three months of the completion of the expansion programme to assess changes in noise emission levels.

8.3 Question

What are the existing and predicted noise levels at the nearest residence from the plant under worst case conditions?

Response

Existing predicted levels under worst case conditions at the Kwinana residential area (2500m from the plant) are 20dB (A).

Predicted levels on completion of the expansion will increase to 23dB(A). Both predicted levels are below normal background residential neighbourhood noise levels. Plant noise emissions are not a contributing factor to residential noise levels.

8.4 Question

What are the existing night time noise levels at the nearest residential area, and are there identifiable characteristics present (e.g. tones) which can be sources to the plant?

Response

Predicted existing night time levels (calm conditions) at 2500 m from the eastern boundary of the plant are 13dB(A) levels. This is below background residential neighbourhood noise levels and the plant noise emissions are not a contributing factor. There are no identifiable tones that can be attributed to the plant.

8.5 Question

What effect will the predicted levels have on the existing noise levels and character?

Response

Predicted night time noise levels at 2500 m from the plant following expansion will remain below ambient noise levels. Tonal characteristics are not expected to alter.

8.6 Question

What commitments (management practices) are appropriate to ensure that the predicted noise levels are consistent with :

(i) achieving Licence Conditions;
(ii) minimising "creeping noise"; and
(iii) maintaining a noise environment free of annoying characteristics.

Response

The annual surveys Tiwest now undertakes at the plant boundary and within the plant will be continued.

These surveys will include a component for tonal analysis to monitor for the presence of, or increase in annoying characteristics.

A comparison of annual noise emission levels (in plant and at the boundary) will identify any "creep" in emissions over time.

From the noise survey data, predictions of noise levels in residential areas (2500 m east of the plant boundary) will be made to confirm compliance with licence conditions.

8.7 Question

Has Tiwest committed to a noise management and monitoring programme?

Response

Yes, in the existing Environmental Management Programme. This noise monitoring programme will be conducted annually.

8.8 Question

How will the programme be able to address unacceptable off site impacts due to excessive noise or tonal components that may be caused by certain equipment or plant processes?

Response

Unacceptable off site impacts due to excessive noise or tonal components will be identified by the annual noise monitoring programme. If a problem is identified, appropriate engineering modifications will be made.

However, given the predicted low levels of noise emissions from the plant, it is extremely unlikely that noise level or tonal components will become an issue.

Radiation

9.1 Question

Although feedstock material is only slightly radioactive, the radioactive material is, in effect, extracted from the feedstock and concentrated. The solid waste thus has the potential to deliver radiation doses in excess of 1 mSv/annum. How does Tiwest propose to address this?

Response

As a result of the planned increase in production, no further concentration of radioactive materials will occur above current levels. Radioactive materials in the process waste will continue at low levels.

Transport and disposal of solid waste now occurs in accordance with the approved Radiation Management Plan. This Plan is currently under review, but any amendments will be approved by the regulatory authorities prior to adoption by Tiwest.

9.2 Question

There could be a potential build up of radioactive material over time in certain areas of the plant such as the chlorinator bed. Are there any provisions for checking such a build up, and the removal and disposal of radioactive contaminated items?

Response

The residue from the chlorinator beds is checked daily for uranium and thorium content. The average value (cumulative) can range from 200 - 550 ppm. This level is not critical for bed dumping, but is part of the standard assaying routine.

Gamma activity of the chlorinator bed material is checked regularly and has been determined at 0.75 μGy/hour. This means that a person would need to remain within one metre of the chlorinator bed for 8 hours per day, 5 days per week, 50 weeks per year, to receive a dose of 1.5 mSv. This dose level is very low.

9.3 Question

It is recommended that the Radiation Management Plan should be reviewed and updated by a suitably qualified professional with radiation protection expertise who can address all radioactive aspects and demonstrate that all radiation exposure pathway are audited. Will the company commit to doing this?

Response

The revised draft of the Radiation Management Plan has had an initial review by a qualified professional with radiation protection expertise. Comments are being incorporated before subjecting the Plan to a follow up review by the same radiation protection professional.

9.4 Question

Is there any likelihood of intake (ingestion) of dust from dried solid waste storage areas? What are the typical gamma levels?

Response

The waste material is stored in a shed where it has a short storage time before transport to the Cooljarloo minesite for disposal. The filter cake waste has a notional moisture content of 25%. Water sprays can be utilised if necessary to further minimise dust.

Gamma level surveys have shown very low activity. Typical levels are about 0.89 µg/hr at a distance of 1 m from the solid waste material. This means that a person who remained in the waste materials shed 1 metre from the waste stockpile for 8 hours per day, 5 days per week, 50 weeks per year, would receive a dose of 1.8 m Sv. This dose level is very low, and in any event, Tiwest personnel visit the solid waste shed only sporadically.

9.5 Question

Will the company provide a commitment that the transportation of solid wastes and other potentially radioactive waste material (e.g. chlorinator bricks, contaminated filters and pipes) will comply with the Code or Practice for the "Safe Transport of Radioactive Substances (1990)" as published by the Department of The Arts, Sport, the Environment, Tourism and Territories under the Environmental Protection (Nuclear Codes) Act (1978).

Response

Tiwest transports all solid process wastes from the Pigment Plant to the Cooljarloo mine for disposal. This transportation and disposal is in strict accordance with licence requirements, Ministerial requirements and the commitments given in the current Radiation Management Plan.

The Pigment Plant solid wastes are not classified as radioactive materials.

Tiwest is currently preparing a revised Radiation Management Plan that will require the approval of the Radiological Council, Department of Mines and Energy, and the DEP.

9.6 Question

The radionuclide content of raw materials and process wastes may not change, however the mass of the raw materials and process wastes will increase. What will be the increase in radiation levels? What are the exposure pathways?

Response

There will be no increase in radiation levels. Existing exposure pathways will remain unchanged.

9.7 Question

Has the proponent considered using the National Health and Medical Research Council (NH & MRC) guidelines for radionuclides in drinking water as a basis for waste water discharges?

Response

Guidelines for radionuclides in drinking water have been compared as a basis for waste water discharges into the marine environment.

The drinking water standards for Gross α and Gross β levels are both set at 100 mBq/l (Western Australian Water Quality Guidelines, 1993), which suggests the Tiwest radionuclides values (Section 5.4.3 of the CER) are satisfactory.

Appendix 5

Comparison of marine discharge concentrations with relevant standards and sea water concentrations

Parameter	1993 Average marine discharge concentration (mg/L unless otherwise stated)	1994 Average marine discharge concentration (mg/L unless otherwise stated)	Concentration after 120-fold dilution within mixing zone	Guideline value mg/L (where available) (Italics = seawater concentrations[1])
pH (pH units)	7.8	8.2		6.5 - 9.0
Suspended Solids	25	30		
Total Dissolved Solids	17782	15049	35,140	*35,000*
Nitrogen	1.4	1.3		
Phosphorus (PO4)	0	0		
Titanium (Ti)	0.01	0.02	0.0012	*0.001*
Sodium (Na)	3342	2639	10,525	*10,500*
Potassium (K)	28	29	380.2	*380*
Calcium (Ca)	2762	2930	424	*400*
Magnesium (Mg)	3.6	9.5	1350	*1350*
Chlorate (ClO3)	8.3	2.5		
Chloride (Cl)	8640	8300	19070	*19000*
Sulphate (SO4)	1447	1373	2712	*2700*
Iron (Fe)	0.09	0.06	0.011	*0.01*
Manganese (Mn)	0.25	0.46	0.006	0.1 (*0.002*)
Aluminium (Al)	2	1.4	0.024	*0.01*
Zirconium (Zr)	<0.001	<0.001		*0.00002*
Niobium (Nb)	<0.0005	0.4	0.0033	*0.00001*
Chromium (Cr)	0.03	<0.01	0.0003	0.05 (*0.00005*)
Tin (Sn)		0.015	0.00093	*0.0008*
Vanadium (V)	0.04	<0.01	0.0023	*0.002*
Radium 228 (Becquerels/L)	73	220		
Radium 226 (Bq/L)	55	59		
Radium 224 (Bq/L)	9	8.7		
Thorium 228 (Bq/L)	9	8.7		

Note

It is noted that guidelines are not standards. Whilst guidelines are used frequently as objectives, it lies with the management agency to use discretion regarding their use.

Italics = seawater concentrations (McGraw-Hill, 1984)

Appendix 6

Comparison of metal levels in mussels in the vicinity of the Tiwest Outfall

Metal	1989 study (BP Jetty) Average value of top and bottom samples (milligrams/kg)	1994 study Average for Cockburn Sound (milligrams/kg)	Tiwest range of data from 1992-1994 (milligrams/kg)
Manganese	0.98	0.79	0.52 (1993) - 4.34 (1994)
Chromium	0.72	0.1	0.1(1993) - 0.37 (1994)
Iron	24.5	20	10.6 (1992) - 23.0 (1994)

Blank.

Appendix 7

List of submitters

Department of Minerals and Energy
Health Department of Western Australia - Radiological Council
Water Authority of Western Australia
Town of Kwinana