8. ENVIRONMENTAL IMPACTS AND MANAGEMENT

8.1 OVERARCHING ENVIRONMENTAL MANAGEMENT

8.1.1 Global Sustainability

The definition for sustainability that has been widely adopted is outlined in the World Commission on Environment and Development's Brundtland Report (World Commission on Environment and Development, 1987) as:

"Development which meets the needs of the present without compromising the ability of future generations to meet their own needs."

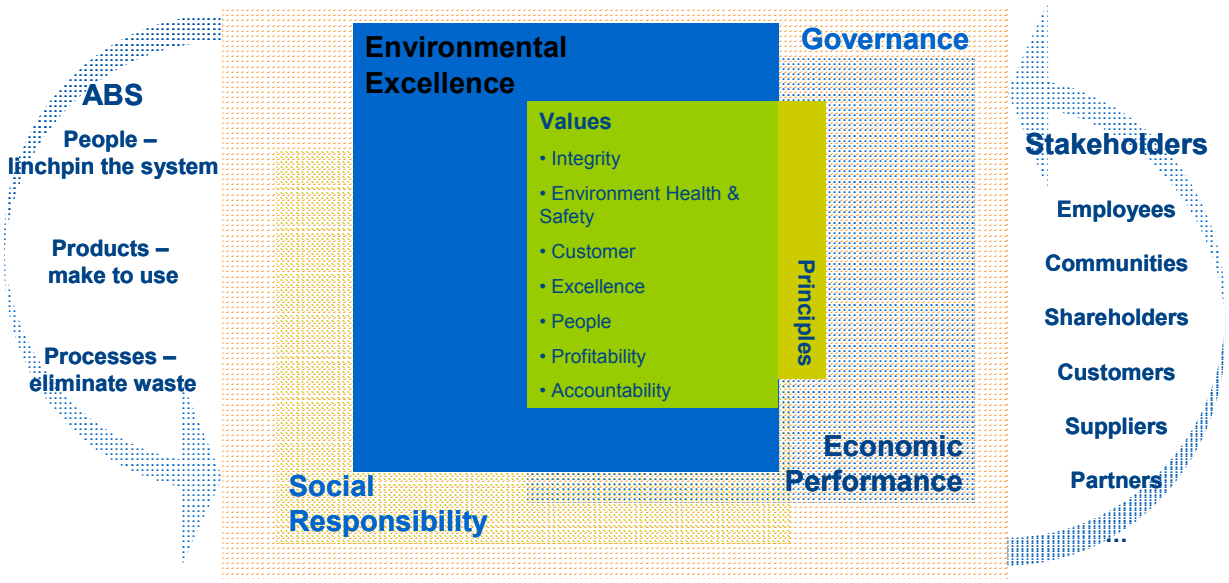
Alcoa's Vision, Values, Principles, and control systems provide the foundation for integrating sustainability into its operations. Alcoa's global sustainability strategy is designed to reflect society's values in Alcoa World Alumina Australia's values to ensure long-term success for the company and all its stakeholders.

Building on its values, Alcoa's sustainability objective is to:

"S*imultaneously achieve financial success, environmental excellence, and social responsibility through partnerships in order to deliver net long-term benefits to our shareholders, employees, customers, suppliers, and the communities in which we operate"*

To achieve this objective Alcoa has developed a sustainability model for the organisation (refer Figure 43).

Figure 43: Alcoa's Sustainability Model



8.1.2 Key global sustainability issues

At the global level Alcoa has identified four broad areas of priority for implementing sustainable practices; these are:

- Climate change
- Engagement with stakeholders, both internal and external
- Integration of sustainability into the company's strategic framework, and
- Energy strategy.

Climate Change

In 1998, globally Alcoa set itself a challenging target on climate change to reduce greenhouse gas (GHG) emissions by 25% below 1990 levels by 2010. That goal was achieved in 2003, and Alcoa is now considering additional targets as it strives to maintain GHG reductions as the company grows significantly.

Alcoa's Western Australian operations continue to improve greenhouse gas intensity, by reducing the amount of greenhouse gas emissions per tonne of alumina produced. The Proposal would see further improvements in greenhouse gas intensity.

Globally, Alcoa actively partners stakeholders to help develop GHG accounting standards in conjunction with the International Aluminium Institute, International Standards Organization, and the International Panel on Climate Change.

Alcoa's aluminium smelters continue to reduce perfluorocarbon (PFC) emissions. In 2004 alone, Alcoa achieved a worldwide reduction of 3.5 to 4.0 million metric tons of CO_2 equivalents per million metric tons of aluminium produced. The company continues to pursue further reductions through the development of a GHG-free (process emissions) inert anode aluminium smelting. In addition, a program to use CO_2 to neutralise bauxite residue in Australia will help improve residue impacts and reduce this emission.

Alcoa has a worldwide commitment to increase the use of recycled metal, which has lower GHG intensity, to 50% of fabricated products by year 2020. The company's beverage can recycling activities save an estimated two million tons of CO_2 each year compared to producing this same metal from primary sources.

Engagement with Stakeholders

Stakeholders are any group or individual affected by the company's operations or that has the capacity to influence operations or future prospects. Alcoa continues to focus on working more closely with stakeholders at an early stage during project development, thereby tapping into their expertise, increasing understanding of their expectations, and defining a stronger relationship.

The community involvement framework developed and implemented as part of this ERMP preparation is shown in Chapter 6.

Integrating Sustainability into Alcoa's Strategic Framework

To take advantage of opportunities for embracing sustainability, Alcoa seeks to further integrate this thinking into internal processes — governance practices, manufacturing and design processes, employee and business systems and business opportunities. Alcoa believes it can achieve this through its strategic framework for sustainability. This is based on:

- Supporting the growth of customer businesses
- Standing among the industrial companies in the first quintile of return on capital (ROC) of the Standard & Poor's Industrials Index
- Elimination of all injuries and work-related illnesses, and the elimination of waste
- Integration of environment, health and safety with manufacturing
- Products designed for the environment
- Environment, Health and Safety as a core Value
- An incident-free workplace (an incident is any unpredicted event with capacity to harm human health, the environment, or physical property), and
- Increased transparency and closer collaboration in community-based environmental, health and safety initiatives.

The integration of sustainability into Alcoa's strategic framework is presented visually in Figure 44 following.

Figure 44: Integration of Sustainability into Alcoa's Strategic Framework

Alcoa also has a strong history of using metrics as a means to drive change within the company. In 2000, it established a 2020 Strategic Framework for Sustainability that is supported by clear targets for measuring progress toward its vision for 2020. These targets are supplemented by environment, health, and safety (EHS) goals and complemented by existing financial goals.

As part of a systematic approach to integrating economic, social, and environmental aspects throughout its businesses, Alcoa has initiated a review of the existing 2020 Framework to make it more comprehensive in terms of sustainability principles. This will also help the company focus future reporting and will be a major project for the Sustainability Team during 2005. The goal is to complete this work for consideration in the 2006 planning processes.

Further, Alcoa together with stakeholders is developing a wide range of performance measures in the economic, environmental and social dimensions of its business. These measures will help gauge performance and enable the setting of targets for the future, including for an expanded Wagerup refinery, should the Proposal proceed.

8.1.3 Energy Strategy

Over the next 30 years, the world demand for energy is expected to double. Most of this growth will come from developing countries like China and India, where demand for electricity will typically outstrip supply and limit the amount of industrial growth that can occur. In addition to finding low-cost sources of energy, Alcoa is also exploring ways to reduce the amount of energy it consumes, to increase use of renewable energy and to reduce the energy used in the life cycle of its products.

8.1.4 Sustainability and the Proposal

This Environmental Review Management Program (ERMP) assesses the environmental elements of the Proposal, including a health risk assessment. The ERMP also includes analysis of certain socio-economic components, for example impacts of a construction workforce on local and regional communities.

In addition to the above, Alcoa recently published a booklet describing socio-economic ideas that could contribute to a sustainable future for the region. Two of these initiatives are a regional sustainability fund, and a learning and enterprise centre. These ideas were developed from research undertaken by Alcoa and others, and following on from dialogue with regional stakeholders, particularly the Socio-Economic Working Group convened for the ERMP preparation phase.

In the following months, during the Government's formal assessment phase, the community is invited to examine the ideas proposed in the socio-economic booklet. It is intended that this dialogue with people from community groups, industry and Government departments will improve upon the projects, with the hope that local people adopt the ideas as their own. They will be better projects with community involvement.

The ERMP and this socio-economic 'Possibilities' document (see www.alcoa.com.au/wagerup3 to download a copy) together help describe Alcoa's approach to sustainability, incorporating environmental and health components, with social and economic considerations.

8.1.5 Sustainability Principles Related to the Proposal

Alcoa's sustainability framework, which complements national and WA sustainability principles, is based on eight principles. These are outlined below and include a description of how these principles are being applied in the Proposal.

Respect for People

We listen to, and respect the views of our workforce and the communities wherever we operate, and we formulate partnerships that strengthen our interdependence and improve well-being.

Alcoa is committed to ensuring that the Proposal makes a positive and sustainable contribution to the local and regional communities in which the refinery operates.

While there are some challenges, Alcoa continues to strive to meet community concerns over health and environmental issues. There has been significant investment in the area of

emissions reduction and monitoring of results, and Alcoa understands it is essential to work with the local community to address their concerns.

The community involvement framework implemented for this Proposal was designed to respect and acknowledge the different information and involvement needs of stakeholders. This framework allowed people to determine whether they wanted to be directly involved through working groups or rely on periodic information distribution through newsletters, advertising, letterbox drops, informal meetings or other channels.

Ongoing community consultation regarding many aspects of Wagerup refinery operations (environmental and otherwise) remain important to Alcoa and members of the local community and will continue well beyond the Proposal discussions.

The needs and expectations of Wagerup refinery employees have been recognised through the workforce briefings offered when the project was first discussed publicly, periodic project updates and through a program specifically structured to ensure employees have a voice in project design. Additional employee involvement programs will consider issues such as workplace ergonomics, occupational health, noise, chemical exposure and the various aspects of workplace safety.

Building Community Experience and Well-being

Our operations contribute to improved quality of life and build skills, knowledge and experience in the communities with which we interact, while respecting the significance and diversity of their culture and heritage.

A significant emphasis has been placed on positively addressing sustainable community needs. This has resulted in the formation of the Alcoa Research Centre for Stronger Communities, as part of our partnership with Curtin University of Technology launched in 2003. Alcoa hopes to use this development to assist with building skills, knowledge and experience in the communities in which it operates along with other Australian communities.

Through this and other community programs underway, Alcoa intends to contribute a positive future for the communities in which it operates, including communities around the Wagerup refinery.

Several community programs are already underway and several initiatives proposed for further discussion over the next few months have been put forward by community members and by Alcoa employees as a key component of building community experience and well-being.

As part of the Proposal, one of the key projects identified is a regional sustainability fund. It is anticipated that the community is represented on a committee including local and state

government, and Alcoa. In this way our host communities will be better able to have a voice about the future of the region. It is also recognised that this responsibility will require assistance and for any representatives of local communities to have the support of the broader community. Dialogue over the next few months will enable local communities to engage in this exciting opportunity and help design how this community experience can be maximised.

Long-term Economic Benefit

Our operations deliver economic benefits to the regions and States in which they operate, to the nation, and to society in general. Our operations foster economic growth, generate wealth for the community, provide commercial returns to our shareholders and contribute to long-term economic health.

Demand for alumina, particularly from China; provides an increasing demand for aluminium which in turn has stimulated an opportunity for growth in Alcoa's Western Australian operations, through the Wagerup Unit Three proposal.

The Proposal would provide substantial economic benefits to the region, the state of Western Australia and Australia as a whole. Implementation of the Proposal would involve further investment of over $1.5 billion by Alcoa in its Wagerup refinery. It would increase production to around 4.7 million tonnes per annum and increase the value of WA exports by more than $550 million per year.

Construction of the Proposal would result in more than 1500 construction jobs. Research has shown that the Proposal would result in an additional 150 new permanent jobs at the refinery, minesite and port, and over 3000 direct and indirect jobs in Western Australia. Alcoa has policies and programs in place to maximise local and regional employment, and is working with local suppliers, in particular local fabricators, to maximise local content.

Efficient Resource Use & Cleaner Production

We use natural resources wisely and manage our environmental impacts to the benefit of the full range of our stakeholders by employing leading technology and best practice management, and by encouraging responsible design, use, recycling and disposal of our products.

Alcoa continues to develop cleaner production solutions and has continued to strive for this and efficient resource use as part of the Proposal. Considerable research, monitoring and consultation has been undertaken in the areas of air quality, noise emissions, residue management, water supply and land management issues. The Proposal includes both production improvements and emission control works, the outcomes of which are assessed and described in sections of this ERMP dealing with environmental impact management.

In the past, Alcoa has invested more than $25 million to reduce odorous emissions in the calcination, digestion, evaporation and clarification areas of the Wagerup refinery and to reduce oxides of nitrogen emissions from the powerhouse.

Noise from the refinery has been an ongoing challenge, leading to a major noise reduction program implemented in 1995 and another in 2000. As part of this Proposal, specialist noise consultants were engaged to ensure the Proposal does not result in increased noise impacts.

Ecological Integrity & Biodiversity

Our operations maintain or enhance biological diversity and the fabric of ecological integrity in the environments in which we operate.

Alcoa will maintain a specific focus on ecosystem biodiversity through its continued support of Landcare biodiversity activities. Alcoa will build on its achievement of 100 per cent species richness in post-mining jarrah forest rehabilitation in the Darling Range.

Restoration work in the forest areas will continue, with a continued effort towards research, development and implementation of innovative practices and technologies in the areas of seed treatment, seed application, topsoil handling, mine planning and native plant propagation. Alcoa will continue to work with scientists from local universities, the WA Department of Conservation and Land Management and Land Management and the Botanic Gardens and Parks Authority.

Meeting the Needs of Current and Future Generations

We take a long-term approach to our activities, and work in partnership with communities and governments to meet the needs and desires of today without compromising the ability of future generations to satisfy their own needs.

Alcoa recognises the collective effort of employees at the Wagerup refinery in the local communities where they live and rewards initiatives in several areas, including where employees volunteer their time working on community projects. Creating lasting community capacity in the region surrounding the Wagerup refinery will continue to be a focus of the Proposal.

An idea outlined in the socio-economic 'possibilities' document recently released describes a regional sustainability fund, which will greatly contribute to the long-term future both for current communities and their children. The specifics of this fund will be discussed with stakeholders in the region during its formation, and it is anticipated that the Principles under which it operates would refer to long-term sustainability objectives, particularly in the area of community capacity building for future generations.

Stakeholder Involvement

We work with our communities, employees, customers, shareholders and suppliers to achieve outcomes and make decisions of mutual benefit. We report regularly to all our stakeholders on the sustainability performance of our operations.

Alcoa wishes to ensure it understands and addresses the needs of all key stakeholders of its Wagerup operations especially employees, neighbours, and local and regional residents, through an effective and ongoing engagement process. The community involvement framework implemented for this project, was developed in consultation with the local Community Consultative Network, and was comprehensive and intensive community engagement. Best practice consultation has been a strength of the Proposal through early definition and resolution of issues.

Accountability & Governance

We practice ethical business governance, are accountable for our actions, continually improve our performance and integrate environmental, social and economic considerations in our decision-making.

Accountability of Alcoa in the Proposal depends on being open, honest and transparent with individuals and in the teams of all people involved in all behaviours and actions. This will determine the success of the project which has major impacts on our customers, employees, shareholders and communities. The remainder of Section 8 of this ERMP outlines the potential impacts of the proposal, and the ways in which these impacts will be avoided, minimised or managed in accordance with the above principles.

8.1.6 Environmental Management System

Alcoa has developed and implemented a comprehensive Environmental Management System (EMS) for the Wagerup refinery, which was certified to the International Standards Organisation 14001 EMS Standard in February 2001.

Key elements of the EMS currently include:

- an Environmental Management Team with specific environmental roles and responsibilities;
- environmental aspects (issues) register;
- environmental improvement plans;
- operational control procedures;
- environmental monitoring;
- regular auditing and feedback, and
- incident reporting and corrective action follow-up.

The EMS is based on the 'Continual Improvement' model outlined in ISO 14001 where organisations:

- develop an Environmental Policy;
- plan how to manage and reduce environmental impacts by setting goals and actions required to meet these goals;
- implement these plans;
- monitor and audit implementation of these plans against the system and raise corrective actions where activities are not achieving the desired outcomes; and
- review the EMS as a whole to see if it is meeting its objectives of improving environmental performance.

The Wagerup EMS is audited by both internal and external parties on a regular basis, to ensure that the system is operating effectively and resulting in continual improvement in environmental management.

The Wagerup EMS is integrated into other management systems within the organisation. The Environmental Management Manual (Alcoa, 2003) unites all the various procedures, work instructions and guidelines applicable to all parts of the operation into a simple, easily accessible cross-referencing system that can be applied by all Alcoa personnel. This helps facilitate good environmental management becoming part of day-to-day operations and is extended, via the employees, to areas outside Alcoa's immediate operations, into the home and community.

The EMS and its associated documentation will be amended as necessary to incorporate changes associated with the Proposal, including specific measures to cover the construction period of the Proposal.

Commitment 1.

Alcoa will be guided by its Sustainability Principles and will operate within the guidelines of its Environmental Management System (EMS) in implementing the Proposal.

8.2 IDENTIFICATION OF ENVIRONMENTAL FACTORS

The EPA has prepared a list of generic environmental factors and associated environmental objectives to be considered for the assessment of new proposals. These factors are broad in their coverage and are designed as a starting point from which proponents may develop site specific factors and objectives.

Alcoa commenced the identification of key environmental factors very early in the Proposal planning stages. The Proposal will be developed at the site of the existing Wagerup refinery which has been operational since 1984. There is therefore a good understanding of the natural and cultural environment within which the Proposal is located.

Of particular significance in understanding issues of community interest has been the community involvement framework established for the Proposal, which is described in detail in section 6. This framework has provided many opportunities for community input during the development of this ERMP. This has occurred through an initial stakeholder forum that identified issues and opportunities of significance and also through the five working groups established for ERMP consultation.

This community involvement framework has allowed ongoing identification and refinement of environmental issues during development of the ERMP.

Key environmental factors were initially identified in the Environmental Referral document (which assists the EPA in setting the level of assessment). These factors and objectives were then finalised in consultation with relevant government agencies and agreed with the EPA. These were presented in the Environmental Scoping document, along with the studies that would be undertaken as part of the ERMP. The Environmental Scoping document was released for a two-week public comment period in September 2004 and finalised in March 2005.

The key environmental factors and issues that are considered to be significant in the assessment of the environmental impacts of the Proposal are presented in Table E1 in the Executive Summary of this document. The key factors and issues identified are:

- Sustainability
- Air Quality – Refinery Gaseous and Dust Emissions
- Air quality – RDAs and Cooling Ponds, Gaseous and Dust emissions
- Air Quality – Bunbury Port
- Air quality – Construction Dust
- Noise – Wagerup Refinery
- Noise – Bunbury Port
- Greenhouse Gas Emissions

- Water Supply
- Surface Water Quality
- Groundwater Quality
- Liquid and Solid Wastes (other than bauxite residue)
- Biodiversity
- Flora and Vegetation
- Fauna - Specially Protected (Threatened) Fauna
- Archaeological Heritage and Ethnographic Issues
- Public Safety Risk
- Visual Impact
- Transport.

Specific management plans have been developed (refer to section 10) for the Proposal for management of the following key factors:

- Air quality;
- Noise;
- Water supply; and
- Spill management.

Management of the remaining environmental factors will be addressed within existing management plans and procedures for the Wagerup refinery.

8.3 AIR QUALITY

The EPA's objective for the Proposal with regards to management of air quality at the refinery is:

- *to ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses, by meeting statutory requirements and acceptable standards.*

8.3.1 Introduction

Air emissions are usually grouped into two categories, point source emissions and diffuse source emissions. The emissions associated with the refinery processing area are considered point source emissions and arise where the refinery gases or particulates are emitted to the atmosphere through identified points such as stacks and vents.

Diffuse source emissions originate over a broader area where there is little or no redirection of the vapours or particulates. Emissions from the various parts of the Residue Drying Areas (RDA) and the bauxite stockpiles are considered diffuse source emissions. Emission estimates have been calculated for these diffuse sources including the stockpiles, drying beds, cooling ponds and superthickener. The specific point (refinery) and diffuse (RDA) source emission locations, their estimated emission rates as a result of the proposal and the reasons for the selection of these emission estimates are described in the Air Quality Summary report accompanying this ERMP (Appendix G)

The emissions from the various point and diffuse sources for Wagerup refinery can be broadly categorised as follows:

- Particulate matter (e.g. total suspended particulates and various sizes of dust);
- Volatile organic compounds (e.g. aldehydes, ketones, PAH's and aromatic compounds (BTEX));
- Combustion gases (e.g. nitrogen oxides (NO_x) and carbon monoxide (CO));
- Trace metals (e.g. nickel, cadmium and mercury)
- Odour

Not all sources have the range of emissions listed above, for example bauxite stockpiles can emit metals in dust, but are unlikely to emit measurable amounts of volatile organic compounds or combustion gases.

8.3.2 Main Emissions Sources

Emissions of particulate matter (or dust) are released from the RDAs, bauxite stockpiles, the calciners (as alumina dust) and to a lesser extent from the oxalate kilns. Dust emissions also arise intermittently from bulk materials handling and transport activities. These latter two sources are considered relatively minor and have not been included as emission sources for the purpose of air dispersion modelling to derive ground level concentrations in neighbouring areas.

Volatile Organic Compound (VOC) emissions from alumina refineries are caused by the breakdown of organic material contained in the bauxite, additives to the liquor stream and by-products of fuel combustion. During the refining process organics are broken down, which can create a wide range of substances, some of which are volatile enough to be emitted by air. These VOCs are considered to be the cause of the characteristic odour of alumina refineries. They are emitted from areas such as vents, stacks and cooling towers within the processing area and mainly from the surfaces of the drying beds, cooling pond, lower dam and superthickener at the residue area.

Combustion gases are released as a result of the burning of natural gas within parts of the refinery processing area, including the powerhouse, calciners and oxalate kiln. The main combustion gases released from the Wagerup refinery are oxides of nitrogen (NO_x), carbon monoxide (CO) and sulphur dioxide (SO_2).

Metals such as mercury, arsenic, cadmium and nickel are introduced into the refining process, mainly through the trace amounts present in bauxite and the current knowledge indicates the majority of metals are recirculated within the caustic liquor stream or deposited with the residue. However, trace concentrations of metals have been found in gaseous emissions from the refinery processing area and the dust leaving sources such as bauxite stockpiles and the RDA.

8.3.3 Emissions Estimates for the Proposal

The sources of emissions used in the air dispersion modelling and prediction of ground level concentrations are listed in the accompanying Air Quality Summary Report (Appendix G).

The significant point sources of emissions included in the ERMP air dispersion modelling account for approximately 96% of the total mass of refinery emissions. Minor sources not included in the modelling together account for the remaining 4% of processing area emissions, with no individual source amongst these accounting for 1% or more of point source emissions.

Wherever possible point source emissions have been estimated for the Proposal using monitored data, which, where relevant, have been adjusted to account for additional

throughput or emission reduction works. Where particular parts of the processing equipment will be duplicated (as part of the proposal) emission estimates have been based on known data considering capacity, technology, anticipated operating conditions and, where relevant, other equipment specifications.

The monitored data used in these estimates have come from a variety of sampling programs including ongoing monitoring required under the environmental licence or specific monitoring campaigns such as the 1999 emissions inventory program. These monitoring programs have been described more fully in the CSIRO Air Quality Review (CSIRO, 2004) and were the subject of an independent audit undertaken for the Department of Environment in 2002/03 (AWN, 2003).

Diffuse source emissions have had limited data collection prior to consideration of this proposal, consequently a specific monitoring exercise at the residue area was undertaken as part of this ERMP.

A full description of the methodology used to estimate emissions from the RDA is provided in Appendix G. Calculations were made for both the existing, based on an active drying area of 168 ha and an expanded residue area with an active drying area of 274 ha. Although refinery throughput significantly increases as a result of the Proposal, a proportional increase in active drying area will not eventuate. This is due to a significant change in the sand to mud ratio of the total residue volume sent to the residue area as outlined in Appendix G.

Dust emission rates from the RDA were calculated considering the impacts of wind erosion, operating circumstances such as bulldozing of the residue surface and the dust control effects of the residue sprinkler system. Wind erosion from the active drying areas is considered the primary source of dust emission from the RDA and an important component of dust control associated with the proposal is the planned upgrade of the residue sprinkler system. This upgrade to increase sprinkler density and reliability contributes to a reduction in total dust emissions.

RDA gaseous emissions were estimated based on a specific monitoring program undertaken during October 2004 to February 2005. This program used a USEPA isolation flux chamber as recommended by CSIRO and AWN, to capture gaseous releases from the surfaces of drying areas, ponds and the superthickener. The measured gaseous emission rates were then multiplied by the surface area of the various sources to generate a combined mass emission rate.

The measured emission rates for the existing RDA were then used to calculate RDA gaseous emissions for the expanded RDA associated with the Proposal. This process included provision for the increased active drying area and the effects various process changes are expected to have on individual area emission rates. For example, while the surface area of the

superthickener, cooling pond and ROWS pond will not increase with the Proposal, their VOC loads are estimated to increase by 20%, 50% and 100% respectively.

A detailed description of the methodology used, the assumptions made and the measured emission rates for the RDA and monitored compounds is contained in the Air Quality Summary report accompanying this ERMP (Appendix G).

8.3.4 Modelled Scenarios

The air dispersion modelling undertaken as part of the ERMP considered three refinery and two RDA scenarios. The cases for the refinery were the base case, which was taken to represent the refinery conditions during 2004, when the project was referred to the EPA. This case is based on an average daily production of 6600 tonnes per day (tpd) of alumina and a peak daily production of 7100 tpd. Two refinery expansion scenarios were also modelled; one assuming additional power and steam supply will be provided by cogeneration units (gas turbines) and the second assuming gas fired boilers will be used. Both expansion scenarios assumed an average daily production of 12,877 tpd of alumina and a peak production rate of 13,699 tpd, which were based on the respective nominal and maximum design production rates for the Proposal.

Over the life of the refinery the RDA will expand regardless of whether or not the Proposal is implemented, however, the active drying area remains relatively constant, driven primarily by the rate of residue generation. Once cells within the RDA are fully used they are stabilised and rehabilitated, while new cells are used for residue drying.

The refinery point source modelling was undertaken by the CSIRO using The Air Pollution Model (TAPM). This work was undertaken in three phases which are described in detail in the reports prepared by the CSIRO (CSIRO 2004a CSIRO 2004b and CSIRO 2005). The methodology and outcomes of this work are also summarised in Appendix G.

Phase 1 of the CSIRO modelling study involved an evaluation of the suitability of TAPM for this application by comparing the hourly-averaged meteorological predictions from TAPM to field meteorological measurements in close proximity to the Wagerup refinery. TAPM was found to adequately predict local meteorological conditions.

Phase 2 of the study involved an evaluation of TAPM as a tool to predict the impact of refinery air emissions on surrounding air quality. This was done by modelling hourly-averaged oxides of nitrogen (NO_x) concentrations at ground level and comparing this to measured NO_x data for the same period. NO_x are emitted from the refinery and dispersed in easily detectable amounts so it is a useful "marker" of refinery emissions (when other sources such as wood fires are accounted for). NO_x data are also available from several locations in the vicinity of the refinery allowing the comparison to be made with modelled predictions. Comparison of the modelled NO_x concentrations against relevant measured data showed

TAPM was able to adequately predict the ground level NO_x concentrations resulting from refinery emissions. It was therefore considered suitable for modelling the concentrations of other refinery air-emitted substances.

Phase 3 of the CSIRO study was to use TAPM to model ground level concentrations of 27 refinery-emitted substances for both the base case and two expanded refinery scenarios. The process used to select the 27 substances is described in the Air Quality Summary report (Appendix G) and was selection based on a combination of the quantity emitted and their potential to cause health effects.

The base case and expansion modelling predicted ground level concentrations of the 27 compounds for every hour in the modelled year. This then allowed identification of predicted concentrations against a variety of health or environmental guidelines, such as maximum 1-hourly concentrations, 95th percentile 24-hour average concentrations and annual average concentrations.

TAPM was not considered to be the best model to use in the case of diffuse sources emissions (from the RDA) mainly due to its limitations in modeling windblown dust. Consequently these were modelled by specialist consultants using the California Puff Model (Calpuff). Calpuff was chosen for diffuse modelling because of its ability to handle releases from large areas, its predictive capability under light winds and its incorporation of variable winds and the effects of terrain. Details of the Calpuff modelling are provided in Appendix G.

Calpuff modelling (using meteorology predicted by TAPM) was used to compare model predicted ground level particulate and odour concentrations against measured concentrations. This comparison confirmed that Calpuff was adequately predicting the dispersion of airborne contaminants from the RDA.

To establish the environmental implications of the emissions and undertake the Health Risk Assessment, it is important to consider the combined effects of emissions from point and diffuse sources. To allow this assessment the ground level concentration contributions from both TAPM and Calpuff modelling were added. This occurred for each of the 27 modelled contaminants and was undertaken hour by hour to generate a combined ground level concentration for each hour of the modelled year.

A description of the model set up parameters and the addition of the TAPM and Calpuff components is provided in Appendix G.

The evaluation of predicted contaminant concentrations against health guidelines and hazard indices is described in full in the Health Risk Assessment study accompanying this ERMP (Appendix F).

Potential Impacts

Emission control measures are included in the Proposal to ensure the changes do not cause a significant detrimental impact on surrounding air quality. Areas for consideration include: dust emissions due to the increased residue drying area; VOC emissions from the new calciners or from various vents; and metal emissions carried in dust and from some refinery point sources.

Alcoa gave public undertakings that the Proposal would not cause increased odour, dust or noise impacts on surrounding residents and that it would meet world class health risk criteria.

8.3.5 Emission Controls

To achieve these undertakings and ensure acceptable air quality outcomes, the Proposal includes some important emission control initiatives, particularly for refinery point sources. These control measures are listed in the accompanying Air Quality Management Plan (refer to section 10) and include initiatives (or equivalent emission control works) such as:

- A Regenerative Thermal Oxidiser (RTO) on the liquor burner;
- An RTO on oxalate process emissions;
- Improved calciner performance;
- Low NO_x burners in new boilers;
- Redirection of calciner low volume vent emissions for destruction;
- Reduction in cooling tower VOC emissions;
- Reduced emissions from causticisation;
- Sealing of some additional tank vents;
- Green liquor filter upgrades, and
- Upgraded sprinkler system for the RDA.

For some sources, the Proposal will result in increased emissions including:

- New pieces of equipment (e.g. additional calciners);
- Areas with emission volume increases (e.g. power house CO_2); and
- Areas where emission concentrations increase (e.g. RDA cooling pond).

Appendix G lists the emission estimates for each modelled point and diffuse source, incorporating the changes included in the Proposal. It is the net outcome of these changes that is represented by the modelled ground level concentrations for the two expanded refinery scenarios.

The modelling studies were undertaken to allow the potential air quality effects of the Proposal to be judged against the public undertakings and accepted ambient air quality standards. The modelling results were then used in a Health Risk Assessment that assesses

the predicted ground level concentrations of emissions against relevant health standards and guidelines (Appendix F).

8.3.6 Results of Modelling

The predicted air quality implications of the proposal have been assessed in three ways:

- Comparison to the National Environmental Protection Council (NEPC) ambient air quality guidelines
- Assessment of changes in ground level concentrations, and
- Completion of a Health Risk Assessment.

The outcomes of these assessments are considered in relation to nearby receptors, in this case nearby residences.

National Environmental Protection Measures (NEPM)

The National Environment Protection Council (NEPC) has produced the following national ambient air quality guidelines for the protection of human health:

- National Environment Protection (Ambient Air Quality) Measure (NEPC, 1998a) which sets national air quality Standards for the criteria pollutants SO_2, NO_x, ozone, CO, particulate (as PM_{10}) and lead

- Draft National Environment Protection (Air Toxics) Measure (NEPC, 2003) which proposes Investigation Levels for the air pollutants benzene, benzo(a)pyrene (as a marker for Polycyclic Aromatic Hydrocarbons [PAHs]), formaldehyde, toluene and xylenes. This measure is in draft and the Investigation Levels are currently being considered by the NEPC, and therefore are subject to change.

A summary of these guideline values is presented in Table 21.

Table 21: National Environment Protection Measures - Ambient Air Guidelines

Pollutant	Averaging Period	Ambient Guideline		Goal
		(ppm)	(µg/m^3) [1]	
Ambient Air NEPM		*Standard*		*See Note 2*
Carbon Monoxide	8 hours	9.0	11,250	1 day a year
Nitrogen Dioxide	1 hour	0.12	246	1 day a year
	1 year	0.03	62	none
Photochemical oxidants (as ozone)	1 hour	0.10	214	1 day a year
	4 hours	0.08	171	1 day a year
Sulphur Dioxide	1 hour	0.20	571	1 day a year
	1 day	0.08	229	1 day a year
	1 year	0.02	57	none
Particles as PM_{10}	1 day	-	50	5 days a year
	1 year	-	8	
Draft Air Toxics NEPM		*Draft Investigation Level* [4]		
benzene	Annual	0.003	8.8	*See Note 5*
formaldehyde	24 hour	0.015	16.9	
toluene	24 hour	2	6,907	
xylenes	24 hour	0.2	795	

Note:

1. Referenced to a temperature of 0 ^oC and absolute pressure of 101.3 kPa.
2. Maximum allowable exceedence of the Standard, to be achieved by the year 2008.
3. Goal is to gather sufficient data nationally to facilitate a review of the standard as part of the review of this Measure scheduled to commence in 2005.
4. Noted that the Impact Statement for the Draft Air Toxics NEPM (NEPC, 1998b) reports the Investigation Levels referenced to a temperature of 25 ^oC, however for consistency within this table the Investigation Levels have been referenced to 0 ^oC.
5. Eight-year goal is to gather sufficient data nationally to facilitate development of a standard.

Table 22 shows the maximum and annual average concentrations predicted at the receptor location(s) exhibiting the highest predicted impact for the expanded refinery, along with a comparison to the relevant NEPM guideline values.

Table 22: Maximum and Annual Average Ground Level Concentrations Predicted at the Receptor Location Associated with the Highest Predicted Concentration

Pollutant	Averaging Period	Maximum Predicted Concentration (µg/m^3)		Expanded refinery scenario - Case 6 (Cogeneration)	
		Base case	Expansion (cogen)	Receptor Exhibiting Highest Predicted Concentration	Percentage of Guideline (%)
Nitrogen dioxide	1-hour	51	52	34	21.2%
	Annual	0.57	0.63	34	1.0%
Carbon monoxide	8-hour	31	39	16	0.3%
Sulphur dioxide	1-hour	11.2	14.1	34	2.5%
	24-hour	2.1	2.7	16	1.2%
	annual	0.04	0.07	16,34	0.1%
Particulates (as PM_{10})	24-hour	35.0	32.7	22	65.4%
Benzene	annual	0.0029	0.0034	16	0.01%
Formaldehyde	24-hour	0.476	0.144	25	1.3%
Toluene	24-hour	0.311	0.040	34	0.01%
Xylenes	24-hour	0.051	0.006	25	0.001%

From the data presented in Table 22 it can be seen that:

- The maximum and annual average ground level concentrations predicted for both the base case and expanded scenario at the receptor exhibiting the highest predicted impacts are well below the Standards (for NO_2, CO, SO_2 and PM_{10}), and the draft Investigation Levels (for benzene, formaldehyde, toluene and xylenes) specified in the relevant NEPM;

- The 24-hour average concentration of PM_{10} at receptor 22 is predicted to most closely approach the relevant NEPM Standard, but is still less than two thirds of the relevant Standard.

Table 23 below presents the relative change in air quality characteristics in the Yarloop town site as a result of the proposal and in comparison to relevant ambient guidelines. Receptor location 4 (Refer Figure 45) has been chosen as representative of Yarloop. Table 24 shows a similar set of data for Hamel, represented by receptor location 10. Yarloop and Hamel are the nearest town sites to the Wagerup refinery and are located 2 kilometres to the south and 4 kilometres to the north respectively.

Table 23: Ground Level Concentrations Predicted at the Yarloop Town site*

Pollutant	Averaging Period	Maximum Predicted Concentration (µg/m^3)			Ambient Guideline (µg/m^3)	% of Ambient Guideline
		Base case	Expansion (cogen)	Expansion (boilers)		
Nitrogen dioxide	1-hour	42	40	44	246	17.9%
	Annual	0.25	0.28	0.26	62	0.4%
Carbon monoxide	8-hour	15	20	20	11,250	0.2%
Sulphur dioxide	1-hour	6.3	6.5	7.7	571	1.4%
	24-hour	1.1	1.3	1.4	228	0.6%
	annual	0.02	0.03	0.03	57	0.1%
Particulates (as PM_{10})	24-hour	4.4	4.3	4.3	50	8.6%
Benzene	annual	0.0009	0.0010	0.0011	60	0.0%
Formaldehyde	24-hour	0.114	0.065	0.065	11	0.6%
Toluene	24-hour	0.105	0.011	0.011	411	<0.1%
Xylenes	24-hour	0.014	0.001	0.001	946	<0.1%

* Note: Receptor 4 was used to be representative of Yarloop Town site

Table 24: Ground Level Concentrations Predicted at the Hamel Town site

Pollutant	Averaging Period	Maximum Predicted Concentration (µg/m^3)			Ambient Guideline (µg/m^3)	% of Ambient Guideline
		Base case	Expansion (cogen)	Expansion (boilers)		
Nitrogen dioxide	1-hour	35	29	30	246	12.0%
	Annual	0.24	0.33	0.27	62	0.5%
Carbon monoxide	8-hour	16	20	20	11,250	0.2%
Sulphur dioxide	1-hour	4.1	4.2	4.8	571	0.8%
	24-hour	1.1	1.2	1.3	228	0.6%
	annual	0.02	0.03	0.03	57	0.1%
Particulates (as PM_{10})	24-hour	5.3	5.8	5.8	50	11.6%
Benzene	annual	0.0010	0.0009	0.0010	60	0.0%
Formaldehyde	24-hour	0.119	0.072	0.072	11	0.7%
Toluene	24-hour	0.062	0.011	0.011	411	<0.1%
Xylenes	24-hour	0.011	0.002	0.002	946	<0.1%

* Note: Receptor 10 was used to be representative of Hamel Town site

From Table 23 and 24 it can be seen that based on accepted health guidelines, the Proposal will not cause a reduction in key air quality indicators within either adjoining town site. When considered in conjunction with ambient concentrations (section 7.9) the overall concentration of these compounds in nearby town sites may be affected more by other sources, such as vehicle emissions and wood fires during winter.

8.3.7 Changes in Ground Level Concentration Contours

For each of the modelled compounds where a GLC guideline exists, contour plotting has shown that the guidelines are met at all receptor locations. In other words, the compound concentrations from refinery and RDA sources at all nearby residences are within accepted guideline levels, including those closest to the refinery.

An understanding of the predicted air quality changes as a result of the Proposal can also be gained by comparing the modelled ground level concentrations (GLC) of key compounds under the existing and expanded scenarios. This can be seen in GLC contour plots prepared for key compounds in each scenario. This allows a visual assessment of the changes at nearby receptor locations (residences).

Figures 45 to 52 are examples of the changes in compound GLC from the existing to the expanded refinery scenario. Examples have been chosen in the four main categories of airborne emissions: VOCs, dust, metals and odour.

In each case:

- Refinery point sources and RDA diffuse sources have been combined;
- The expanded refinery scenario includes the cogeneration power supply;
- Nearby residences are indicated by numbers; and
- The dashed white line shows the current "Area A" land management boundary.

For contours other than odour, the averaging time and peak percentile location have been selected based on the comparison to guidelines undertaken in the accompanying Health Risk Assessment.

Figures 45 and 46 show that the predicted peak 24-hour formaldehyde and acetaldehyde ground level concentrations contours contract as a result of the Proposal. This is primarily due to emission control works in refinery areas included as part of the Proposal, particularly the capture and destruction of vent gases and reduction in VOC emissions from cooling towers.

Figure 45: Peak (99.5th percentile) 24-hour average formaldehyde concentrations for the existing (top) and expanded refinery (bottom) scenarios

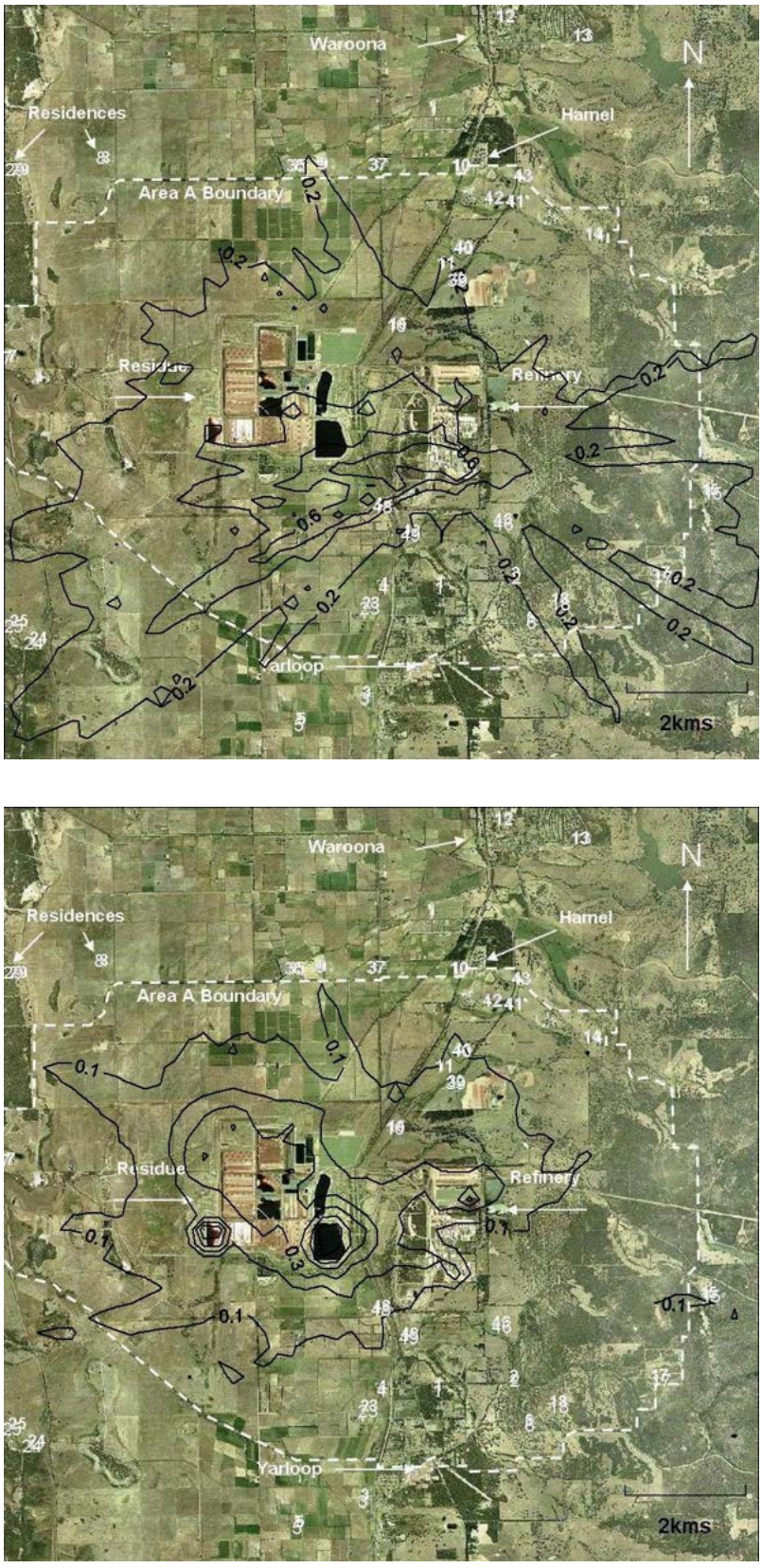


Figure 46: Peak (99.5th percentile) 24-hour average acetaldehyde concentrations for the existing (top) and expanded refinery (bottom) scenarios

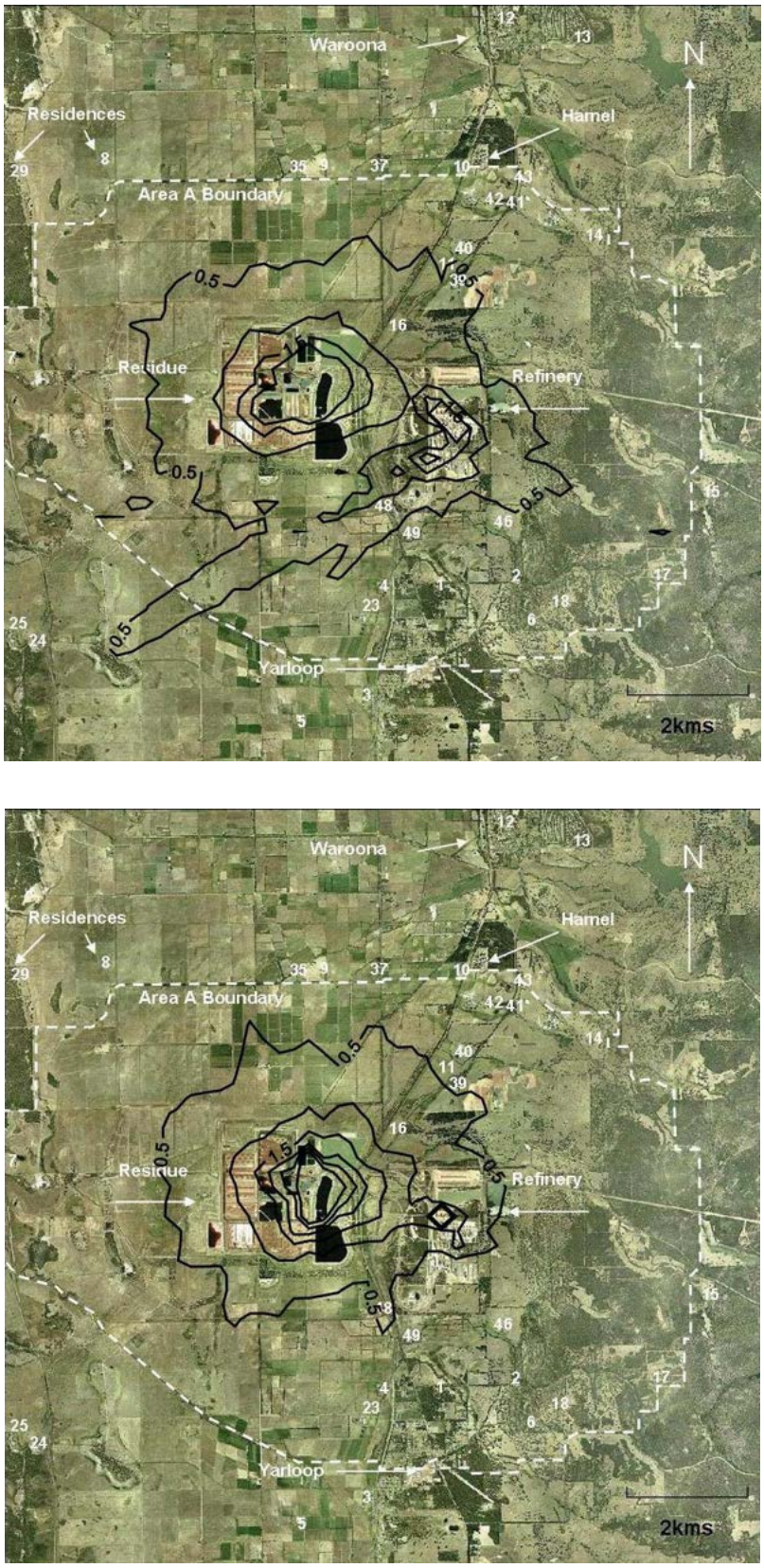


Figure 47 shows that predicted peak (99.9th percentile) 1-hour ground level concentrations for mercury increases very slightly at some receptor locations. However these changes are extremely small; less than 0.0015 micrograms per cubic metre (ug/m^3). Ground level concentrations are still some 2 % (or less) of the 1-hour guideline value of 1.8 ug/m^3 (*California Office of Environmental Health hazard Assessments Toxicity Criteria database*)

Figure 48 shows that annual average ground level concentrations of arsenic are predicted to spread slightly further from the refinery and RDA areas as a result of the Proposal. However, these concentrations are at extremely low levels. The maximum predicted concentration experienced at receptor locations, after implementation of the Proposal, is between 0.00013 and 0.000018 ug/m^3, which are 8,000 to 55,000 times less than the relevant guideline value of 1.0 ug/m^3 (*Dutch National Institute of Public Health and Environment human-toxicological Maximum Permissible Risk Levels, 2001*)

Figures 49 and 50 show that for all receptor locations the peak 24 hour dust concentrations (PM_{10} and TSP) reduce as a result of the Proposal. This is due to the combination of dust control initiatives at both refinery point sources and the RDA.

Figure 47: Peak (99.9th percentile) 1-hour mercury concentrations for the existing (top) and expanded refinery (bottom) scenarios

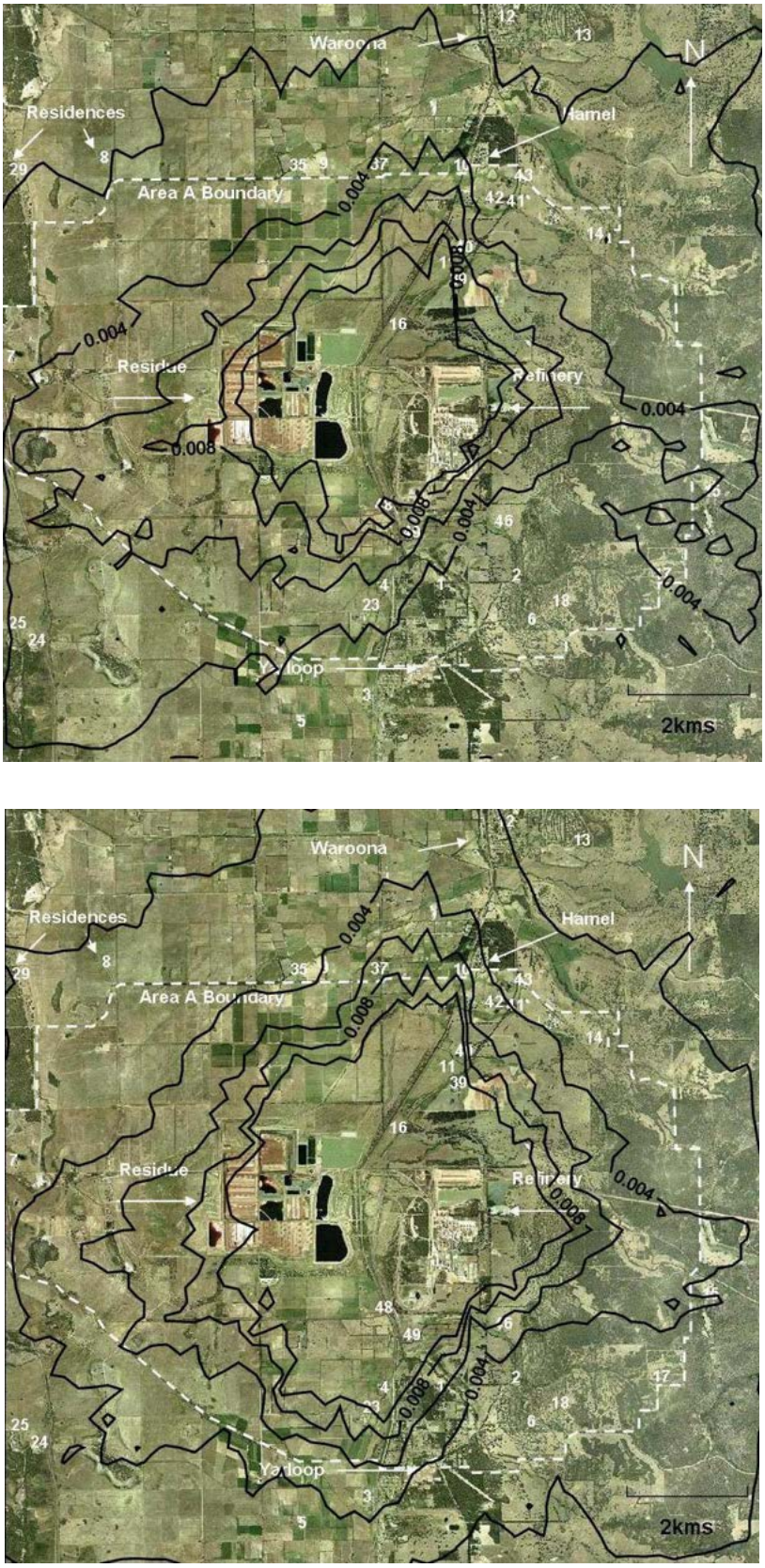


Figure 48: Annual average arsenic concentrations for the existing (top) and expanded refinery (bottom) scenarios

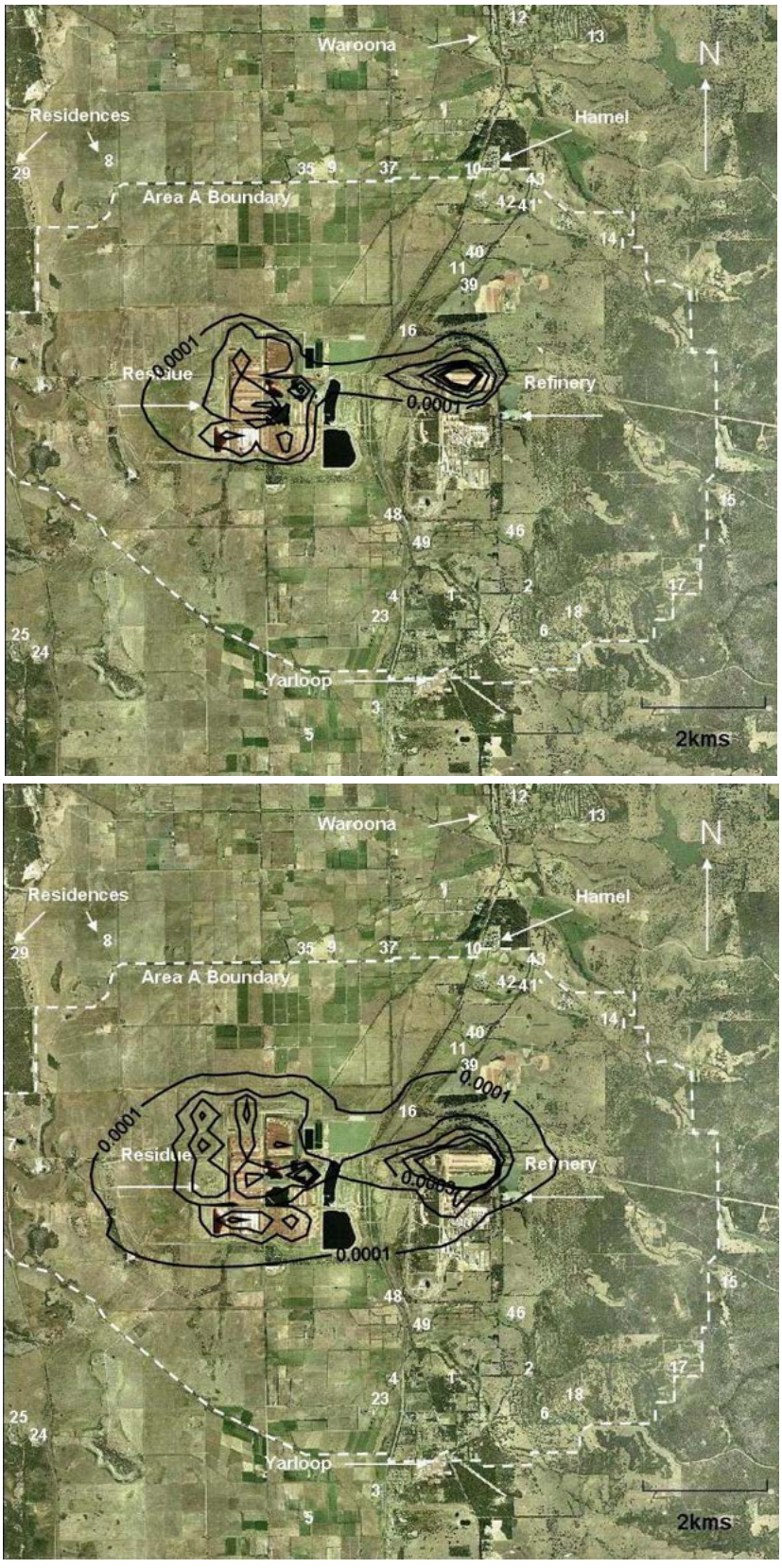


Figure 49: Peak (99.5th percentile) 24-hour average dust (PM_{10}) concentrations for the existing (top) and expanded refinery (bottom) scenarios

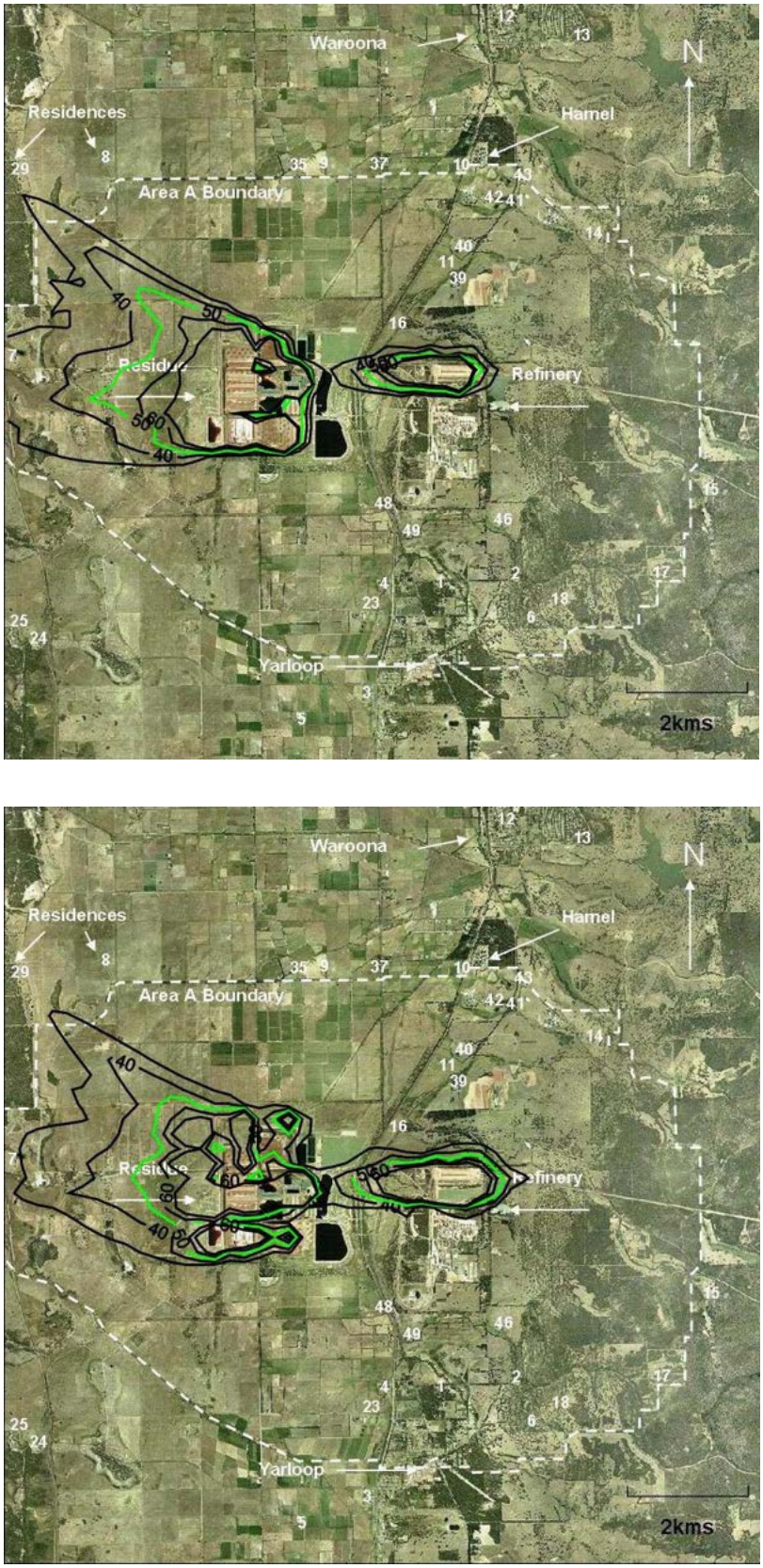
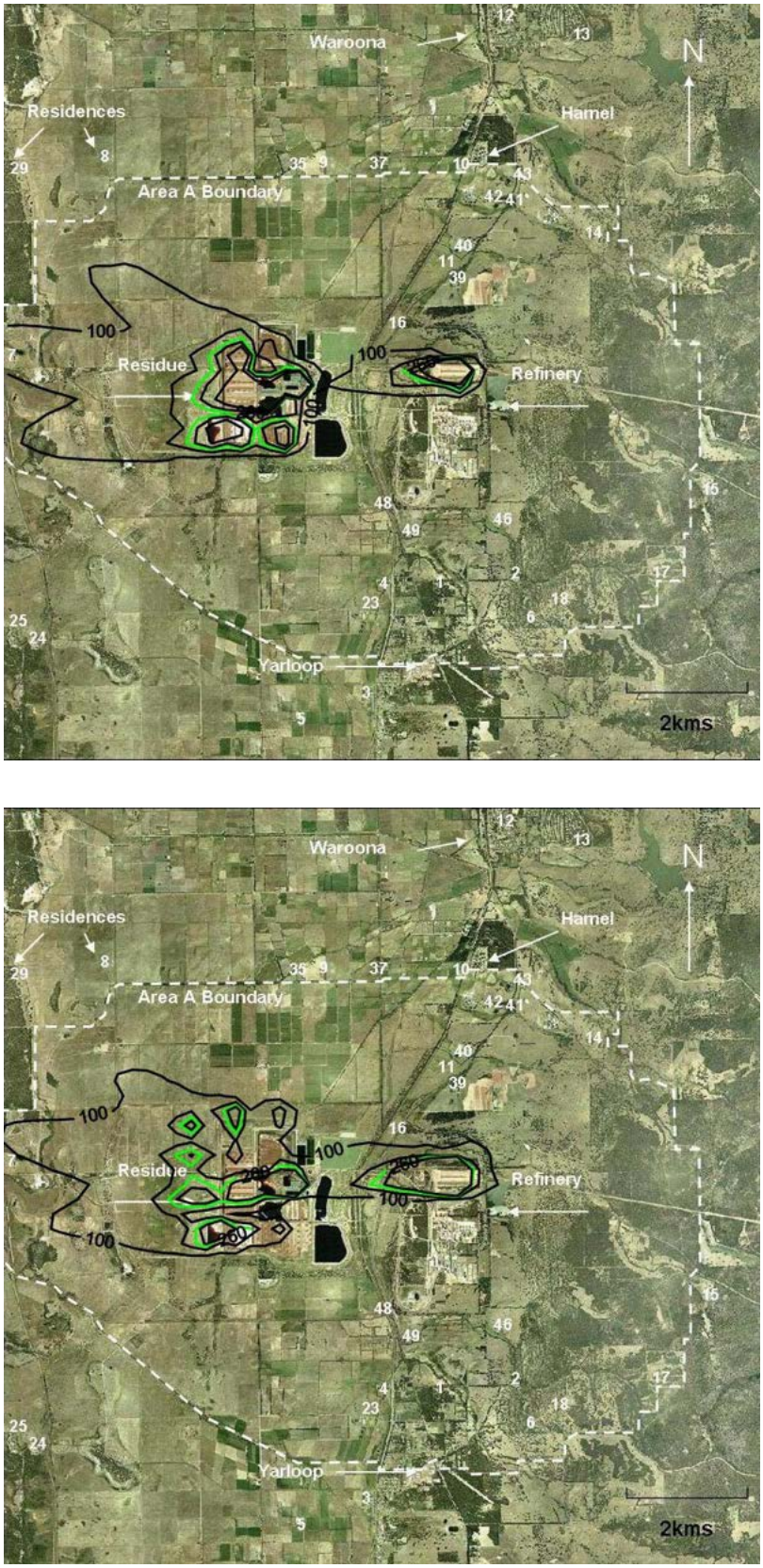


Figure 50: Maximum 24-hour average dust (TSP) concentrations for the existing (top) and expanded refinery (bottom) scenarios



8.3.8 Odour Assessment

Odour emissions from the refinery point sources were determined based on odour emission monitoring of key points and the development of an odour:VOC relationship. Odour emission rates from the residue area diffuse sources were determined from campaign sampling using a flux hood at the source to air interface and nearby ambient odour monitoring. The combination of measured emission rates and back trajectory analysis allowed emission rates to be modelled using TAPM (point sources) and Calpuff (diffuse sources) with the results combined to model the total ground level concentration (GLC) of odour from all Alcoa sources. The sampling and modelling approaches taken for odour estimates and a description of key odour sources are provided in Appendix G.

In 2002, the Western Australia EPA released its guidance document on the assessment of odour impacts from new proposals. (EPA, 2002) This document is a general guide to odour assessment and contains specific guidelines for new proposals. However the document also provides guidance for assessment of expanding existing facilities:

> "If an existing facility wishes to expand but does not itself comply with the odour criteria for new sources then the EPA would expect, as a minimum requirement, that predicted odour concentrations at sensitive land uses would not increase (i.e. there would be no deterioration of current amenity values)."

The following two figures (Figure 51 and Figure 52) show the predicted 3 minute odour concentrations at the peak 99.9th and average 99.5th percentiles respectively for the existing and expanded refinery. Both figures show the predicted ground level concentrations of odour from the combination of refinery (TAPM) and residue area (Calpuff) modelled sources.

The two figures show that, although refinery odours will still be detected on occasion in nearby townships, there is a significant decrease in the predicted odour concentrations for the expansion scenario for both the average 99.5th and peak 99.9th percentiles three minute ground level odour. It is therefore considered that the Proposal satisfies both the EPA's guidance statement requiring no deterioration of amenity values and Alcoa's undertaking that there is no increase in odour impacts on residents from the expansion.

It was earlier noted (section 7.9.3) that TAPM may over predict ground level concentrations of odour, therefore the concentrations shown in Figures 51and 52 may be higher than would actually occur. The emission control works associated with the proposal will still result in a significant reduction in the predicted odour concentrations from the existing refinery case, however, the reduction between the current and expanded cases may be slightly smaller than shown here.

Figure 51: Peak (99.9th percentile) 3-minute odour concentrations for the existing (top) and expanded refinery (bottom).

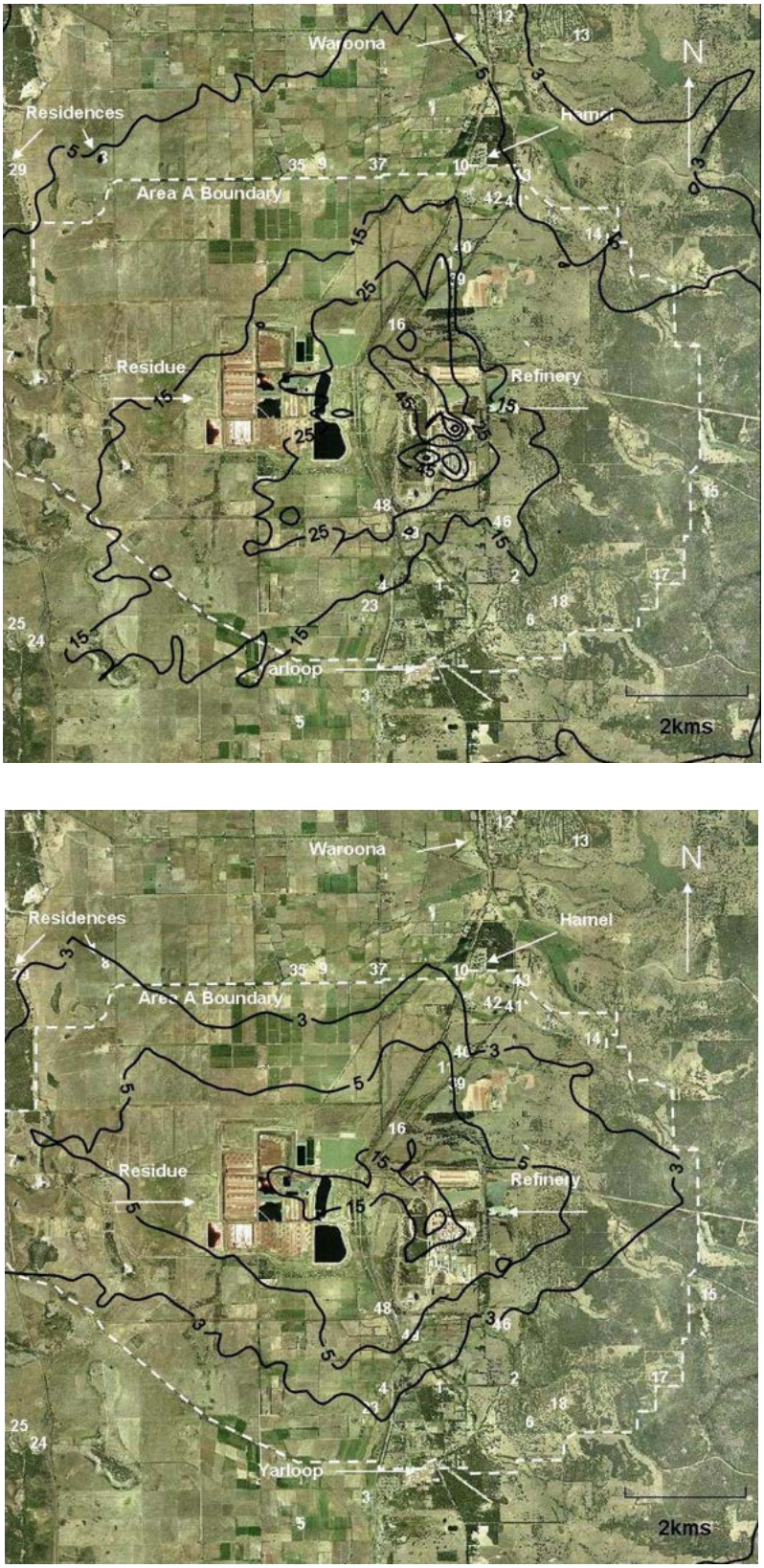
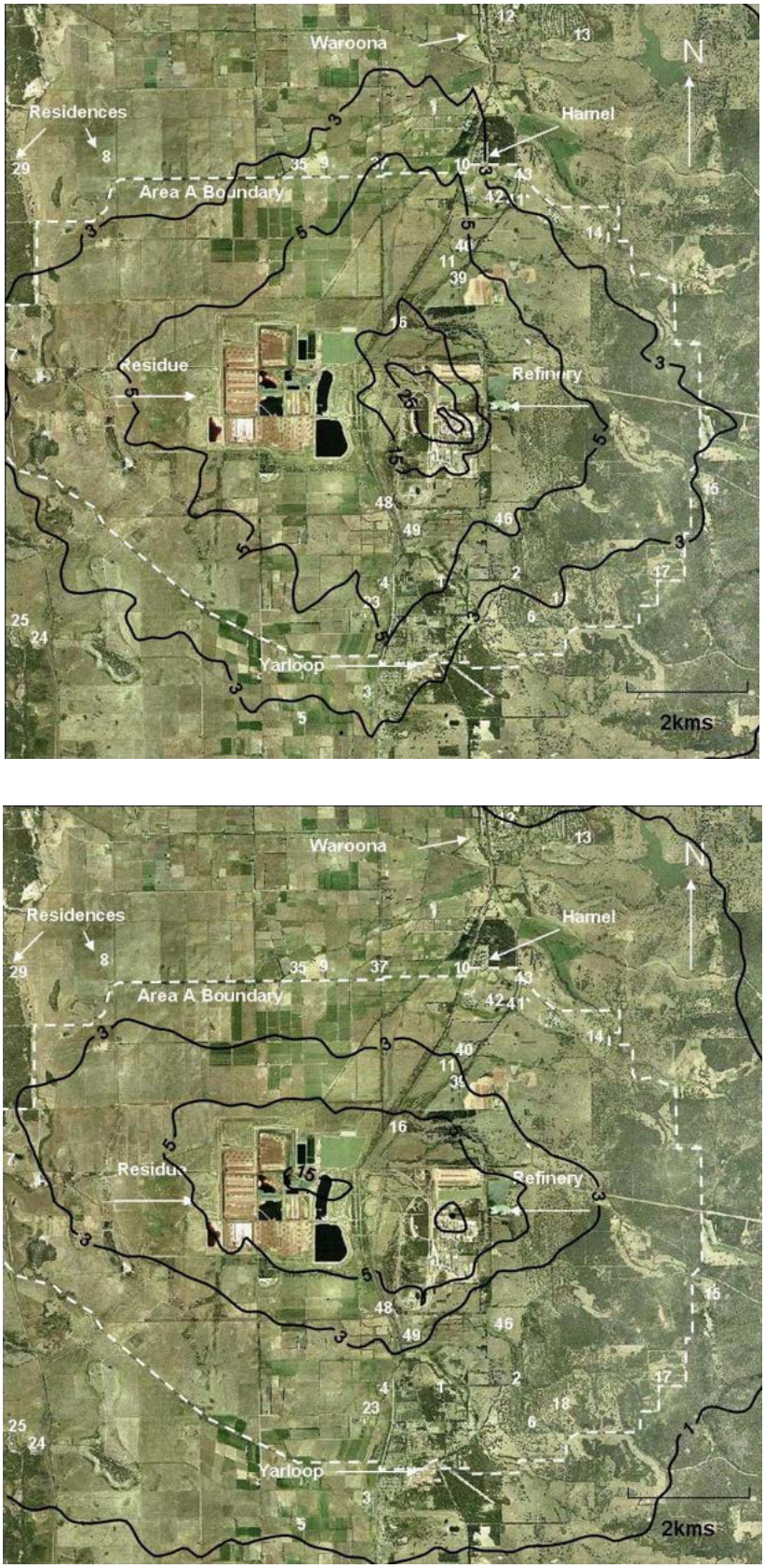


Figure 52: Average (99.5th percentile) 3-minute odour concentrations for the existing (top) and expanded refinery (bottom)



The reduction in ground level odour concentrations is due to various point source emission control works associated with the Proposal, such as redirection of calciner low volume vent emissions for destruction; reduction in cooling tower VOC emissions; reduced emissions from causticisation and the sealing of some additional tank vents.

Commitment 2.

Alcoa will implement the Air Quality Management Plan to monitor and manage aspects of proposal implementation with a potential for impacts on surrounding air quality.

Commitment 3.

Alcoa will manage the bauxite residue generated from the Proposal in accordance with the Wagerup refinery endorsed Long-term Residue Management Strategy (LTRMS).

Commitment 4.

Alcoa will improve the management of dust from the residue drying areas through an upgrade of the existing sprinkler control network

8.3.9 Expert Review of Air Dispersion Modelling

A consultant with Katestone Environmental was selected by the Emissions and Health Working Group to undertake an independent desk-top review of the Air Quality assessments for the existing and proposed Wagerup refinery.

The objectives of the review were to comment on the:

- completeness of the information presented;
- suitability of the measurements performed for assessing the project impacts;
- correctness of the analysis performed on the data presented;
- suitability of the methodology used to make predictions; and
- conclusions reached in the report(s) being reviewed.

As a desktop review; the air quality (modelling) reports were assessed to determine if the information contained in them was adequate, whether methodologies used were adequate in determining the impacts on air quality, and whether the conclusions drawn from the work were appropriate.

It was not intended to be an audit of input data, an evaluation of the process or technology associated with the Proposal, or an evaluation of the air quality impacts. The results of the expert review are provided in Appendix L.

Some of the points raised in the reviews have already been addressed, and Alcoa will continue to work with the Department of Environment to determine appropriate actions to address any remaining issues raised in the expert reviews.

Summary of Expert Review (TAPM Modelling)

The expert reviewer concluded that generally the use of TAPM for modelling the Wagerup refinery plumes should be suitable, and is probably the best available model. Generally, the modelling undertaken for the Proposal adequately assesses the potential impacts on the local atmospheric environment so long as a degree of conservatism is taken into account when applying the uncertainty factors from the modelling results presented by CSIRO in the HRA.

Katestone Environmental noted that any model or measurement process has associated errors for which it is important to estimate the likely influence on the conclusion of a given study, however, keeping this in mind the errors of a particular model will be the same for the current scenario as for the expansion and therefore the relative difference in impacts can be as important as the magnitude of impacts.

For the refinery expansion scenarios the changes depend on the pollutant and location. Due to the changes in emission rates and stack characteristics for the proposed expanded refinery it is difficult to check the validity of the predicted impacts for the refinery expansion. However, based on the reduced emissions for some sources and better dispersion for others with the inclusion of a new multiflue source, the changes in impacts seem reasonable.

The reviews found the question "is the model predicting the right answer for the right reason" remains unanswered. It would give more confidence in the results if this question was answered but due to the limited monitoring information available for the region it may not be possible.

Katestone Environmental gave key recommendations to provide more confidence of the TAPM modelling for the Proposal undertaken by CSIRO. These were:

- The TAPM modelling use data assimilation as the more appropriate meteorological scenario for the region;
- Daily average emission rates be used for configuration of the model (TAPM); and
- Modelling results be presented for the maximum exposed location as well as at the discrete receptors. This will reduce the uncertainty due to year to year variability in wind patterns.

The full review was provided to the CSIRO to enable any issues raised to be addressed before finalisation of the final report.

Summary of Expert Review Diffuse Source Modelling

Katestone Environmental acknowledges the complex nature of assessing emissions from the diffuse sources at Wagerup refinery operations. This detailed modelling of these types of diffuse sources is groundbreaking and forms the basis for further understanding and modelling of the diffuse sources.

Katesone Environmental found:

- Overall the assessment of dust impacts is very detailed and has used appropriate methodologies. A sensitivity analysis into the methodology used to estimate the emissions for the proposed expansion is recommended and would provide a further level of confidence in the final outcomes of the HRA.
- The conclusions drawn from the odour assessment seem reasonable. Katestone Environmental provided some comments on small technical issues with respect to the modelling and emission estimation techniques that should be addressed over time. These are unlikely to change to outcomes of the assessment (refer to Appendix L).
- A detailed list of uncertainties is included in the Air Assessments report (refer to Air Quality Summery report Appendix G). This list should be referred to and if possible activities undertaken in the future to reduce the uncertainty. A list of detailed recommendations for further work is also resented in Section 10, and Katestone concur with all items listed and recommend that all actions are undertaken to complete these recommendations and those presented in other reports such as the CFD modelling, outlined in the Air Quality Summary report (Appendix G).

8.3.10 Health Risk Assessment

A quantitative health risk assessment (HRA) has been conducted by specialist consultants; Benchmark Toxicology Services Pty Ltd and ENVIRON. The HRA process examines the potential health impact of refinery and RDA atmospheric emissions on the nearby population using a comparison of the predicted ground level concentrations (GLC) of selected compounds to their accepted health guideline levels. This occurs for the individual compounds and the results are totalled for all of the selected compounds. This includes evaluation of acute (i.e. short term) hazard and chronic (i.e. long term) hazard risks as well as the incremental carcinogenic risk.

The HRA concluded:

- the potential for emissions from the existing or expanded Wagerup refinery to cause acute health effects is low and is primarily driven by the particulate emissions from the RDA and oxides of nitrogen emissions from the refinery

- the potential for emissions from the existing or expanded Wagerup refinery to cause chronic non-carcinogenic health effects is very low, and

- the potential for emissions from the existing or expanded Wagerup refinery to contribute to the incidence of cancer based on inhalation exposure is below USEPA *de minimis* threshold of one in a million (i.e. 1×10^{-6}) at all of the residential receptors considered.

Furthermore, to ensure that potential risks are not underestimated, uniformly conservative assumptions have been used to characterize exposure and toxicity in the HRA. Due to the resultant compounding of conservatism, the quantitative risk indicators should be considered as over-estimates of potential health risks associated with emissions from the Wagerup refinery.

The full HRA report is contained in Appendix F and includes details of the methodology, results and findings of the investigation. The following represents a summary of the HRA undertaken for the Proposal.

In order to assess the air quality impacts associated with potential acute (i.e. short-term) and chronic (i.e. long-term) exposures, emissions associated with daily peak and annual average plant activity were modelled for the base case and two expansion scenarios. Assuming the daily peak activity occurred for the full 24 hour period the modelling predicted the average ground level concentration for each hour during the day and the average for the year. In the risk assessment the 9th highest (99.9th percentile) one hour concentration that occurs at any time during the year has been used for assessing potential acute health impacts. The predicted 99.5th percentile 1-hour modelled concentration has also been evaluated to provide insight to the frequency with which such high concentrations are predicted to occur. The HRA also considered the 99.5th percentile (i.e. 2nd highest) and 95th percentile 24-hour average concentrations when assessing the acute effects. The annual average concentration was used to assess the impact of potential chronic and carcinogenic exposures.

The potential health impact of emissions at receptor locations has been assessed firstly by comparing the predicted ground level concentrations with health based air guideline values for the individual emission components. These guidelines have been sourced from reputable regulatory agencies and incorporate large safety factors to ensure they are protective of public health. The methodology used for assessing the health risks is consistent with that

recommended by the US EPA, the National Health and Medical Research Council of Australia and the enHealth Council of Australia.

When predicted ground level concentrations are less than the health guideline values there is very little likelihood of an adverse health effect occurring. The ratio of the ground level concentration to the health guideline value is called the hazard quotient. The impact of exposure to all of the individual emission is then assessed by assuming the effects of the individual components are directly additive. The sum of the individual hazard quotients is referred to as a hazard index. It should be noted that the assumption that the impacts of all pollutants is directly additive is considered to be very conservative; in reality relatively few of the emission components will have a directly additive affect on health risk.

A general rule of thumb for interpreting a hazard quotient or hazard index is that values less than one, present no cause for concern. Values between 1 and 10 generally also do not represent cause for concern because of the inherent conservatism embedded in the exposure and toxicity portions of a preliminary risk assessment. Hazard quotients or indices that are around ten present some concern regarding possible health risks, although in these circumstances it is usual to evaluate the extent to which the conservative assumptions have given rise to an overestimate of risk.

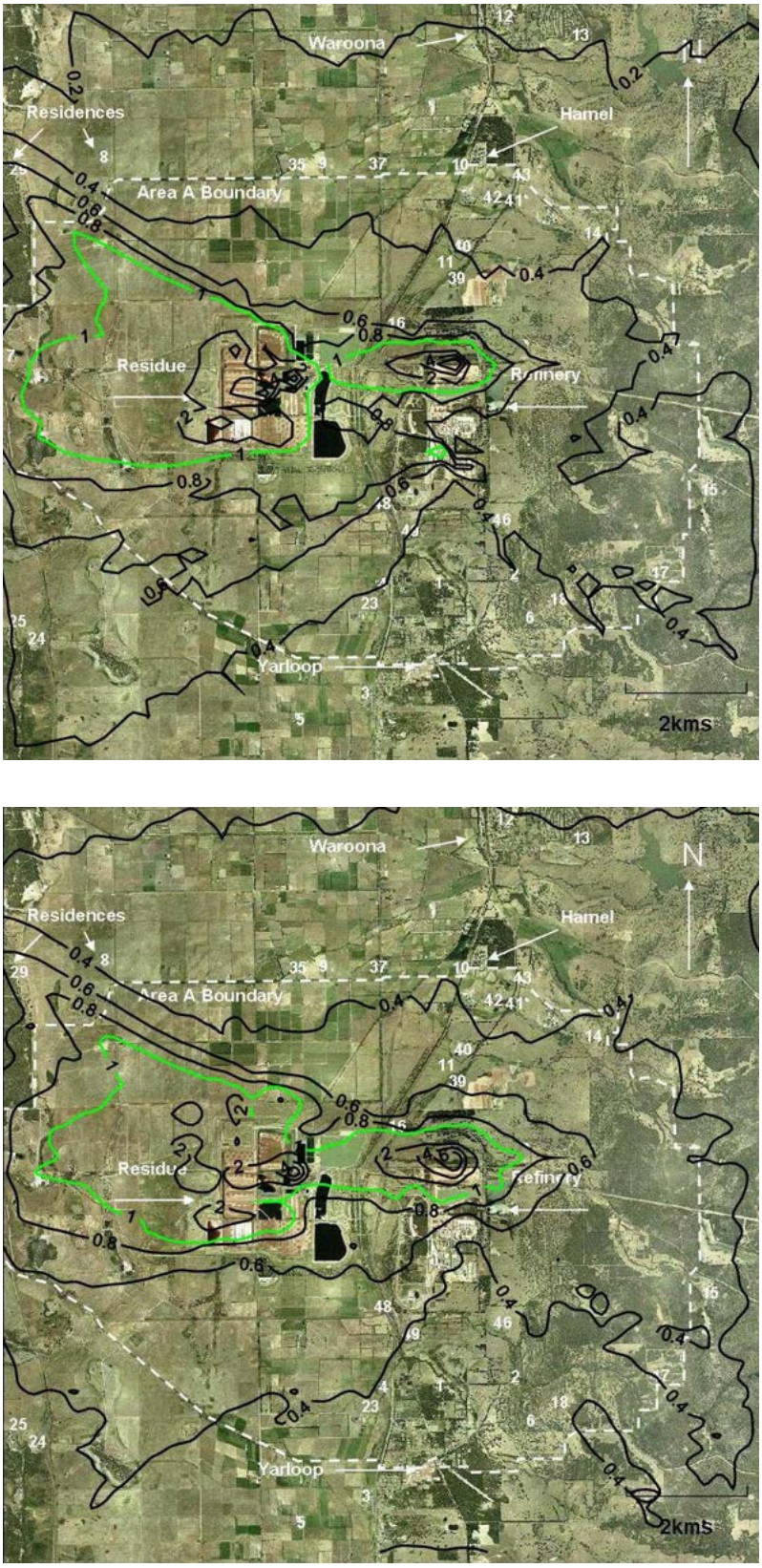
The HRA concluded there is little likelihood of an acute adverse effect occurring because all hazard quotients and hazard indices for all receptor locations are less than one (unity) and for less than the target range of one to ten (Figure 53). Furthermore, the highest concentrations are modelled from worst case emission assumptions and they will be rarely achieved which adds a further degree of conservatism to the results.

Figure 53 shows the calculated acute hazard index for both the current and expanded refinery (cogeneration option) scenarios. Representative nearby (occupied) residences have been chosen as "receptor locations" and are shown in Figure 53 as white numbers. The white dashed line represents Alcoa's land management area A boundary.

The receptor locations (residences) closest to the refinery represent the potential worst case exposure locations. However, the HRA results indicate the acute hazard indices are low at all of the residential receptors.

The HRA is applicable to environmental (community) exposures; different exposure circumstances and health guidelines apply for occupational circumstances. However, based on the outcomes of this HRA and the systems and procedures in place at its workplaces, Alcoa is also confident that atmospheric emissions associated with the Proposal represent no appreciable health risk for workers at the Wagerup refinery.

Figure 53: Acute hazard index for existing (above) and expanded cogeneration scenario (below). The 1.0 risk contour is shown in green.



The chronic hazard indices for the existing and expanded refinery scenarios are much less than unity (Figure 54) indicating the likelihood of adverse health effects from chronic exposure to the refinery emissions is extremely unlikely. For dioxin-like compounds conservative estimates of background intakes have been assumed, even so the overall intakes are much less than the intake level that Australian authorities have deemed to be tolerable and without adverse health effects.

For emission components that are carcinogens, the carcinogenic risk from an assumed life time exposure has been calculated and compared with the USEPA's *de minimis* threshold of one in a million (i.e. 1×10^{-6}) (Figure 55). The lifetime risk is based on continuous exposure for 70 years.

The incremental carcinogenic risk that is considered acceptable varies amongst jurisdictions, typically ranging from one in a million ($1x10^{-6}$) to one in ten thousand ($1x10^{-4}$). The most stringent criterion of one in a million represents the USEPA's de minimis, or essentially negligible incremental risk level, and has been adopted for this screening assessment as a conservative (i.e. health protective) indicator of acceptable carcinogenic risk.

In conclusion, the health risk assessment indicates that there is little likelihood of health effects being caused by either acute or chronic exposure of the general public to the atmospheric emissions from the existing refinery, and the Proposal will result in no significant change from this case.

Figure 54: Chronic hazard index contours for existing (above) and expanded cogeneration scenario (below).

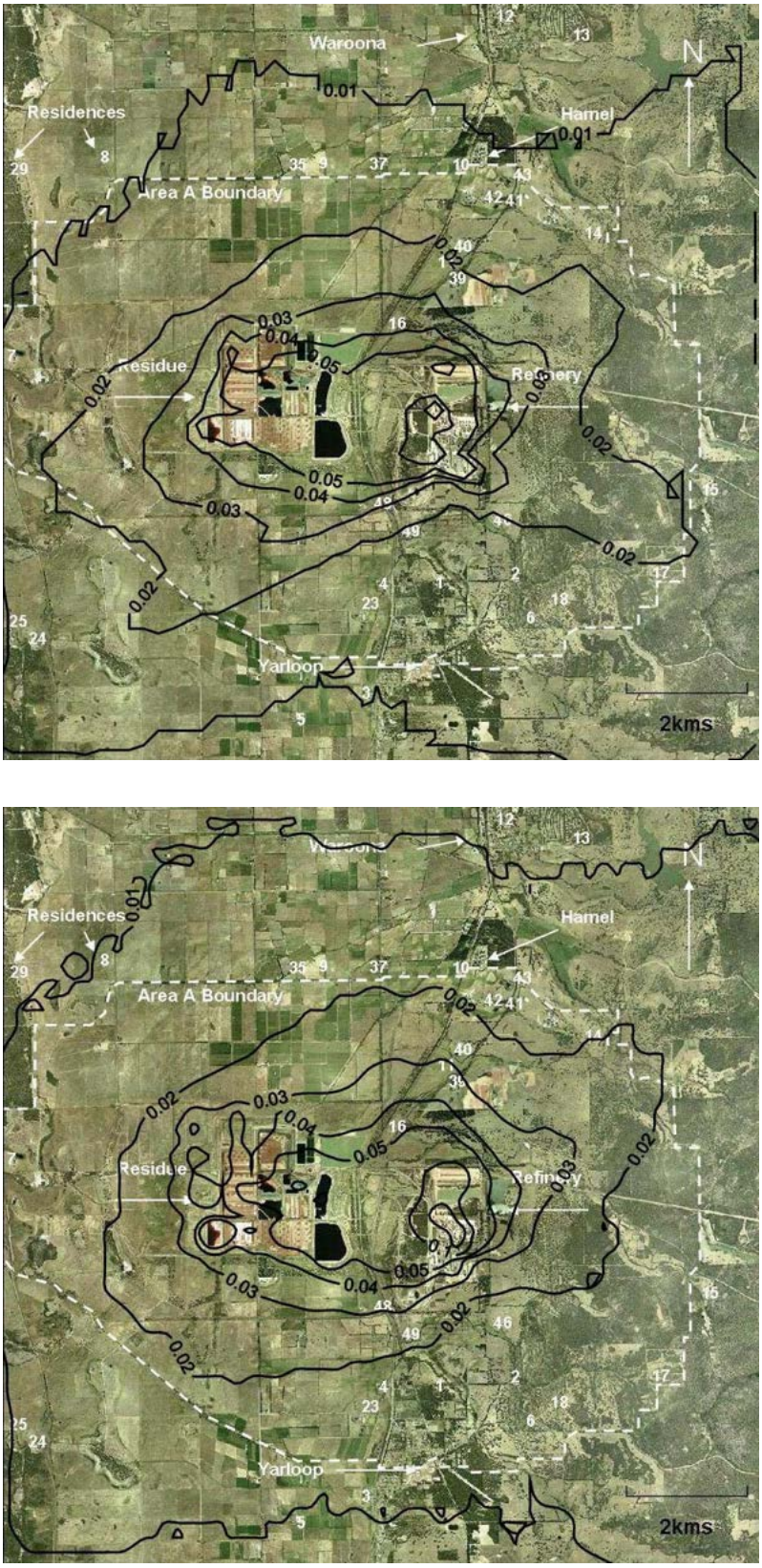
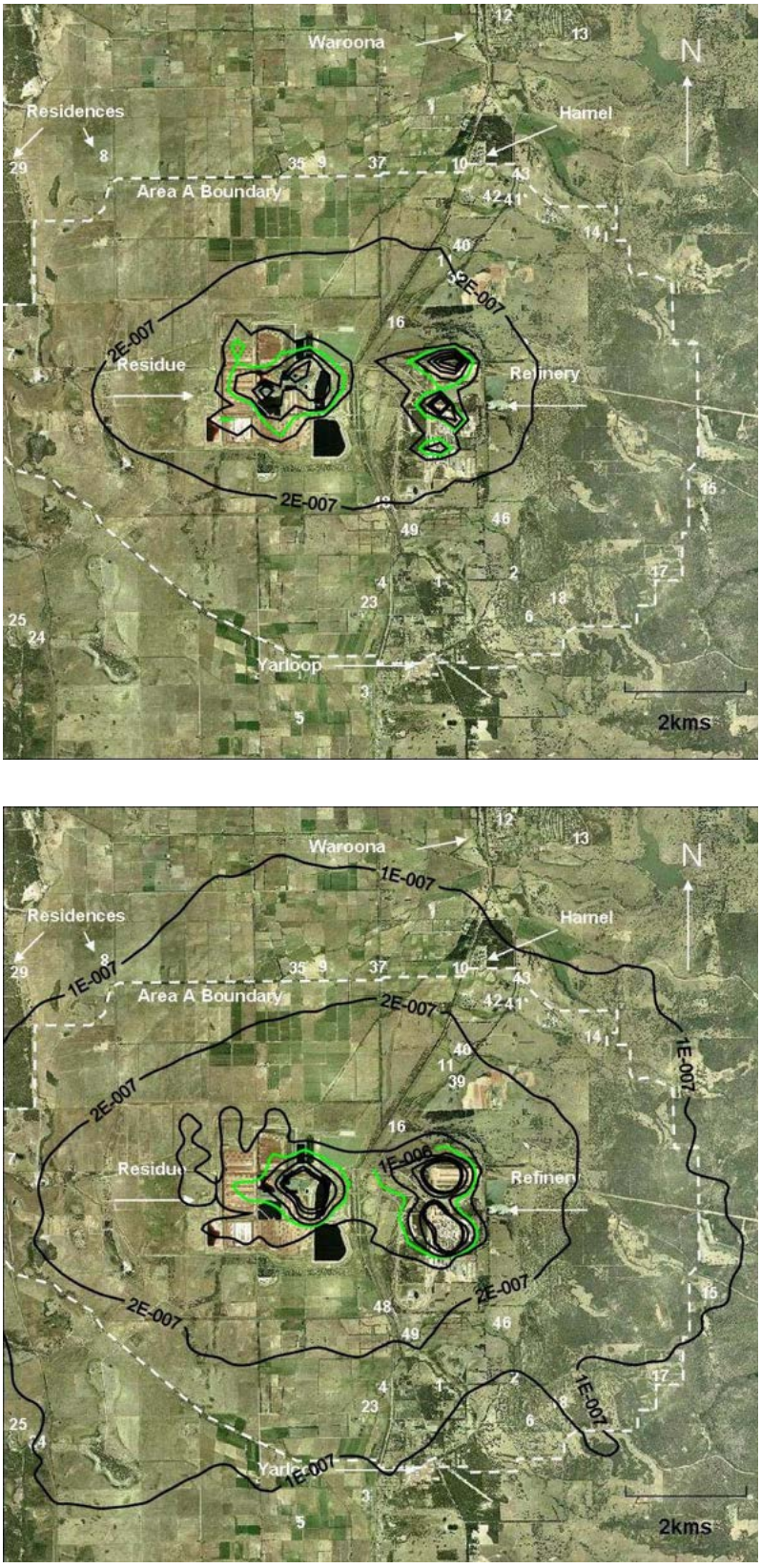


Figure 55: Incremental carcinogenic risk contours for existing (above) and expanded cogeneration scenario (below). The "one in a million" risk contour is shown in green.



Expansion including additional boilers

The health risk assessment, including contours of acute, chronic and incremental carcinogenic risk was also conducted on the expansion scenario which includes two additional boilers, rather than cogeneration units. These HRA risk contours for the boiler option are shown in Figures 56, 57 and 58.

In each case the conclusions drawn for the cogeneration expansion scenario apply equally to the scenario including additional boilers:

- the potential for emissions from the existing or expanded Wagerup refinery to cause acute health effects is low;
- the potential for emissions from the existing or expanded Wagerup refinery to cause chronic non-carcinogenic health effects is very low; and
- the potential for emissions from the existing or expanded Wagerup refinery to contribute to the incidence of cancer based on inhalation exposure is below USEPA de minimis threshold of one in a million (i.e. 1 x 10^{-6}) at all of the residential receptors considered;

Figure 56: Acute hazard index for the expanded scenario (boilers). The 1.0 risk contour is shown in green.

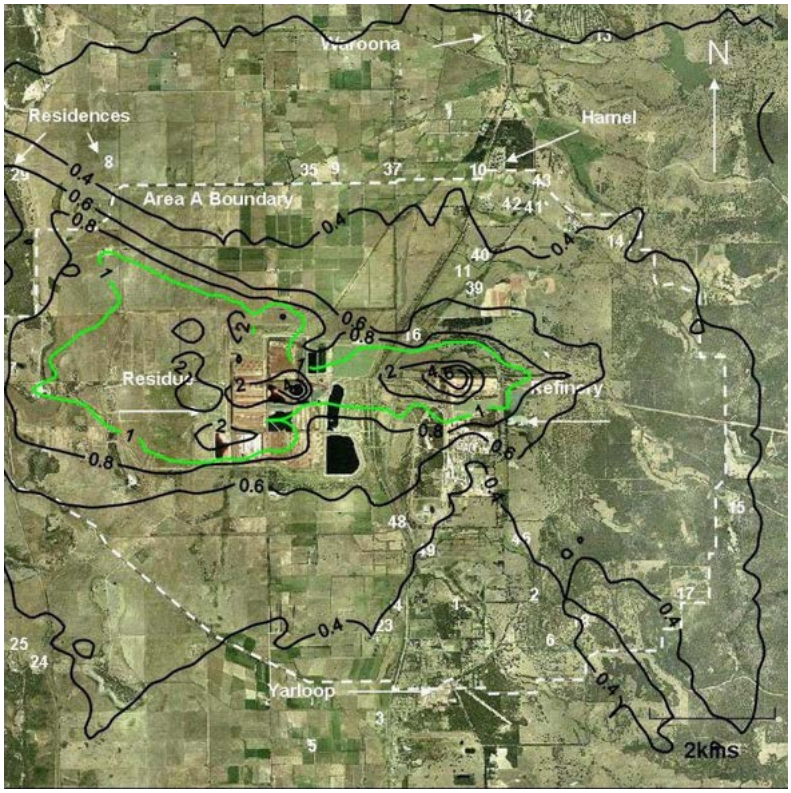


Figure 57: Chronic hazard index contours for expansion scenario (boilers).

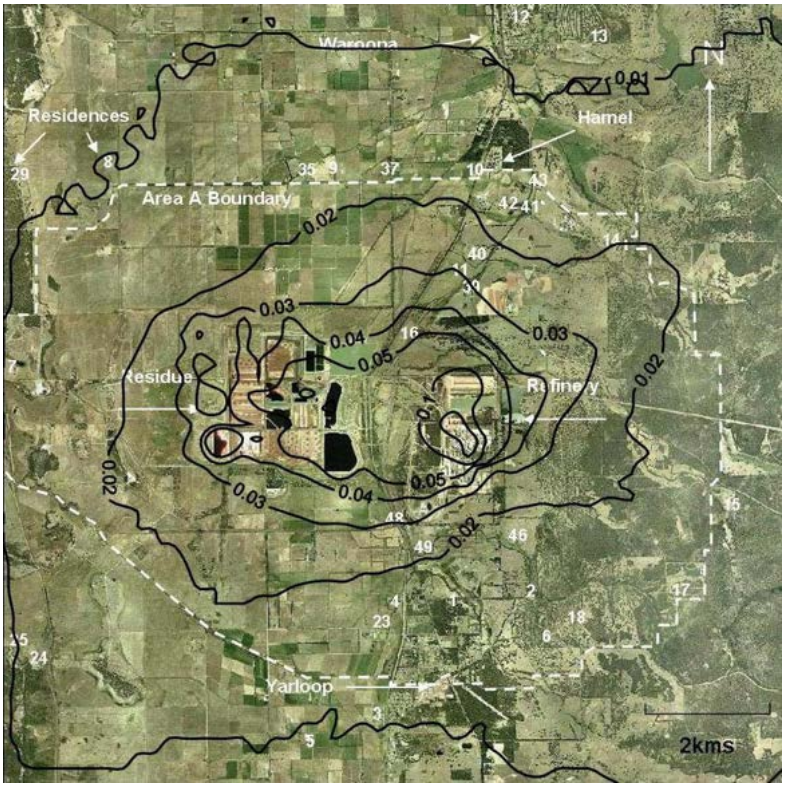
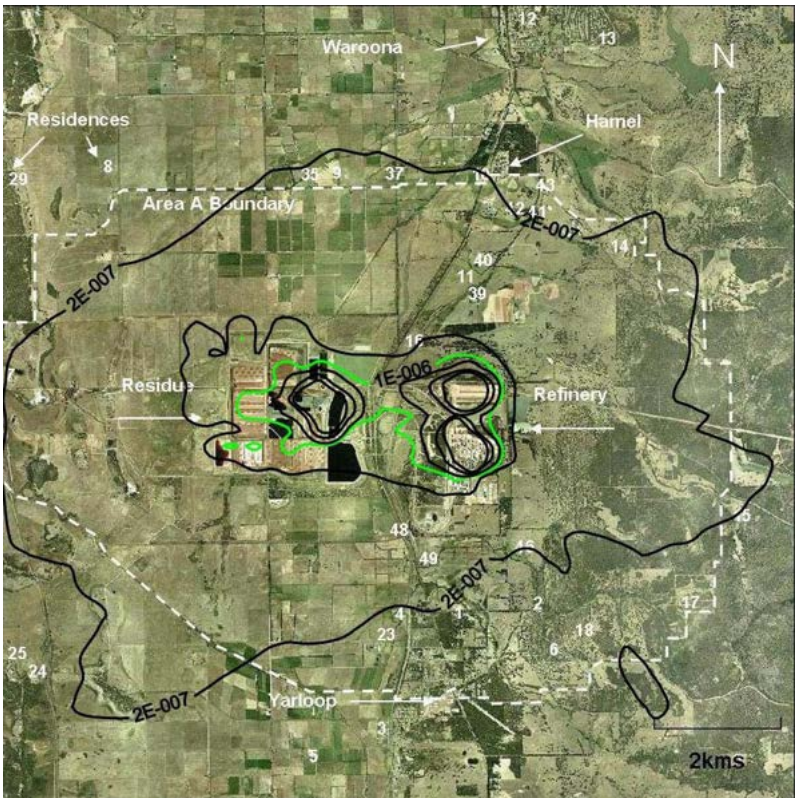


Figure 58: Incremental carcinogenic risk contours for expanded scenario (boilers). The "one in a million" risk contour is shown in green.



Substance selection for the HRA

In selecting the 27 compounds to be included within the HRA, Alcoa initially considered the 141 compounds or groups of compounds that were quantified as part of the Pinjarra Refinery Efficiency Upgrade health risk assessment. A screening assessment of these compounds found that the 27 individual compounds or groups of compounds considered in this assessment contributed over 93% of the acute HI, over 86% of the chronic HI, and 100% of the incremental carcinogenic risk calculated for the Pinjarra Refinery Efficiency Upgrade health risk evaluation at the maximally affected receptor (receptor 1) (Toxikos, 2003). Based on the findings of the Pinjarra Refinery Efficiency Upgrade health risk evaluation (Toxikos, 2003), the compounds considered in the Wagerup refinery screening assessment are expected to contribute the vast majority of the potential health risks. ENVIRON considered the process used to identify and select the compounds included within the HRA was comprehensive and appropriate given the current state of knowledge of the refinery and RDA emissions.

The 27 individual compounds or groups of compounds comprise the following compound classes and are presented in Table 25:

- particulates
- products of combustion
- metals
- organic compounds (e.g. aldehydes, ketones and aromatics [including polycyclic aromatic hydrocarbons (PAHs)], and
- ammonia.

Table 25: List of 27 Compounds modelled

No.	Compound Name	No.	Compound Name
1	Oxides of Nitrogen[1]	15	Acetaldehyde
2	Carbon monoxide	16	Formaldehyde
3	Sulphur dioxide	17	2-Butanone
4	Particulate matter	18	Benzene
5	Arsenic	19	Toluene
6	Selenium	20	Xylenes
7	Manganese	21	Acrolein
8	Cadmium	22	Ethylbenzene
9	Chromium (VI)	23	Methylene Chloride
10	Nickel	24	Styrene
11	Mercury	25	1,2,4 Trimethylbenzene
12	Ammonia	26	1,3,5 Trimethylbenzene
13	Polycyclic Aromatic Hydrocarbons	27	Vinyl chloride
14	Acetone		

Notes: 1. Oxides of Nitrogen expressed as Nitrogen Dioxide.

8.3.11 Expert Review of Health Risk Assessment

A consultant with International Health Consultants was selected by the Emissions and Health Working Group to undertake an independent desk-top review of the Health Risk Assessment for the existing and proposed Wagerup Refinery.

As a desktop review; the HRA was assessed to determine if the information contained in it was adequate, whether methodologies used were adequate in determining the impacts on health, and whether the conclusions drawn from the work are appropriate.

The full expert review report is provided in Appendix M.

Summary of HRA Expert Review (Environ / Benchmark Toxicology Services report)

The expert reviewer found the HRA was an initial screening assessment of potential for risks arising from direct toxic actions of air pollutants in predicted Wagerup emissions.

The HRA had been carried out correctly, within its limited scope and the methodology is consistent with initial assessments as defined by Australian authorities.

- The measurement of predicted risk levels was based on calculation of measures described as Hazard Index (HI) and Incremental Carcinogenic Risk (ICR). The final conclusions of the HRA are given in qualitative terms. However, being based on quantitative methods, the conclusions are regarded as semi-quantitative.
- A prudent, conservative, and highly health-protective approach was taken in the HRA.
- Review of Air Quality information and the Criteria selected shows that inputs used to calculate the measures of risk were conservative and appropriate.
- Air Quality data and information for the areas surrounding Wagerup is valid and extensive, and its quality has been independently reviewed.
- Choice of methods was appropriate, although other approaches and the limitations of the methods have been discussed in the review. Comparison of predicted GLCs with published health guidelines was carried out on a comprehensive selection of pollutants.

The expert reviewer raised the following issues with respect to the HRA:

- Some lack of clarity and readability in the HRA which may lead to confusion or unnecessary concern;
- The choice of some overseas criteria and methods, because applying overseas criteria developed for overseas contexts is not always appropriate. In this case there were no technical difficulties apparent; and

- The lack of information about context e.g. the relative importance of Wagerup emissions compared to general background levels, and overall intake of chemicals which may be important for health.

The expert reviewer found:

- The HRA presents useful and almost certainly correct assessments, on the levels of risk contributed by the predicted Wagerup emissions;
- The HRA conclusions are that low, very low, or de minimis risk of health effects on any residents can be foreseen. Given the low levels of GLCs predicted (in comparison with published standards, goals and guidelines) and review of the information presented, these conclusions are considered to have been supported by the evidence put forward in the HRA;
- On the basis of the evidence and results in the HRA the review concludes that all levels of foreseeable risk are essentially the same, and the term de minimis is preferred. Conclusions are therefore reassuring on the matter of future air quality and the de minimis nature of any health risks, taking into account the limitations of the HRA; and
- Further investigation of health complaints or health effects may be necessary or desirable, because there are as yet unresolved questions regarding "health effects" and health complaints in the community. Careful preparation will be needed to determine what types of health study or Health Impact Assessment are feasible or appropriate, if resolution of these questions for the community of Wagerup is to be achieved.

It was recommended that effort is made to enable readers and particularly the residents and community groups to understand what the HRA concluded, so that the value of it is accepted as part of the engagement process between Alcoa and the local communities.

8.3.12 Short-term emission exposures

Discussions with some members of the local community have identified a need to consider the potential for very short-term transient air quality impacts. For example, at times some local residents report the presence of refinery odour which has been noticeable for only a few minutes at a time before disappearing. This could be due to either unusual weather conditions or unusual plume behaviour.

As part of the scope of this ERMP Alcoa undertook to investigate several potential aspects of this phenomenon including:

- Ground-level concentrations at the timescale of a few minutes;
- Ambient monitoring data;
- Statistical analysis of the historical data set;

- Analysis of complaints data.

A comparison of the maximum modelled short-term (3-10 minute) ground level concentration of key refinery-emitted substances is shown in Table 26. A list of the predicted 3minute and 10 minute concentrations for all modelled substances is contained in the air dispersion modelling reports prepared by the CSIRO (CSIRO 2005, Appendix G of Appendix G)

Table 26: Comparison of maximum modelled short-term GLCs for existing and expanded refinery

	Maximum predicted concentration (3 minutes)				
Pollutant	**Averaging period**	**Ambient guideline (ug/m3)**	**Base case (ug/m3)**	**Expansion (cogeneration)**	**Expansion (boilers)**
Nitrogen dioxide	1 hour	246	54	54	54
Carbon monoxide	8 hours	11,250	210	220	220
Sulphur dioxide	1 hour	571	220	230	300
Particulates (PM_{10})	1 day	50	16	8.9	8.9
Benzene	Annual[1]	8.81	0.94	0.19	0.18
Formaldehyde	24 hour[1]	16.91	2.4	1.3	1.3
Toluene	24 hour[1]	6,9071	2.4	0.18	0.19
Xylenes	24 hour[1]	7951	0.56	0.01	0.01

[1] Draft investigation levels from Draft Air Toxics NEPM

These data for all modelled substances were considered during the health risk assessment process with the following conclusion. A comparison of modelled maximum 3-min and 10-min GLC indicates that the short term averaging GLC are lower than the reference values for 1-hr averages or annual averages (where no 1-hr average was available). In most cases, the short term estimated GLC were lower than the reference values for annual averages. These observations indicate that short term peaks in the concentration of irritant substances in air are unlikely to be sufficiently high to cause adverse health effects. (ENVIRON 2005-HRA)

A description of the refinery emissions contribution to ambient compound concentrations is given in section 7.9 and more fully in Appendix G. Among other findings this work found that all chemical compounds detected in the ambient monitoring investigations were found to be at levels well below applicable limits set for the protection of human health and were generally within the ranges expected for rural environments.

The chemical compounds detected and their levels in the atmosphere showed little spatial variation and for the most part appeared to be randomly distributed, limiting the ability to attribute specific sources. Elevated levels of both carbonyls and VOCs were found at the Waroona and Yarloop township sites, consistent with the effects of human activities associated with the use of fossil fuels. (van Ember and power 2005)

Portable Gas Chromatograph Mass Spectrometer (GCMS) monitoring for a wide range of ambient VOCs was also undertaken during the August – September period in 2004, including attempts to measure ground level concentrations downwind of the refinery and in nearby townships. In the vast majority of cases this monitoring failed to detect measurable concentrations of VOCs and in the instances where VOCs were detected they were present at concentrations well below accepted health guidelines or amounts that would normally be expected to result in health impacts (Chemistry Centre of WA 2004).

Statistical analysis of the historical data set including evaluation of short-term (six minute) NOx and particulate data, meteorological conditions, air quality and complaints, and the alkalinity of airborne particles is described in sections 7.11.3 to 7.11.6. Findings of this work included that NOx and particulate concentrations at the Boundary Road monitoring location are strongly influenced by wind direction and that wind direction from the refinery increases the concentration of both parameters at Boundary Road, although these increases are "not markedly greater" than those associated with wind direction from the Yarloop residential area.

The study also considered whether or not the alkalinity of refinery particulate emissions might cause irritation of the respiratory tract and therefore might be the cause of health complaints. The 6-minute ambient monitoring data includes occasional short-term peaks in particulate concentrations. It was considered important to determine if the alkalinity of these peaks could cause short-term irritation.

Evaluation of this potential found that the alkalinity of fine particulate samples was such that the maximum six minute average value recorded for PM_{10} at Boundary Rd corresponded to the equivalent alkalinity of 93ug/m^3 of sodium hydroxide. This suggests that short term peaks in ambient particulate concentrations are not high enough to cause irritant effects on the basis of alkalinity.

The Emphron (2005) study concluded that "in summary, it is possible that complaints are increased by airborne material from the refinery. The source within the refinery cannot be localised [identified]. There is no evidence that complaints are due to an irritant response to alkaline particles." "Complaints do seem to be more common when the wind is blowing from the North, and they may be increased when there are elevated Oxides of Nitrogen concentrations. These elevated Oxides of Nitrogen concentrations are far too small to be of physiological significance, but they may serve as a marker for the stack plumes. In other words, days experiencing a higher proportion of time with peak NOx levels are likely to be days in which the stack plumes are detected at Boundary Rd (near Yarloop). Plume odour is the most probable cause of complaints (and indeed odour is the most common issue for complaints)" (Emphron 2005). The air dispersion modelling undertaken for the ERMP has identified that the expansion is predicted to reduce peak odour concentrations in nearby townships.

In summary; statistical analyses of short term ambient concentrations of particulates and oxides of nitrogen indicate that neither of these substances reach concentrations likely to be irritant to the respiratory tract. The same conclusion holds when the alkalinity of the particulate matter is considered.

The maximum three minute average concentrations predicted by modelling are all substantially less than the ambient guidelines established for longer averaging periods. This strongly suggests that short-term exposures for these compounds are unlikely to result in health effects. This conclusion holds for the base case and the two expansion scenarios.

Alcoa will continue air quality monitoring at appropriate locations in the vicinity of the Wagerup refinery as well as maintain the existing complaints response procedures to ensure concerns about potential short-term emission impacts are properly investigated and responded to.

8.3.13 Survey of Health Status within the Local Community

A health survey of local community members will be undertaken prior to commissioning the Proposal, if approved. The survey will aim to measure the current health status of local community members to enable a comparison to Western Australia wide health results. This could allow for a follow-up survey after full implementation of the Proposal.

The proposed methodology for the health status survey is outlined following:

- A cross-sectional survey method will be undertaken. This involves surveying the community at a point in time, rather than over a period of time;
- Selection of a random sample of the populations of Yarloop, Hamel and nearby townships;
- The sample sizes will be large enough to be statistically valid (with adequate statistical power). A biostatistician will advise on appropriate sample size;
- The Computer Assisted Telephone Interview (CATI) technique will be used;
- The WA Health and Wellbeing Questionnaire developed by the Department of Health will be used for the survey. The questionnaire covers topics such as, demographics, health enhancing behaviours, health risk factors, socioeconomic status, psychological distress and chronic health conditions;
- Demographic and socioeconomic data will be obtained from the Australian Bureau of Statistics for input into the survey analysis;
- Age standardised prevalence rates for males and females will be calculated;
- A statistical comparison of the survey results with the most recent health results obtained for Western Australia;
- Logistic regression techniques will be applied to detect associations between the likelihood of chronic health conditions and several factors, including; geographic

location, health enhancing behaviours, health risk factors, socioeconomic status, psychological distress and demographic variables; and

- Logistic regression techniques will be applied to detect associations between the likelihood of individual symptom types and several factors, including; geographic location, health enhancing behaviours, health risk factors, socioeconomic status, psychological distress and demographic variables.

The final report would be made publicly available.

Commitment 5

Alcoa commits to implementing the proposal in a manner which ensures no significant change to the air quality predictions for surrounding areas (from refinery and RDA contributions) or Health Risk Assessment findings detailed in this ERMP. This will be confirmed following commissioning of the proposal.

Commitment 6

Should the Proposal proceed, Alcoa commits to commissioning a local community health survey. The results of this study would be available prior to commissioning of the Proposal.

8.3.14 Bunbury Port Air Emissions

Potential Impacts

Presently around 8.3Mtpa of alumina is exported through Alcoa's ship-loading facility at the Bunbury Port including approximately 3.2 Mtpa of alumina from Worsley and approximately 5.1Mtpa of alumina from Alcoa.

Worsley Alumina is in the process of constructing a ship-loader to handle its alumina export at the Bunbury Port. This should be operational in early 2006 and as a result Alcoa's ship-loader will manage approximately 5.7 Mtpa, including the additional 600,000 tpa expected from the Pinjarra refinery efficiency upgrade. Operations would continue at this level until the Proposal, if approved, is commissioned, resulting in the tonnage handled by the Alcoa ship-loader increasing to approximately 8.0 Mtpa.

Therefore, after inclusion of alumina from the Proposal, Alcoa's Bunbury Port facility will be operating within its current capacity. Consequently, no increase in dust impacts are expected at the Alcoa port operations. The main potential sources of dust are ship loading activities,

conveyor operations and filling of the alumina bins, all of which are sized and operated to cope with the current 8.3Mtpa export load.

The Bunbury Port has an internal reporting standard for particulates of 260 ug/m3. Operations at the Port in recent years have shown continual improvement in dust control with fewer exceedences of this internal standard in 2004 (Section 7.9.5).

Proposed Management

Existing procedures are in place at Alcoa's Bunbury Port operations for controlling dust emissions (Document No. 44146 Minimising Dust During Shiploading). These include:

- ensuring that the loading chute discharge is as close as possible to the floor of the hold and that the rubber skirt is in contact with the hold to maintain a seal
- keeping loader movements to a minimum
- keeping the alumina loading chute as close to the alumina pile as possible
- lowering the chute as soon as the loader moves off the pile
- informing the relevant officer immediately if dusting appears to be excessive, so that appropriate action can be taken, and
- ceasing ship loading under bad weather conditions.

If dust generation is evident and the wind direction is blowing the dust cloud toward residential areas in Bunbury, an assessment is made about whether the dust is being carried more than 500 metres from the terminal. If this is the case, then loading is ceased until there is an acceptable wind condition change. If a dust cloud continues to hover above the loading facility because of stagnant wind conditions, then loading is also ceased until there is an acceptable wind condition change. The normal checks on dust collection performance are carried out prior to the decision to shut down.

Special procedures are followed when 'topping off' vessels to maximum hold capacity. If the wind speed exceeds 25 knots (47 km/h) regardless of wind direction, topping off is ceased. Under these conditions normal centre loading may continue, providing the seal with the rubber skirt is not broken and excessive dust is not observed.

Alcoa's Bunbury Management team reviews the dust monitoring data at the end of each month. The data are extrapolated to determine if there is a correlation between any exceedences of Alcoa's internal reporting standard and shiploading operations. This information is then used to influence future decision-making.

Sample analysis is carried out by a contracted consultant and analysed in accordance with the Wagerup procedure Determination of Total Suspended Particulate Concentration in Air (Document No. 4962).

These measures would continue to operate during the proposed Wagerup refinery expansion with the objective of continually improving dust control at the Bunbury Shipping Terminal.

Commitment 7.

Alcoa will manage ship-loading of alumina at the Bunbury Port to minimise the potential for dust impacts on the surrounding community.

8.4 NOISE

8.4.1 Refinery Noise Emissions

The EPA's objective for the Proposal regarding management of refinery noise is:

- *To comply with statutory requirements on a stand-alone basis.*

Concerns about refinery noise levels were expressed by some neighbours in the mid 1990's and in response Alcoa initiated a noise monitoring program and examined options for noise control. This program continues to the present day (refer section 7.14.1).

The Environmental Protection (Noise) Regulations were promulgated in 1997 and came into effect in 1999. Although some major refinery noise sources had already been acoustically treated, monitoring conducted in 1999 indicated that refinery noise levels exceeded regulatory limits under worst-case propagation conditions and tonal characteristics were present. A noise reduction program carried out in 2000 and 2001 successfully reduced noise levels as measured at Boundary Road to the south of the refinery by around 5 dB(A) and removed tonality (as defined by the regulations).

Despite this significant reduction, monitoring and modelling confirm that under certain weather conditions refinery noise exceeds the regulatory criteria at a number of neighbouring private residences (refer to section 7.14.2). Stakeholder consultation indicates that approximately five neighbours continue to be adversely affected by refinery noise under some conditions.

Monitoring and modelling conducted over a number of years has shown that the refinery contribution to noise levels in its vicinity is caused by the combined emissions of many pieces of equipment. This means that further noise reduction would require a large number of sources to be acoustically treated. Alcoa and its consultants have reviewed options for further noise reduction in the vicinity of the refinery. On the basis of these reviews Alcoa has concluded that all reasonable and practicable measures to reduce noise have already been implemented (refer to section 7.14.3).

In 2002, Alcoa applied to the Minister for Environment for a variation to the assigned noise levels, as allowed under Regulation 17, such that the refinery would be fully compliant with the Regulations. This application has undergone intensive review over the last two years and is now being considered by the EPA in parallel with the assessment of the proposed Wagerup expansion.

In developing the Proposal, Alcoa has set an objective that the expansion will not increase noise impacts on surrounding residences. An acoustic assessment of the proposed expansion has been undertaken to verify that the noise objective is technically feasible, and to detail the noise control and management methods required from design through to operational phases.

8.4.2 Acoustic Assessment of Refinery and Overland Conveyor Expansion Proposals

The acoustic assessment of the Proposal was undertaken by SVT Engineering Consultants (SVT) and independently reviewed by a representative of the Acoustics and Vibration Unit, School of Aerospace, Civil & Mechanical engineering, University of New South Wales at the Australian Defence Force Academy in Canberra (refer to Appendix J).

The acoustic assessment involved liaison with the engineering design team to identify key noise generating equipment related to the expansion, noise modelling and site visits to identify reduction opportunities for existing equipment. SVT have prepared three reports as part of the development of this ERMP.

- Noise Model Development Report for Wagerup 3 Expansion project (Report No. A/04/12/005) (refer to Appendix H)
- Environmental Noise Management Strategy for the Wagerup 3 Expansion Project (Report No. A/05/01/010) (refer to Appendix I)
- Noise Control Review for 4 dB(A) Noise Reduction Scenario for Wagerup 3 Expansion Project (Report No. A/05/02/002) (refer to K)

The information contained in these reports has been used by Alcoa for decision making during preliminary engineering design and the preparation of a noise management plan for the Proposal.

Noise modelling of the Proposal (including the overland conveyor system) was conducted by SVT using the SoundPlan noise modelling software (version 6.2) and the associated CONCAWE algorithms.

The most recent version of the existing refinery acoustic model (December 2004) and the overland conveyor acoustic model (September 2004) developed by Herring Storer Acoustics (HSA) were provided to SVT. SVT adopted these models in full as the base for the expansion modelling. SVT developed new noise sources to represent emissions from new

equipment related to the proposed expansion and modified existing sources where these will be affected by the expansion.

The expansion models were used to predict the refinery noise contribution at neighbouring noise sensitive premises under maximum (worst-case) sound propagation conditions (i.e., 3 metre per second wind blowing from the source to the receiver combined with a thermal inversion). The methodology and assumptions used in developing the expansion models are detailed in the Noise Model Development Report provided as Appendix H (SVT, 2005a).

The important receptor locations for the Wagerup refinery and the ore conveying system are neighbouring privately owned residences. Modelling has been used to determine the worst-case noise levels at privately owned residences for the existing refinery and conveyor operations (Refer to Figures 59 and 60).

Figure 59: Existing Refinery Worst Case Modelled Noise Predictions

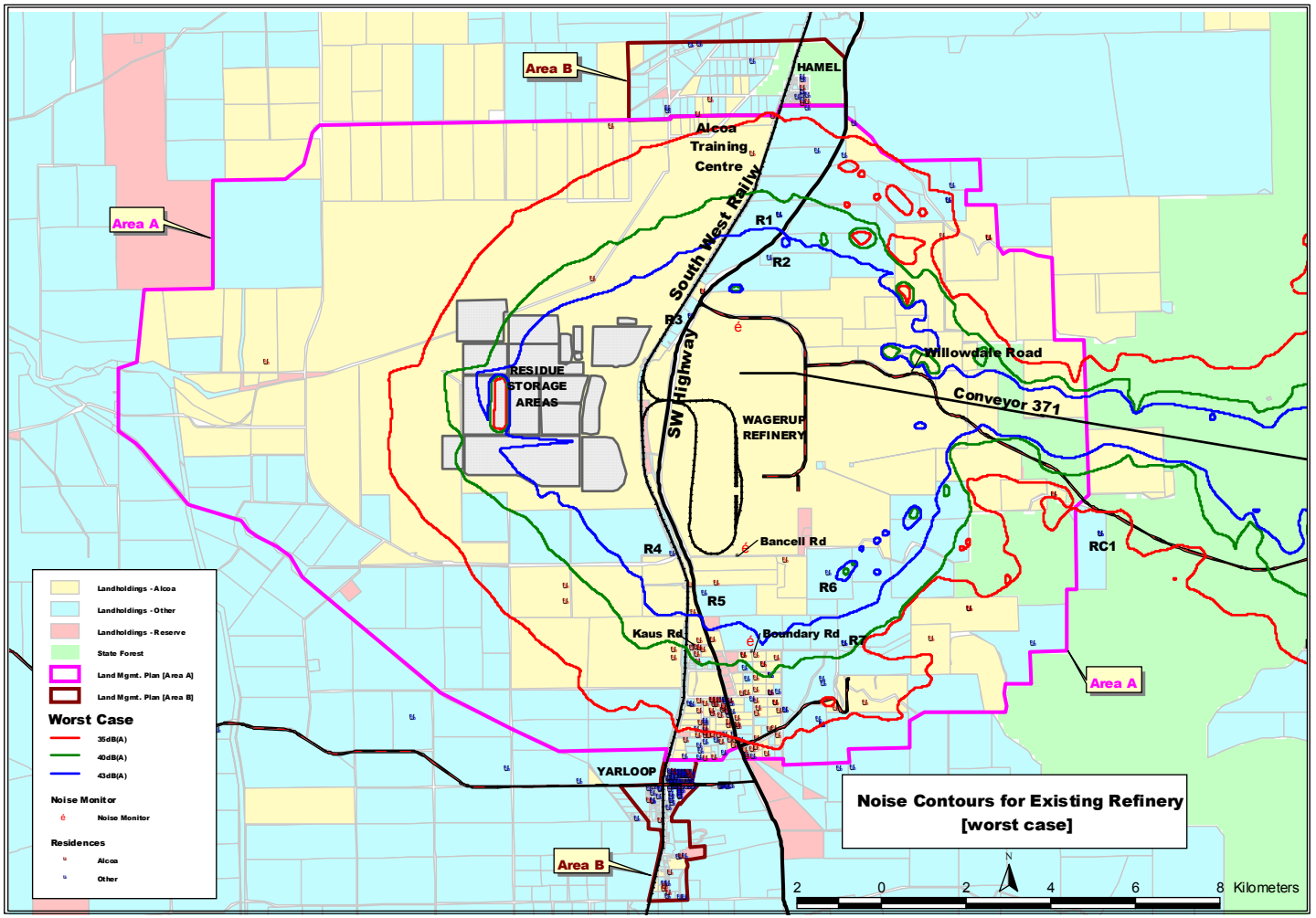
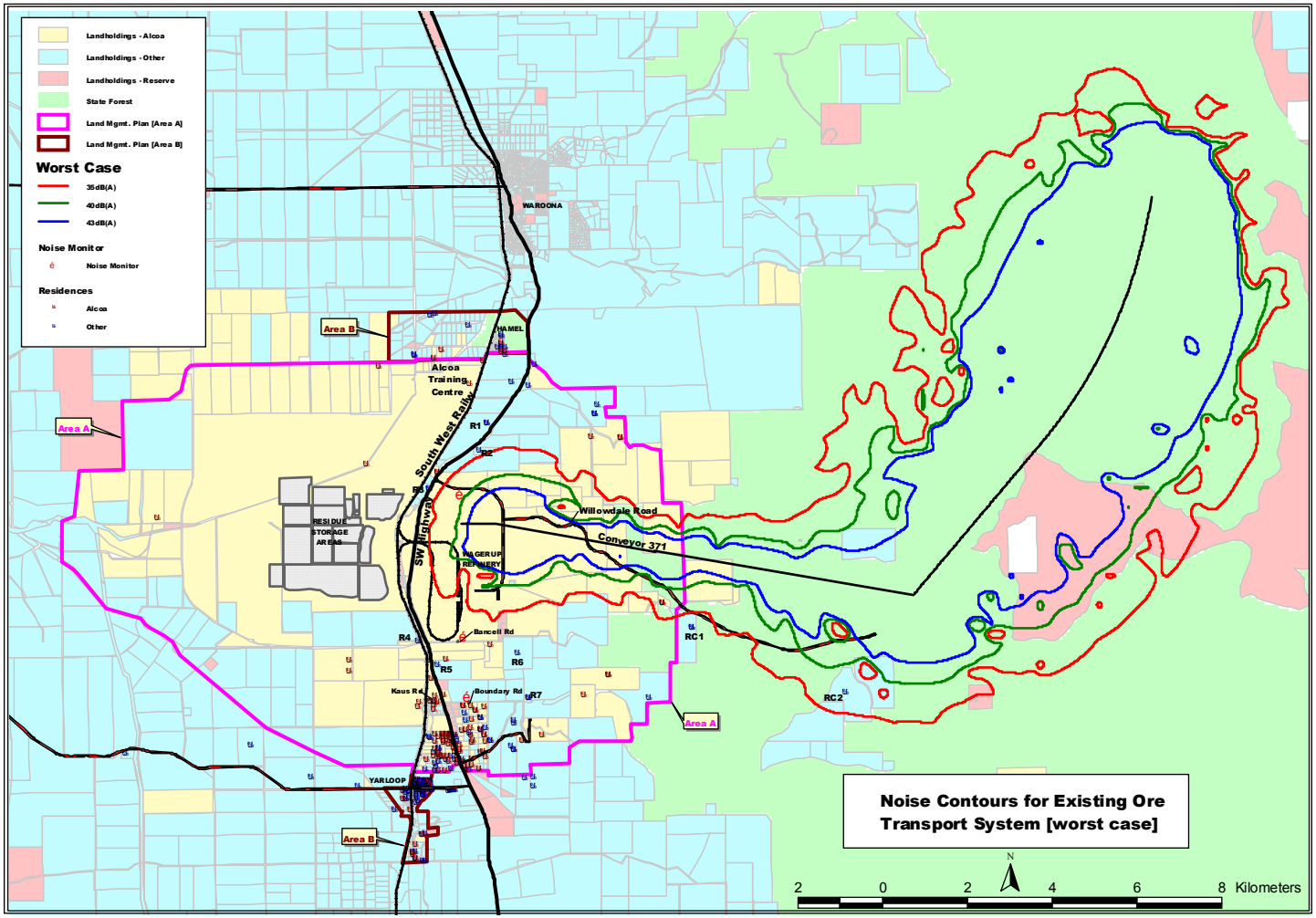


Figure 60: Existing Overland Conveyor Worst Case Modelled Noise Predictions



The effect of the proposed refinery expansion has been specifically reviewed at seven of the closest privately owned residential locations, designated R1 to R7 in SVT report A/04/12/005 (SVT, 2005a). These locations were chosen because of their proximity to the refinery and because the predicted noise levels at these locations will be indicative of the effects of the expansion in the directions where the majority of private residences are located. The overland conveyor expansion model has been used to predict noise levels from the conveyor expansion at two noise sensitive locations to the south of the overland conveyor designated RC1 & RC2 in SVT report A/04/12/005 (SVT, 2005a).

Modelling was initially used by SVT to predict worst-case noise emissions from the expansion scenarios assuming no acoustic controls were implemented. The effect of expanding the refinery and overland conveyor with no acoustic control is shown in Table 27 and Figures 61 and 62.

Table 27: Predicted noise levels at residential locations for expanded refinery and ore transport system assuming no noise mitigation

Location	Existing Noise Level dB(A)	Noise Level after Expansion dB(A)	Noise Impact dB
R1	42.0	45.7	3.7
R2	45.6	49.5	3.9
R3	48.8	53.1	4.3
R4	47.8	51.4	3.6
R5	45.9	49.9	4.0
R6	47.2	50.9	3.7
R7	40.9	45.1	4.2
RC1	32.8	34.2	1.4
RC2	37.3	38.7	1.4

Notes:

1. R1 – R7 represent private residences surrounding the refinery (SVT, 2005a).
2. RC1 - RC2 represent private residences surrounding the overland conveyor (SVT, 2005a).

It can be seen that if the expansion were to be implemented with no acoustic controls, offsite noise levels could increase by over 4 dB(A) (i.e., the noise levels will revert to levels similar to those present before the implementation of the 2000 and 2001 noise reduction program).

Figure 61: Expanded Refinery Worst Case Modelled Predictions without Acoustic Control

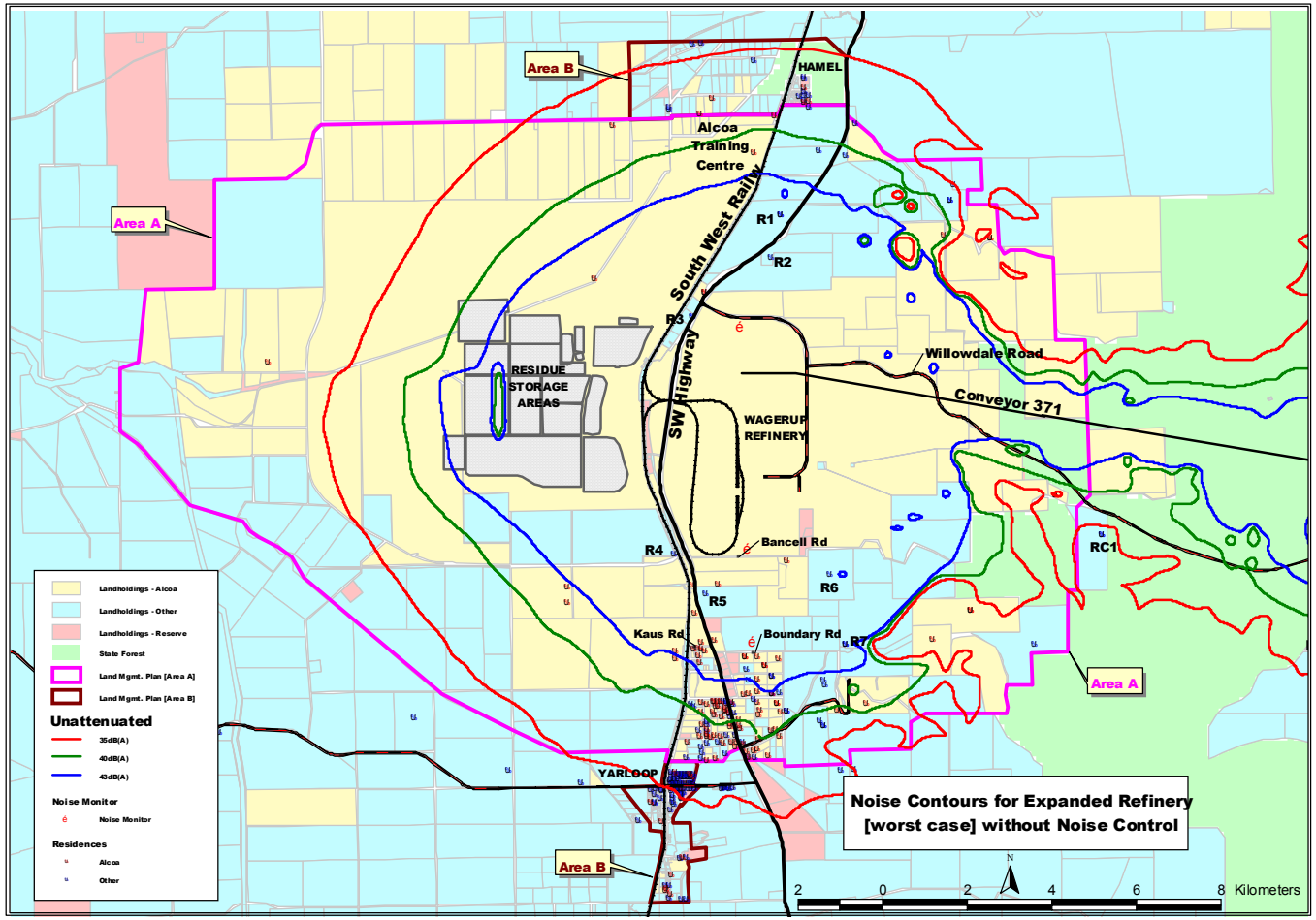
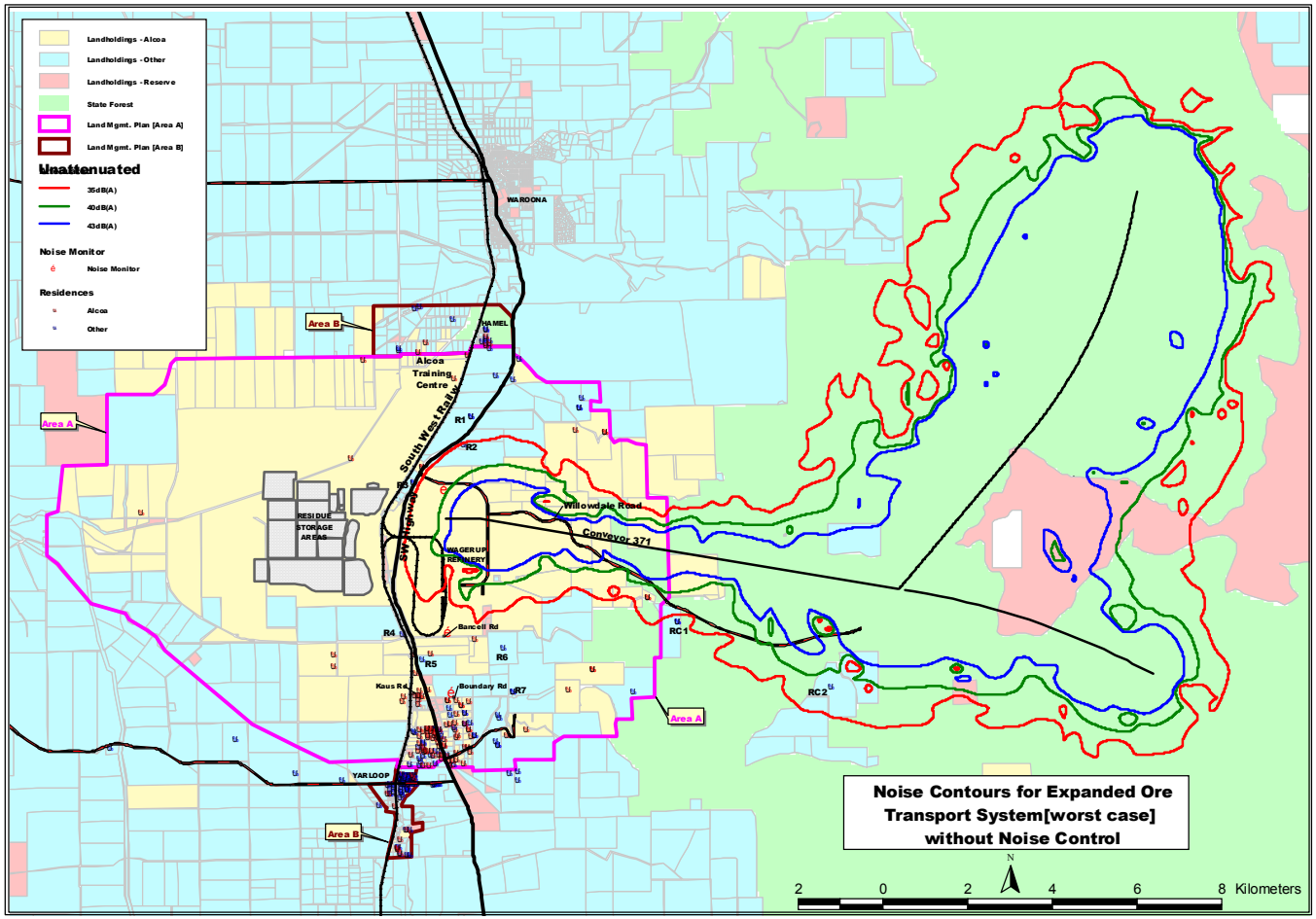


Figure 62: Expanded Overland Conveyor Worst Case Modelled Predictions without Acoustic Control



If Alcoa's noise undertaking is to be met, acoustic controls need to be incorporated into the expansion design to ensure noise levels are adequately controlled.

Modelling the proposed expansion without any acoustic controls provided SVT with a base from which to set the noise emission criteria for significant areas of the refinery and conveying system, and it enabled identification of the project items that significantly contribute to offsite noise levels. Reduced sound power level allocations were then developed for these significant plant areas (SVT, 2005a).

The sound power levels proposed for new equipment were based on SVT's knowledge of available technology and represent a significant reduction when compared to existing equipment.

In order to meet the sound power level allocation it was recognised that it will be necessary to reduce noise from existing sources. It was also evident that the expansion project provides an opportunity to implement noise reductions for some existing plant that would otherwise not be practicable. Reduced sound power level allocations were therefore applied to new and existing equipment within the refinery, where feasible and relevant.

Acoustic controls have been proposed for three major categories of equipment:

Existing Plant: As part of the expansion project, acoustic controls will be applied to some existing plant that would otherwise be unaffected by the expansion. For example installation of silencers on existing powerhouse fans.

Upgraded Plant: Some plant will be upgraded as part of the expansion process. This may provide an opportunity to upgrade acoustic controls at the same time. For example, upgrading of the stockyard conveyors may allow additional acoustic controls to be incorporated.

New Plant: Any new equipment exclusively associated with the proposed expansion will be sourced to meet low noise requirements. Due to technology advances it is possible to source new equipment that is quieter than similar equipment installed previously. For example, installation of lower noise pumps and calcination equipment.

Since the existing and expanded refinery components can't be operated independently, noise emissions from existing, upgraded and new plant will combine to determine the overall noise emission from the expanded refinery at specific receiver locations. The combined effect of acoustic controls applied to existing plant, upgraded plant and new plant is dependent on the relative contribution of each to overall noise emissions from the refinery. The overall effect

of the acoustic control opportunities provided by the Proposal at specific receiver locations are detailed in Table 28 and Figures 63 and 64.

Suggestions on the generic and specific controls that could be applied to achieve the reduced sound power allocations are detailed in the Noise Management Strategy document provided as Appendix I (SVT, 2005b). This document was commissioned as an additional tool to aid the detailed design process. It is envisaged that this document will be updated to represent the latest available information throughout the design process. Therefore, the noise control measures to be implemented as part of the Proposal may change during engineering design, however the sound power level approach will ensure the same environmental outcome is achieved.

Table 28: Predicted noise levels for expanded refinery assuming implementation of noise control measures

Location	Existing Noise Level dB(A)	Noise Level after Expansion dB(A)	Noise Impact dB
R1	42.0	41.5	-0.5
R2	45.6	45.6	0
R3	48.8	48.7	-0.1
R4	47.8	48.3	0.5
R5	45.9	46.8	0.9
R6	47.2	46.8	-0.4
R7	40.9	41.5	0.6
RC1	32.8	32.1	-0.7
RC2	37.3	34.8	-2.5

Notes:

1. R1 – R7 represent private residences surrounding the refinery (SVT, 2005a).
2. RC1 and RC2 represent private residences surrounding the overland conveyor (SVT, 2005a).

Table 28 demonstrates that even with noise controls to existing, upgraded and new plant it translates to relatively small overall change at receiving locations as there is no single dominant noise source at the refinery, rather a large number of sources contributing to the noise received at nearby residences (SVT, 2005a).

This modelling confirmed that if the proposed sound power allocation is implemented there would be minimal change to noise levels experienced by neighbours from the Proposal.

Figure 63: Expanded Refinery Worst Case Modelled Predictions with Acoustic Control

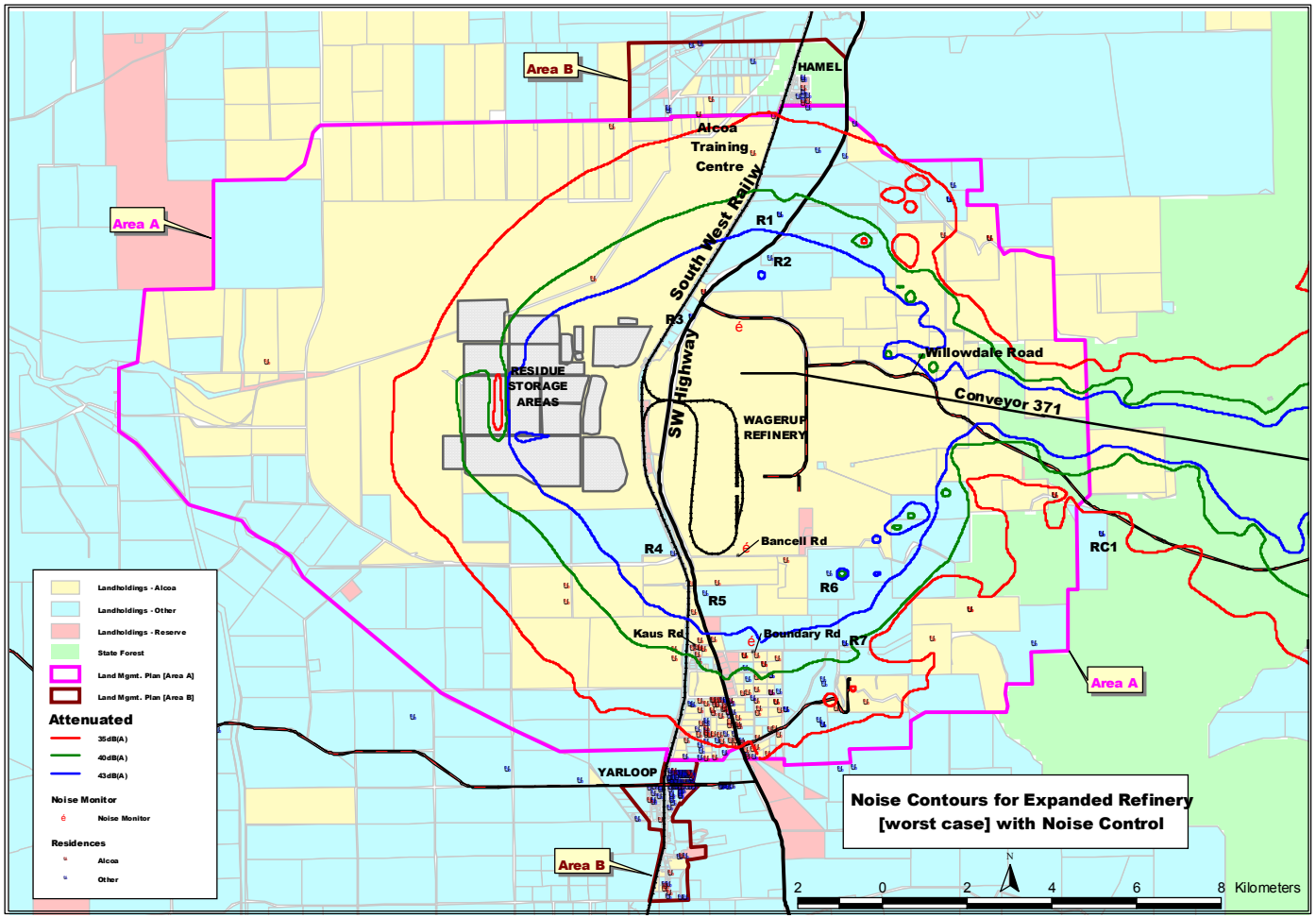
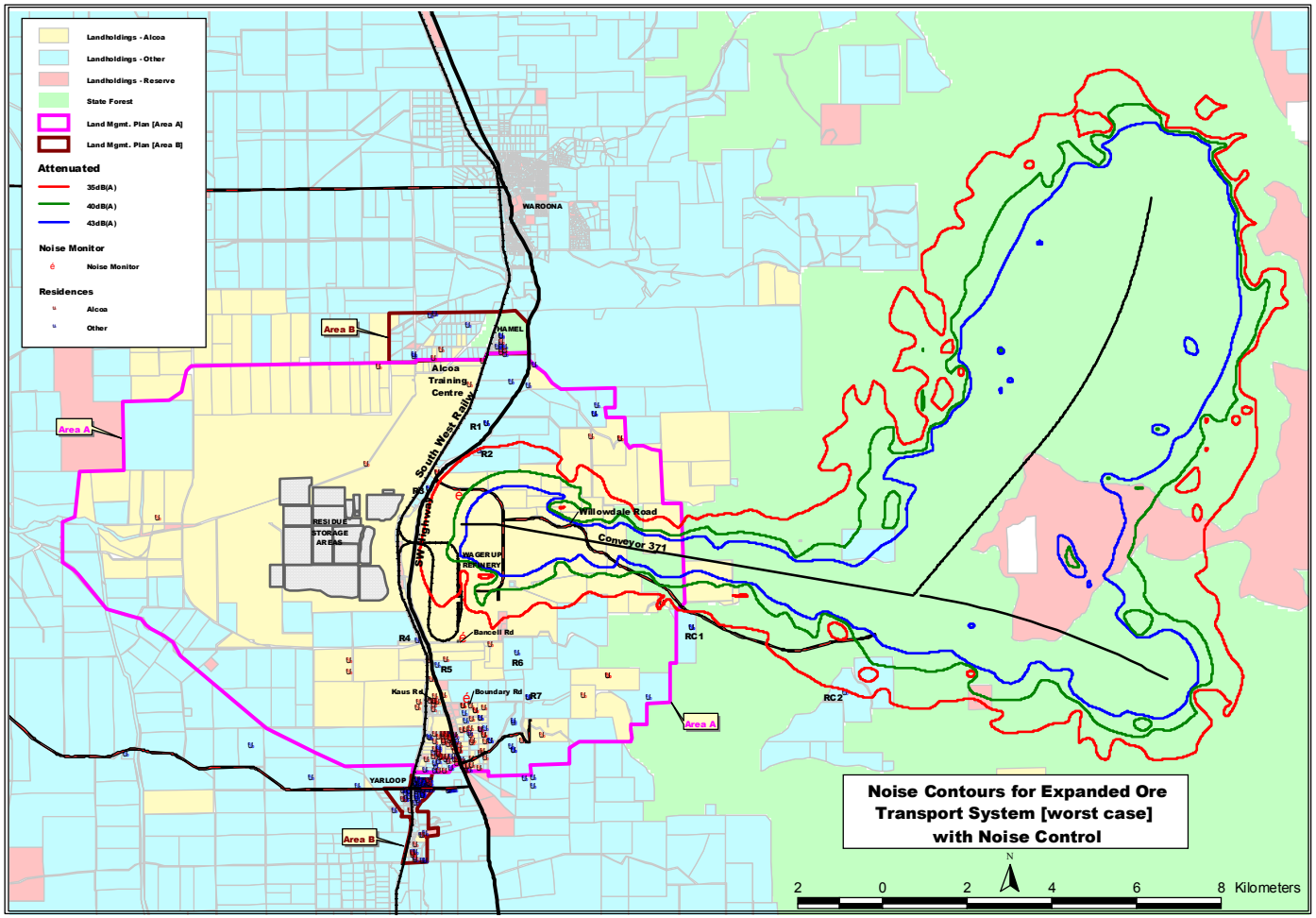


Figure 64: Expanded Overland Conveyor Worst Case Modelled Predictions with Acoustic Control



8.4.3 Compliance of New Plant with Noise Regulations

The expansion proposal involves the installation and operation of new equipment, upgrade of some existing equipment, and the integration of both with existing equipment.

SVT has assessed the compliance of new equipment with the night-time regulatory criteria of 35 dB(A). This was undertaken even though new equipment associated with the Proposal cannot be operated in isolation of existing equipment. This analysis indicated that even with significant noise attenuation, the new equipment would be unable to meet the regulatory criteria in its own right.

The contribution of new plant to overall noise levels at the nearest noise sensitive premises ranges from 34.6 to 42.6 dB(A) (SVT, 2005a). Based on their knowledge of the latest available technology, SVT concluded that it was not practical for new equipment to be installed to meet sound power allocations that would satisfy the 35 dB(A) night time criterion at all affected locations.

SVT highlighted the fact that the benefit of the new plant complying with the 35 dB(A) criteria, were it achievable, would not be realised unless the contribution from existing plant was similarly reduced (SVT 2005a). Investigations into further noise reduction conducted by SVT in 2005 and HSA in 2002 indicate that further overall noise reductions at the Wagerup Refinery are not reasonable or practicable (SVT 2005c, HSA 2002c).

8.4.4 Additional Considerations

SVT and the expert reviewer believe that the proposed sound power level allocations are technically achievable. Preliminary advice from Alcoa's engineering design team indicates that meeting the sound power allocation will require in excess of $50 million to be spent on acoustic control of new, upgraded and existing equipment. These costs do not include ongoing operational and maintenance costs associated with acoustic treatment of existing plant. The proposed acoustic treatment imposes a significant additional cost of over $50 million to the Proposal.

It has been recognised by Alcoa, SVT and the expert reviewer that the acoustic assessment and modelling has been undertaken early in the design phase when specific equipment details have not been finalised. While this is advantageous as it provides a framework for detailed design, it means that the current design information and models do not represent the final 'as-built' situation. The model will need to be reviewed as detailed design progresses to ensure it represents the latest possible information. This requirement has been reflected in the Noise Management Plan (NMP) presented in Section 10.

Alcoa recognises that ongoing model review and update will be required to provide input to the design team, allow the sound power level allocations to be refined, enable equipment sound power level specifications to be incorporated into supply contracts and to help form the basis of future operational noise management strategies at the refinery.

Providing the NMP and associated sound power allocations are implemented, the Proposal should meet the outcome of no increase in noise impacts over the existing refinery.

Commitment 8.

Alcoa will implement the noise management plan provided to ensure that the noise objectives for the Proposal will be met.

Commitment 9.

Alcoa will implement the Proposal such that there is no increase in noise impacts on nearby residents.

8.4.5 Bunbury Port Noise Emissions

The EPA's objective for the Proposal with regards to management of noise from Alcoa's Port facilities is:

- *to comply with statutory requirements.*

The noise emissions from Alcoa's Bunbury Port facility currently comply with the assigned levels in the *Environmental Protection (Noise) Regulations 1997*. Only a small number of noise complaints are lodged with Alcoa and feedback from port neighbours does not indicate that noise emissions from Alcoa's operations are a major concern for them.

Noise emissions from the port facility are measured periodically and modelling has been conducted to determine Alcoa's current contribution to noise levels at neighbouring residences.

The acoustic assessment of the Proposal was undertaken by SVT Engineering Consultants (SVT) and independently reviewed by the Acoustics and Vibration Unit of the University of New South Wales, Australian Defence Force Academy in Canberra. The reviewer provided some suggestions related to information presentation and inclusion of additional information,

but generally agreed that the acoustic assessment conducted by SVT had been undertaken in an appropriate manner (refer to Appendix J).

The acoustic assessment involved close liaison with the engineering design team to identify key noise generating features of the Proposal, a review of the most recent noise model (2001 version) and site visits to measure sources that had been modified since the last model update.

Noise modelling was not conducted for the Alcoa port operations because design information identified that the modifications associated with the Proposal would not significantly affect noise emissions. Instead calculations were performed to determine the contribution to noise levels received at neighbouring residences by the modifications. The methodology and assumptions used for the Bunbury Port facility acoustic assessment are detailed in the Noise Management Strategy Report provided as Appendix I (SVT, 2005b).

The critical receiver locations for Alcoa's Port facility are two neighbouring privately owned residences located to the south-west and north-east of the facility. The current noise model predicts worst case noise levels from Alcoa's Bunbury port facility of 35 and 31 dB(A) respectively for these residences.

Since 2001 the only change to equipment operated at Alcoa's Port facility is an upgrade of the ship loader dust collector fan. SVT conducted measurements of this source as part of the proposed expansion acoustic assessment. These measurements indicated that the new fan is approximately 3 dB quieter than the old equipment.

In the 2001 model, the ship loader dust collector fan was identified as the most significant contributor to noise received at the residence to the south-west of the port operation. Therefore SVT concluded that worst-case noise levels have also reduced by approximately 3dB to the south-west of the port.

SVT predicted that following the modification to the dust collector fan, current worst-case noise levels will be 32 dB(A) at the south-western residence and 31 dB (A) at the north-eastern residence.

After reviewing the existing model and the design changes associated with the proposed expansion, SVT concluded that provided low-noise new equipment is selected and the duplicate conveyor is enclosed, the proposed changes to the Alcoa facility should have no noticeable noise impacts at nearby residences (SVT, 2005b).

Commitment 10

Alcoa will ensure that noise from the Bunbury Port Facility continues to comply with the requirements of the Environmental Protection (Noise) Regulations 1997 following the implementation of the Proposal.

8.4.6 Expert Review of Noise Assessment studies

A representative of the Acoustics and Vibration Unit, School of Aerospace, Civil & Mechanical Engineering, University of New South Wales at the Australian Defence Force Academy in Canberra, was commissioned to undertake an independent desk-top review of the acoustic assessment conducted by SVT on the Proposal. The objectives of the review were to:

- Comment on the completeness of the information presented;
- Comment on the suitability of the measurements performed for assessing the project impacts;
- Comment on the correctness of the analysis performed on the data presented;
- Comment on the suitability of the methodology used to make predictions;
- Comment on the conclusions reached in the report(s) being reviewed

The results of the expert review are provided in Appendix J (Burgess, 2005 a & b)

Since this was a desk top review, it did not involve an investigation into the accuracy of the model, the detail of the modelling program or a review of measurement data.

A review of the noise monitoring program (both fixed and hand held) and the 2000 version of the noise model developed by HSA, was conducted in 2002 as part of the audit of Alcoa's Regulation 17 application commissioned by DoE. DoE awarded the 2002 audit contract to SVT (SVT, 2002).

As a result of the 2002 audit, SVT concluded that Alcoa's noise monitoring network is a comprehensive system, employs up to date technology, is well conceived and is capable of accurately measuring sound levels (SVT, 2002).

SVT made several recommendations relating to the 2000 version of the Refinery acoustic model. SVT concluded that the accuracy of this version of the model for predicting overall A-weighted sound pressure levels is likely to be of the order of +/- 5 dB(A) over the entire area covered by the model and they concurred with HSA's estimated accuracy of +/- 3 dB(A) for worst-case propagation conditions at locations selected for calibration (SVT, 2002).

The acoustic model has been updated since this audit to take into account the recommendations made by SVT. The December 2004 version of the model, which was used to develop the expansion model, includes the most recent sound power level information for refinery sources. The model has been re-calibrated and the contours have been extended to the north and east of the refinery.

Given the focus and outcomes of the 2002 audit commissioned by the DoE, the expert review of restricted to the acoustic assessment conducted for the Proposal.

Summary of Expert Review

The expert reviewer acknowledged that there are difficulties conducting and reviewing an acoustic assessment performed during the preliminary design phase. Ongoing modelling and acoustic review will be required throughout the detailed design phase.

The reviewer concluded that that:

- The refinery noise model appears to be appropriate and the summary of the validation of the model appears to support this
- Noise contours indicate that compliance with the sound power allocation table should lead to noise levels in the area surrounding the refinery and overland conveyor after the expansion being similar to those existing before the expansion, and
- The Bunbury Port facility components of the Proposal should not have an adverse impact on the surrounding area.

The reviewer concluded that the approach taken by SVT during the preliminary design phase appears to be correct and that "overall it would appear that the noise assessment, the determination of sound power allocations and the nature of the mitigation measures has been undertaken in a careful and appropriate manner".

8.4.7 Rail Noise

Noise from train pass-bys was raised as an issue through the Noise and Transport working group and also in discussions with the Department of Environment. Although the issue is outside the scope of this ERMP and all rail noise is exempt from the *Environmental Protection (Noise) Regulations 1997*, Alcoa recognised the issue is of importance to some community members.

Alcoa undertook to monitor typical train pass-bys to provide information on current noise impact of trains travelling along the South West Main line between the Bunbury Port and the Wagerup Refinery. Table 29 provides a summary of hand held measurement data recorded during train pass-by's during a 24 hour study conducted in November 2004.

Table 29: Sound Pressure Level Data for Trains on Line between Wagerup and Bunbury

Data collected by Herring Storer Acoustics on 22 & 23 November 2004								
All Sound Pressure Levels are 15 m from train line								
Locomotive	**Wagon Type**	**Load Status**	**Direction**	**Wagons**	**Notch Setting**	**L_{aeq} (2 min)**	**Train L_{Amax}**	**Horn L_{Amax}**
S-Class	Alumina	Unloaded	North	38	0	**69.8**	**79.6**	**79.4**
S-Class	Alumina	Unloaded	North	38	3	**82**	**88**	**100.6**
S-Class	Alumina	Unloaded	North	38	0	**86.9**	**89**	**89.5**
S-Class	Alumina	Unloaded	North	34	0	**72.1**	**76.2**	**76.1**
S-Class	Alumina	Loaded	South	38	8	**68.7**	**74.7**	**79.3**
S-Class	Alumina	Loaded	South	38	0	**68.5**	**72.5**	**89.2**
S-Class	Alumina	Loaded	South	38	8	**77.9**	**86.1**	**86.4**
S-Class	Alumina	Loaded	South	34	6	**73.3**	**82.2**	**82.7**
DB-Class	Caustic	Unloaded	South	20	4	**73.3**	**77.2**	**88**
DB-Class	Caustic	Loaded	North	20	8	**75.4**	**85.3**	**87**
Australind	-	-	North	-	-	**83.7**	**89.7**	**88.9**
S-Class & DB-Class	Coal/Lime	Loaded	South	41	0	**78.8**	**86.7**	**88.1**
S-Class	Coal	Loaded	North	29	8	**73.8**	**76**	**-**
2300 Series	Goods	Loaded	North	10	1	**70.3**	**74.7**	**79.9**
Crossing Measurements								
Locomotive	**Wagon Type**	**Load Status**	**Direction**	**Wagons**	**Notch Setting**	**L_{aeq} (2 min)**	**Train L_{Amax}**	**Horn L_{Amax}**
S-Class	Alumina	Unloaded	North	38	0	**83**	**-**	**3**
S-Class	Alumina	Unloaded	North	38	-	**81.1**	**86.9**	**3**
S-Class	Alumina	Loaded	South	34	6	**80.4**	**82.7**	**2**
S-Class	Coal	Loaded	North	29	8	**76.7**	**86.3**	1
Locomotives @Idle (15 m)								
Locomotive	Laeq (2 min)							
S-Class	68.2							
DB-Class	72.3							
Prepared for noise and transport working group meeting 24 Nov 2004								

L_{Amax} – maximum noise level of event
L_{Aeq} – continuous equivalent level over the full time event

The summary data shows that L_{Amax} values of trains measured during the study ranged from 72.5 dB(A) for a loaded 38 wagon alumina train to 89.7 dB(A) for the 'Australind' passenger train. The L_{Aeq} values ranged from 68.5 dB(A) for a loaded 38 wagon alumina train to 86.9 dB(A) for an unloaded 38 wagon alumina train. The summary data suggests that unloaded alumina wagons have a slightly higher L_{Amax} than loaded alumina wagons and that the noise level of trains related to the Alcoa operations are relatively similar to the noise levels of Non-Alcoa trains using the rail line.

8.5 WATER SUPPLY

The EPA's objective regarding water supply for the Proposal is to:

- *maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected*.

Alcoa commissioned two studies to investigate the potential impacts of the Proposal on surface water supplies. Options for water supply were investigated and the ecological water requirements (EWRs) and water availability in the lower Harvey River catchment considered (Appendix A).

As a result of the investigations and Water and Residue Working Group input, the preferred future water supply options identified were:

- to increase abstraction from the Harvey River Main Drain;
- to transfer part of Alcoa Farmlands Irrigation Water Entitlement to the water requirements for the refinery.
- to invest in upgrades of the existing irrigation systems and use the water savings from this upgrade; and
- to harvest winter surface flow from other agricultural drains to supplement the Harvey Drain source.

These options are discussed in detail in Appendix A. For the Proposal, Alcoa will continue to evaluate both the option to increase abstraction from the Harvey River Main Drain and the possibility of realising additional water through efficiency increases within the irrigation district. The potential issues and management measures associated with increased abstraction from Harvey Main Drain are discussed below.

A surface water supply management plan has been developed which provides more detail on the management of surface waters associated with the Proposal (refer to section 10).

8.5.1 Additional Surface Water Abstraction from the Harvey River Main Drain

Potential Issues

Based on historical stream flow data CENRM (2005) estimated about 75.2 GLpa flow passed the Logue Brook confluence, suggesting there is approximately 28 GLpa available in winter at the proposed Harvey Main Drain abstraction point after allowing for environmental flows (CENRM, 2005).

The water requirement for the Proposal is expected to be an additional 1.1 GLpa under average rainfall and runoff conditions (see Table 5; Section 5.3.3) and potentially up to 4.8 GLpa under drought conditions (see Table 6; Section 5.3.3). These requirements are well within the additional 28 GL identified as available from the Harvey River Main Drain pumpback station (CENRM 2005).

The estimates of available water provided by CENRM are based on the assumption that for multiple-use non-pristine rivers and streams at least one-third of natural flows are required to maintain ecological water requirements (EWRs). However, this needs to be calculated on a seasonal basis to ensure that over-allocation of surface water does not occur during seasonal low-flows. The one third estimate is the general 'rule of thumb' used when no formal EWR assessment has been conducted, and has been applied to the lower Harvey catchment.

It is recognised that the constructed nature of the Harvey River Main Drain means that in-site ecological value is low. Therefore, calculation of EWRs are based mainly on the need to maintain upstream connection for migratory fish and downstream flows of detritus (from the forested upper reaches) to subsidise downstream food webs (CENRM, 2005).

Proposed Management

A gauging station has been installed on the Harvey River Main Drain immediately downstream of the abstraction point in preparation for monitoring winter flows in 2005. This will allow accurate assessment of the potential yield from this source. The data obtained from such monitoring prior to, and during the construction of the Proposal (a period of several years) would allow the yield of the current pumping system to be confirmed, including consideration of EWRs. The amount of water available for use by the Proposal will therefore depend on this flow data and an ecological assessment of the Harvey Main Drain below the abstraction point, however preliminary estimates indicate sufficient water is available for the Proposal.

Alcoa will undertake an assessment of the ecological value of the Harvey River Main Drain downstream of the abstraction point prior to commissioning of the Proposal, if approved. The requirements of the ecological study for the drain will be determined through discussion with the Department of Environment.

Water supplies for the Proposal will be managed in accordance with the Water Supply Management Plan presented in section 10. The Water Supply Management Plan is based on current licence requirements and will be updated to reflect any changes to the surface water abstraction licence.

Commitment 11

Alcoa will implement the Water Supply Management Plan to manage additional water requirements for the Proposal.

8.5.2 Surface Water Supply from Irrigation Water Efficiency Upgrades

Potential Issues

Access to irrigation water through improving irrigation efficiencies of the Harvey Water Irrigation System is a potential water supply source. Much of the Harvey Water Irrigation System was constructed more than 60 years ago, and is considered inefficient by modern standards resulting in high losses from evaporation and seepage. Overall irrigation efficiency has been estimated at around 50% (ENVIRON, 2005).

Harvey Water Cooperative has commenced a programme of irrigation infrastructure improvements and is promoting more efficient on-farm irrigation practices in conjunction with the Western Australian Department of Agriculture. As a result of distribution system improvements already completed in the Harvey and Waroona irrigation districts, Harvey Water believes that more than 6 GL has been saved at a cost of around $2 million to $3 million per GL (Harvey Water *pers. comm*.). It is believed that water gained through infrastructure efficiency improvements should be available to trade for non-agricultural use with the income used to fund further improvements to the irrigation system. (ENVIRON 2005).

An option Alcoa is therefore considering is investing in water distribution improvements with the view to securing the water savings for industrial use, and benefiting the local farming community through improved irrigation practices.

8.5.3 Water Conservation Initiatives

The Wagerup refinery was designed to recycle process and runoff water in recognition of the climate, fresh water availability and environmental factors associated with effluent discharge. This means that opportunities to reduce water consumption without major process and equipment modifications are limited.

Alcoa developed a Water Conservation strategy in 2001 in recognition of the growing concerns about water in the community (Alcoa, 2001). This strategy was shared with external stakeholders including key Government personnel and community consultative networks. While recognising that opportunities to reduce total water consumption are limited for the existing refinery without major process and equipment modification (due to current water

recycling and runoff capture practices), the strategy calls for a reduction in the use of high quality (potable) water supplies in competition with other users. Initiatives such as the Harvey River Main Drain Pumpback at Wagerup are considered to be consistent with this strategy.

Water conservation options considered as part of the Proposal are presented in Appendix A (ENVIRON, 2005).

Commitment 12

Alcoa will continue to implement water saving measures into plant modifications and expansions where practicable and feasible, in line with sustainability principles and cleaner production goals.

8.6 SURFACE WATER QUALITY

The EPA's objectives with regards to surface water quality for the Proposal are to:

- *retain the integrity, functions and environmental values of protected wetlands, and to ensure that the EPP lakes are protected and their key ecological functions are maintained; and*
- *maintain the integrity, functions and environmental values of rivers and ephemeral streams, and to ensure that alterations to surface drainage do not adversely impact native vegetation.*

8.6.1 Refinery Surface Water Management

Potential Issues

Alcoa uses risk assessment methodology to determine the main potential surface water pollution sources. These are reviewed during the annual review of the Operating Centres Impacts and Aspects Register as part of the EMS. The main potential sources of pollution have been identified as:

- process spills (sand, silt, high alkalinity water, hot condensate and acid);
- caustic contamination of condensate stored in the Lower Yalup Dam;
- caustic, alumina and hydrocarbon spills from railway loading and unloading facilities;
- silt runoff from bauxite stockpiles;
- paint, rust and sand particles from sandblasting in old laydown area; and
- hydrocarbons from oil, petrol and diesel from vehicles parked in car parks.

For the existing refinery, management systems are in place to capture all stormwater runoff and process spill water that is not contained within bunds. This water is contained and drained by the stormwater drainage system to the stormwater surge pond and into the cooling water pond or run off water storage (ROWS) pond in the residue area. Water from the ROWS pond and cooling pond is used in the refinery and residue area.

Stormwater runoff from the bauxite stockpile area drains to the Lower Yalup Dam, which also contains condensate from the refinery process. The electrical conductivity (EC) of water in this dam is controlled to less than 200 μS/cm and re-used around the refinery for cooling tower make-up water, washing the catalyst from the liquor burning plant, and mill flushing.

The storm sewer and surge pond for the refinery have been designed for a 1:100 year storm. The design surge capacity of the Storm Pond is 53 ML, with pipelines taking water to the ROWS and cooling pond. Should this system not cope with a rainfall event an additional 10 ML is available within the unsealed overflow pond. Existing surface drainage down gradient of the refinery area is intercepted by the Diversion Drain and a recovery system is in place. Therefore the risk of contaminated water leaving the property is considered low and manageable. The stormwater surge pond is surveyed occasionally to check capacity and remove silt build up, if required.

No wetlands identified in the Draft Wetlands EPP 2004 will be directly impacted by the Proposal (Section 7.5.1).

The nearest streams are North Yalup Brook to the north of the refinery and Lower Yalup Brook to the west, which both flow into the Diversion Drain (Figure 13) and Bancell Brook to the south of the refinery. Downstream of the refinery these streams become agricultural drains which have little native riparian vegetation and low environmental values due to their disturbed nature. Areas downstream of the refinery are mostly cleared for agricultural purposes. The risk of adversely affecting the environmental values of protected wetlands and rivers, streams or vegetation downstream of the refinery is considered low, since all surface water runoff and discharges are retained on-site for use in the refinery or residue area. The risk of seepage to groundwater coming to the surface is addressed in Section 8.7.

Implementation of the Proposal will mean an increase in the volumes of process chemicals, materials and liquors in the refinery system, and an increase in the requirement for containment vessels and pipework, thereby increasing the potential risk of surface water contamination off-site. The Proposal will occur within the existing boundary of the refinery stormwater collection systems and therefore the potential impact on surface waters is considered minimal.

Proposed Management

Any new capital project proposed by Alcoa is required to be internally assessed via a comprehensive set of management tools and designed in accordance with appropriate design principles. The design and capacity of the existing stormwater management system at the Wagerup refinery will be reviewed as part of detailed engineering design to ensure the Proposal can be accommodated. The Proposal has been designed in accordance with the following principles for the prevention of pollution of surface waters:

- Release of contaminated liquor outside the controlled refinery environment is not acceptable;
- Stormwater drainage systems are for collection of stormwater runoff, not process water;
- Primary and secondary containment systems are to be designed to eliminate the potential for uncontrolled spillage to the environment (e.g., through process controls, bunds, sumps, and pumps sized appropriately in accordance with the risk assessment results);
- Installation of any process fluid pipelines are to be above ground for quick detection of leaks and to facilitate inspection and maintenance during service life;
- Drain down pipes, valves and future maintenance are to be contained within the confines of the steel containment system;
- Steel lined drains, pipes or sumps are to be used to carry aggressive fluids (the release of hot caustic, acid or other aggressive fluids directly onto concrete surface is not acceptable); and
- Drain down fluids are to be directed to collection sumps within steel lined drains or pipes, not across unprotected concrete aprons or floor slab.

Monitoring of surface water around the refinery is undertaken to meet the requirements of the Department of Environment licence, the Surface Water licences, and is also used as a tool to detect leakage of process materials. The water monitoring programme is designed to provide the necessary information to make the most appropriate decisions regarding water quality management.

A Spill Management Plan (SMP) has been developed for the Proposal to manage the impacts from potential spills associate with the refinery Proposal. The SMP forms part of this ERMP and is presented in section 10.

8.6.2 Residue Area Surface Water Management

Potential Issues

The residue area has a 100% surface water containment policy. Surface water runoff and underdrainage is collected in either of the two Runoff Collection Ponds (ROCPs) and pumped from these to the ROWS or Cooling Pond.

The ROCPs have a typical total design capacity of around 150 ML to 200 ML. The ROWS pond is used to accommodate the surges in total water storage capacity (i.e., cooling lake, mud lake, sand lake, RDA2 and all dry disposal runoff ponds) as the evaporation and rainfall vary throughout the year. In winter, water from the detention pond is pumped to the ROWS pond for storage to be recovered in summer.

Under normal rainfall conditions water collected on the surface of the residue area is allowed to drain freely to the stormwater drainage via the decant. Under severe storm conditions water may need to be retained in the residue drying areas by closing the decant weirs. This prevents an unmanageable amount of water reporting to the ROCPs. Operational guidelines stipulate that storm surge capacity must be maintained on the residue area to capture 100% of any storm event, based on a 1:100 year 72 hour storm and a 12 to 13 day recovery period.

The main potential sources of pollution at the existing residue area are alkaline leachate (with some high levels of metals) from the residue deposited and liquor sent to the Cooling Pond; oxalate, scale and inert waste from the landfill facility at the residue area; and hydrocarbons from areas where waste oils have been used for dust suppression.

The Proposal will result in an increase in the bauxite residue deposition rate and an expansion of the active drying area. There will therefore be greater volumes of residue and liquor reporting to the residue area and cooling pond respectively and a greater area of surface water runoff from the drying areas that will need to be contained within the stormwater drainage system.

Proposed Management

The existing stormwater management system at Wagerup was designed to accommodate the additional run-off from the Proposal. The new equipment for the Proposal is all within the existing footprint of the refinery and therefore no new large areas of hardstand require containment. The stormwater management system is reviewed on annual basis as part of the Operating Centres Impacts and Aspects Register in accordance with the EMS.

Surface water and stormwater management during the operation of the Proposal will continue to be undertaken in accordance with the relevant procedures as outlined in the EMS.

8.7 GROUNDWATER QUALITY

The EPA's objective with regards to groundwater quality for the Proposal is to:

- *maintain the quality of groundwater so that existing and potential uses, including ecosystem maintenance, are protected.*

Potential Issues

Alcoa maintains an extensive groundwater monitoring network of some 420 monitoring bores. A groundwater plume has been detected below the northern part of the refinery and in the vicinity of Building 45 (Precipitation), west of the caustic unloading facility and the former hydrate stockpile pads. This plume is largely within the superficial aquifer and influenced by the seasonal variation in the groundwater table, although it is having a very low level impact on the underlying Cattamarra Coal measures formation. Plumes extend up to 500 metres west of the refinery buildings and have impacted surface waters northwest of the former hydrate stockpile, which was removed in 2000.

In the past, minor cracks in building slabs have enabled alkaline process liquors to seep into the underlying ground. Chemical reactions have resulted in expansion of the ground and heaving has exacerbated minor cracks, creating a contaminant pathway. Alcoa is investigating appropriate remediation of this groundwater contamination. The decision to install an alkali recovery system, or to continue monitoring as plumes dissipate will depend on ability to recover the plume and will be made in consultation with the DoE. (Section 7.6.1).

Minor seepage of residue leachate has been recorded in bores around the residue area, indicated by elevated alkalinity in the groundwater. Recent monitoring showed some low or moderate levels of contamination in parts of the upper superficial formations (Parsons Brinckerhoff/Neild Consulting, 2004). Groundwater contamination is most significant beneath RDAs 1 and 2 and there is low level impact on surface waters in farm drains a few metres west of ROCP1 and RDA4 (Figure 16).

The cooling pond, runoff water storage pond (ROWS pond) and runoff collection pond 2 (ROCP2) adjacent to the residue area incorporate basal clay-geomembrane liners. The elevations of the liners are lower than normal maximum groundwater levels. Alcoa therefore operates groundwater depressurising systems around these ponds to maintain safe groundwater levels and prevent upward pressure on the liners. Without the depressurising systems, mounding and rupture of the liners may occur when groundwater levels exceed pond water levels.

Groundwater abstraction by Wagerup's groundwater depressurising systems is carried out under Groundwater Well Licence 102669, issued by the Water and Rivers Commission on 28 May 2001. There are plans to assess the need for any remediation of groundwater at the Wagerup residue area.

Implementation of Proposal will result in an increase in the volumes of process chemicals, materials and liquors in the refinery system, and residue deposited in the residue area. It will also require additional containment vessels and pipework, thereby increasing the risk of leaks and spills. Any spilt material, leaks or releases from the refinery and residue area that are not contained have the potential to percolate into the ground and contaminate the underlying groundwater.

Proposed Management

Alcoa is in the process of implementing a Groundwater Remediation Plan to address existing groundwater contamination issues. At the Wagerup refinery the remediation plan will initially focus on recovery of contaminated groundwater from beneath process buildings in 2005 and planning remediation at ROCP1 in conjunction with construction of new RDA's. Investigations to assess the need for remediation of the plume emanating from beneath the now decommissioned hydrate stockpile, will continue in 2005 and remediation of these areas undertaken, if required. Further investigation into possible groundwater contamination present beneath old landfills at the RDA and the middle process buildings will be undertaken in the coming 5 years.

Planned management of contaminant plumes beneath the refinery involve:

- recovery of contaminated groundwater from beneath process buildings where significant amounts of alkaline contamination are present
- installation of monitor bores near buildings and facilities where contaminant recovery is being carried out to measure contaminant loading;
- determining the extent of plumes west of the refinery, and
- identifying surface and groundwater being (or likely to be) impacted by plumes.

Measures implemented for the protection of surface waters (refer Section 8.6) will also minimise the risk of groundwater contamination. Measures to be incorporated into the design of the Proposal include:

- primary and secondary containment systems of process materials
- above ground installation of any process fluid pipelines for quick detection of leaks and to facilitate inspection and maintenance during service life, and
- providing steel containment systems for drain down pipes and valves, and steel lined drains, pipes or sumps used to carry hot, caustic or acidic fluids.

A Spill Management Plan has been developed for the Proposal incorporating measures that are in place (refer to section 10), to minimise the risk of future groundwater contamination as a result of spills (see Section 8.6.1).

Whilst the older RDAs at Wagerup are lined with 0.5 metre of re-compacted clay and overlain by a basal drainage layer, these are not 100% impermeable and some seepage is possible. The newest areas constructed (RDA 6 onwards) incorporate a geomembrane as part of a composite liner. 'Dry stacking' of residue commenced in 1991 (see Section 4.2) and significantly reduces the moisture content in the residue. In combination with the latest composite liner design, the risk of leachate seepage into the underlying groundwater is significantly reduced.

During construction and operation of the Proposal, groundwater monitoring will continue in accordance with the WA Operations Groundwater Monitoring Manual (Doc. Number 53409) and the network of monitoring bores expanded as required. The current groundwater monitoring strategy at Wagerup is summarised as follows:

Type of release	**Monitoring**
1. Seepage and continuous slow release	• Aquifers are monitored for long-term effects of seepage contamination. Monitoring occurs for parameters that can be used to quantify alkaline contamination and gauge any trends. Monitoring occurs at a frequency dictated by the groundwater movement rates and the risk posed to sensitive receptors. • General Chemical analysis[1] is typically measured at longer frequencies, such as 6 monthly as groundwater movements are typically very slow. • Comprehensive chemical analysis[2] is typically carried out to support the main data set collected. Data are collected upstream and downstream from anticipated sources.
2. Groundwater movement	• Horizontal movement and vertical movement are critical operational measurements. Tracking of horizontal movement allows plumes and impacts on prospective receptors to be measured. Vertical movement allows groundwater head pressure measurements to be assessed and also allows analysis of drawdown effects on aquifers. • Static Water Level measurements are used to estimate groundwater movements. The measurements are typically taken at high frequencies (e.g. up to twice a week) depending on the level of risk of an event.
3. Hydrocarbons	• Free phase hydrocarbons are tested semi-quantitatively around oil storage facilities and the residue area once a year

Notes:

1. General analysis (e.g. EC, pH, alkalinity, sodium and chloride concentration)
2. Comprehensive chemical analysis (e.g. major cations, anions, trace elements, EC, pH, alkalinity, TDS, dissolved organic carbon, ammonia, total Kjeldahl nitrogen)

The groundwater monitoring programme has been based on the following guidelines and standards:

Monitoring and Sampling

- AS/NZS 5667 Series: Water Quality 1998, in particular Part 11: Guidance on Sampling of Groundwaters;
- ANZECC - Australian and New Zealand Guidelines for Fresh and Marine Water Quality – Part 4 (2001);
- ANZECC - Australian Guidelines for Water Quality Monitoring and Reporting - Part 7 (2001)
- Water Resource Council Guidelines (AWRC) – 1991;
- National Environmental Protection Measure (NEPC) - Groundwater Sampling Guidelines 1999;
- Western Australian Department of Environmental Protection Water Quality Guidelines 2001;
- ARMC of Australia and New Zealand Minimum Construction Requirements for Water Bores in Australia (1997);
- Victorian EPA Guidelines on Groundwater Sampling (2000);
- Murray-Darling Basin Commission (MDBC) Groundwater Quality Sampling Guidelines; and
- US EPA Standard Operating Procedures for groundwater sampling.

Analysis

- APHA-AWWA-WEF - Standard Methods for the Examination of Water and Wastewater, 20th Edition, (1998);
- NATA - General Requirements for Registration (1992);
- NATA - Supplementary Requirements for Registration (1993);
- NATA - Assessment of Uncertainties of Measurement for Calibration and Testing Laboratories (1999);
- NH&MRC - Australian Drinking Water Guidelines (1996);
- ISO 9696 Water Quality - measurement of gross alpha activity in non-saline water, thick source method (1992); and
- ISO 9697 Water Quality - measurement of gross beta activity in non-saline water (1992).

8.8 TRAFFIC AND TRANSPORT

The EPA's objectives for the Proposal regarding traffic and transport are to:

- *ensure that roads are maintained and road traffic managed to meet an adequate standard of level of service and safety;*
- *ensure that transportation and storage of fuels/chemicals complies with the Australian Dangerous Goods Code; and*
- *ensure the requirements of Main Roads Western Australia are met.*

Changes to Road Freight Movements

Implementation of the Proposal will result in an increase of road freight vehicles to a total of around 280 vehicles per week (one-way) as outlined below in Table 30.

Table 30: Estimated Change to Road Freight Movements to Wagerup refinery

	Current transport requirements	Proposal Transport requirements
Lime trucks	7 daily	11 daily
Tray trucks	5 daily	9 daily
Semi-trailers	1 daily	2 daily
Couriers	3 daily	5 daily
Weekly deliveries	9	13
Mining	46 weekly	78 weekly
Total weekly (one-way)	167	280
Total weekly (two-way)	334	560

The road freight movements associated with the Proposal represents approximately 12% of all freight movements, or 1.5% of all vehicle movements on South Western Highway in this locality. This is based on Main Roads daily class data giving an average of 36,000 vehicle movements and 4680 freight movements (class 3 to 12) per week on South West Highway.

Construction Vehicles and Workforce

During the construction phase of the Proposal it is anticipated that the workforce at Wagerup refinery will temporarily increase to over 1500 employees, during the peak construction period. There is therefore on average the potential for an estimated 400 additional passenger vehicles travelling to and from the refinery on a daily basis during construction. During the peak construction period this number could increase to a maximum of approximately 1000 additional vehicles travelling to and from the refinery.

The construction of the Proposal is likely to result in an additional 12 to 15 small to medium trucks per day during the busy periods of the construction phase. The construction phase will also require the transport of large loads into the refinery that will cause occasional periods of heavy traffic.

Alcoa's Transport coordinator will maintain liaison with the relevant local authorities on the management of potentially significant road transport issues (see below).

Changes to Rail Freight Movements

The increase in rail movements associated with transportation of alumina and caustic on the South West main line between Pinjarra/ Wagerup and Bunbury is summarised in Table 31. The following movements are based on the latest information available from the rail operator with respect to rail capacity and scheduling and should be taken as indicative only.

Table 31: Average increase in Train Movements per day – one-way

	Wagerup Trains	**Pinjarra Trains**	**Total**
Alumina[1]	3 to 5	4	7 to 9
Caustic[2]	1 to 2	Separate fleet from Kwinana	1 to 2
Total[3]	**4 to 7**	**4**	**8 to 11**

Note:

1 - On occasion there may be four Wagerup and five Pinjarra alumina trains.

2 - Sometimes two caustic trains are required

3 – The total number of trains may vary depending on the number of wagons per train.

Potential Issues

Increases in the number of vehicles on the road as a result of the Proposal has the potential to increase traffic congestion, risk of accidents along the main transport routes, and road wear. This is likely to be most noticeable on the South West Highway. Increases in traffic are likely to be most noticeable during the construction phase, with a notable increase in the number of workers travelling to and from site each day, and construction vehicles. Alcoa is aware of the potential risks this poses and will develop a specific road transport strategy for the Proposal.

The main potential for impact from increased rail movements is more frequent noise impact on residents and communities located close to the railway and near the port facility. Level crossing times will increase slightly due to the longer train configuration, and road crossings will be interrupted more frequently due to the increased number of trains.

Proposed Management

Alcoa has its own transport department and works with relevant State Government agencies, such as the Main Roads Department, to carefully monitor road freight movements and ensure that high safety standards are maintained when transporting freight.

A transport coordinator will be nominated for the Proposal, whose role will be to evaluate transport routes both on and off the Wagerup refinery site and to ensure that equipment is delivered to Wagerup in a manner that meets all legislative and Alcoa standards. The transport coordinator will prepare the traffic management plan for the Proposal, which will include monitoring traffic entering the refinery via the main access road before, during and after construction. The transport coordinator will also ensure delivery time restrictions are implemented for the delivery of goods to the Wagerup refinery during construction. This will ensure that peak times on the road are avoided and notification is given to the local Police and local Shires before heavy loads pass through the townsites.

Current delivery time restrictions imposed by Main Roads are:

- oversize loads are restricted to daylight hours
- oversize loads from the Kwinana area can travel at any time between sunrise to sun down, and
- oversize loads from Fremantle, Henderson or Perth areas can only travel after sunrise, but not between 7:30am to 9:00am or 4:30pm to 6:00pm on weekdays only.

Alcoa will consult with the Shire authorities and the local community about traffic movement management and the traffic management plan which will be implemented to minimise disruption to the local community.

Large vehicle movement routes to and from the Wagerup refinery are determined by the Main Roads Department and follow designated (>24 tonne) heavy load routes. For the Proposal it is anticipated that some heavy loads will come through the Waroona townsite during the construction phase given the South Western Highway is the approved route. However, it is expected that the frequency of these large trucks will be low. Where practical and appropriate, Alcoa will divert freight movements to avoid the Waroona and Yarloop townsites.

There will be times during construction where larger volumes of materials will be required, such as concrete. Traffic, truck availability, time of day, weather, concrete pump capacity and availability will be considered when making decisions on when these concrete pours will commence and complete.

Potentially significant aspects of traffic management for the Proposal will involve consultation through the Community Consultative Network or similar existing community consultation forums, the local Shires and the local police. Alcoa will also communicate these large traffic movements through communicated advice to the communities in the Shires of Harvey, Waroona, Murray and City of Mandurah.

Whilst detailed traffic planning for the Proposal is yet to commence, Alcoa will consider the following measures to address the impacts on road safety due to the increase in number of passenger vehicles during the construction period:

- investigation into the viability of buses to pick up construction personnel from key points locally and in Mandurah and Bunbury ;
- encouraging car-pooling;
- staggering the construction shifts from operations shifts; and
- safety briefings which will include traffic issues and enforcement of rigorous drug and alcohol policies.

Discussions with the Australian Rail Group (ARG) have commenced to establish how the rail service between Wagerup and Bunbury Port could accommodate the Proposal. The South West Main Line track is a single narrow gauge track with a number of crossing loops and therefore has capacity constraints. ARG is currently reviewing its rail operations and has indicated it intends to operate four sets of alumina trains (one loco and approximately 28 to 32 wagons each) and two sets of caustic trains (one loco and approximately 10 wagons each) from around mid 2005. This will result in an average increase of three alumina trains and one caustic train per day on the South West Main from Pinjarra and Wagerup to and from Bunbury.

The, number of train services associated with the Proposal and Pinjarra upgrade combined would result in an increase from 8 to 11 trains, one-way per day. The rail operator (ARG) is proposing to move to this new schedule (11 trains per day) in mid 2005. Assuming this level of service is maintained, no increase in train services would be expected on commissioning of the Proposal, however, train lengths would be extended from 28-32 wagons to up to 46 wagons for alumina, and from 10 wagons up to 14 wagons for caustic.

Alcoa has no management control over, or proponent responsibility, for the South West main line as it is owned and operated by ARG.

Commitment 13

Alcoa will prepare and implement a Traffic Management Plan to manage road traffic associated with construction of the Proposal.

8.9 PUBLIC SAFETY RISK

The EPA's objective for the Proposal regarding risk to public safety is:

- to ensure that risk from the proposal is as low as reasonably achievable and complies with acceptable standards and EPA criteria including Guidelines and Criteria for EIA No 2, *Guidance for Risk Assessment and Management: Off-site Individual Risk from Hazardous Industrial Plant.*

Potential Issues

A Public Safety risk assessment has been undertaken for the existing Wagerup refinery and the Proposal, by Qest Consulting (Appendix Q). This risk assessment focussed on accidental events which may have an acute impact on members of the public. The risk assessment was undertaken in accordance with the EPA *Guidance for Risk Assessment and Management: Off-site Individual Risk from Hazardous Industrial Plant, July 2000*. This study did not include incidents with only occupational impacts, health impacts and issues associated with continuous releases (Qest Consulting, 2005).

A range of hazards were identified that had potential consequences outside of the immediate workplace, followed by analysis to determine if these risks offered potential to affect areas outside Alcoa's boundary where the public risk criteria apply. The types of hazards identified were:

- Chlorine gas leak or vessel failure of two chlorine drums (920 kg max.) which are used for the chlorination of the potable water supply
- Rupture of natural gas pipeline (which reaches the surface near the site boundary and is used for onsite power requirements) and resultant fire
- Catastrophic process incidents such as explosion of high pressure/high temperature digesters and resultant caustic release. There are currently three banks of five digesters and the expansion will require another bank of digesters, and
- Chemical release from dangerous goods storage (e.g., caustic, acid, LPG storage) in 36 different locations at the refinery.

The analysis indicated that none of the events associated with these hazards has the potential to result in serious acute harm to persons outside of Alcoa's boundary. The level of public risk associated with the existing refinery and the Proposal therefore comply with the EPA criteria for 'Off-site Individual Risk from Hazardous Industrial Plants' (Qest Consulting, 2005).

Whilst this type of risk analysis does not normally address road safety issues, the increase in number of vehicle movements as a result of the construction workforce has the potential to

impact on the public. Appropriate recommendations to ensure management reduces the road safety risk to 'As Low As Reasonably Practicable' are made by the Qest Consulting (2005) report and are addressed in Section 8.8.

Proposed Management

The maintenance and performance monitoring of the controls associated with the identified hazards for the existing plant, expansion and on-going operations are addressed within the Wagerup Safety Management System (which meets the requirements of AS 4801 "Occupational Health and Safety Management Systems) and the Alcoa Major Hazard Management System.

The management of public safety will be an ongoing process throughout construction and operation of the Proposal. Alcoa will implement the following recommendations made in the risk assessment undertaken for the Proposal (Qest Consulting, 2005):

- Alcoa is in the process of implementing a comprehensive Major Hazards Management System at the Wagerup refinery that focuses on equipment whose failure could result in major hazards impacts. This process will provide a systematic approach to identifying the critical equipment controls for managing major hazards and ensuring these are in place and their performance effectively monitored. The implementation of this process (planned for 2005) will include a review of all major hazards identified within the public safety risk assessment undertaken by Qest Consulting. The routines for monitoring the performance of the relevant critical equipment controls will be established and in place prior to the commissioning of the Proposal;

- The auditing and monitoring requirements of the Wagerup Safety Management System will continue to be utilised to ensure that the relevant control systems (including Dangerous Goods reviews, effectiveness of management systems, etc.) remain effective, beyond the commissioning of the Proposal;

- A road transport strategy will be implemented for the Wagerup refinery to accommodate the increase in traffic during construction (Section 8.8);

- The on-going design process for the Proposal will include all the normal hazard review processes such as HAZID, Risk Reviews and HAZOP for example; and

- Existing procedures for the management of hazardous material will be reviewed and amended if necessary to ensure that potential off-site impact is considered in addition to the normal Dangerous Goods licensing requirements.

8.10 GREENHOUSE GAS EMISSIONS

The EPA's objectives for the Proposal regarding greenhouse gas emissions are:

- *to minimise emissions to levels as low as practicable on an on-going basis; and*
- *to ensure that potential greenhouse gas emissions from the proposed project are adequately addressed and best practicable measures and technologies are used.*

Background

Greenhouse gases (GHG) is a term used to refer to a group of gaseous compounds that absorb infrared radiation and trap heat in the Earth's atmosphere. These occur naturally in the atmosphere but since the Industrial Revolution, the combustion of fossil fuels has dramatically increased the quantities of greenhouse gases emitted to the atmosphere, which is resulting in an increase in the Earth's temperature. The principle greenhouse gas (by volume) is carbon dioxide (CO2), although methane (CH4), nitrous oxide (N2O), hydrochlorofluorocarbons (HCFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6) are also significant contributors. The Intergovernmental Panel on Climate Change (IPCC) estimates the global average surface temperature increased by about 0.6 °C over the 20th Century. In its third assessment report, the IPCC concluded that most of the observed warming over the past 50 years is likely to be attributable to human activities (IPCC, 2001).

The most recent National Greenhouse Gas Inventory indicates that GHG emissions from stationary energy sources were 261.9 Mt CO2-e in 2002, which is equal to 47.6% of net national emissions (AGO, 2004). Alumina refining is an energy intensive activity which has the potential to release large volumes of anthropogenic GHG in power generation. The largest source of GHG emissions from alumina refining at Wagerup is from the combustion of natural gas to generate steam and electricity to meet process energy demands. The other major source is combustion of natural gas to provide direct heat for calcination and ancillary kiln-based processes.

There are significant emissions associated with the production of some of the raw materials used in alumina refining such as lime and caustic soda. Alcoa purchases these materials from other companies and has no means of reducing emissions associated with their production, other than to improve the efficiency of use of these materials in its own production processes.

Bauxite mining operations account for a relatively minor proportion of GHG emissions associated with alumina production. The main source of mining-related emissions is in the consumption of diesel fuel in heavy mobile equipment and in the clearing of vegetation for mining. Carbon stores on mined land are restored by mine rehabilitation, albeit over a considerable period of time as the post-mining ecosystem develops. The EPA has advised that mining is not part of this assessment and therefore will not be included in determining greenhouse gas emissions for the Proposal.

Wagerup Refinery 2004 Greenhouse Gas Emissions

Alcoa has used the World Business Council for Sustainable Development (WBCSD) methods for calculating GHG emissions from 2003 onwards. The calculation methods are similar to the Australian Greenhouse Office (AGO) methods more commonly used in Australia. The main difference between the two methods is that indirect emissions are not included in the final reporting figure (for WBCSD) and multiplication factors can vary.

The GHG emission calculation relies upon multiplying the amount of energy generated by various fuels by appropriate factors. For natural gas, the main fuel source for energy production at the Wagerup refinery, the WBCSD calculation method uses 1 GJ of energy corresponds to 56.06 kg CO2 equivalents. This compares with AGO calculations, whereby 1 GJ of energy corresponds to 61.6 kg CO2 equivalents.

The GHG emissions for the Wagerup refinery under the current situation and with the Proposal are presented in Table 32. GHG emissions are predominantly from combustion sources and therefore are released as CO2, with the emitted quantities of other GHG considered sufficiently small to be negligible.

Table 32: Greenhouse Gas Emissions for the existing Wagerup refinery and the Proposal (two energy supply options).

Scenario	Fuel	Projected Energy Use (GJ)	Emission Factor[1]	Total GHG Emissions (Gg CO_2 equiv.)
	Natural gas	-	-	1,327,000
Existing	Other fuels	-	-	15,000
			TOTAL	**1,342,000**
	Natural gas	4.5×10^7	5.6×10^{-5}	2,529,000
Boilers	Other fuels	-	-	15,000
			TOTAL	**2,544,000**
	Natural gas	4.0×10^7	5.6×10^{-5}	2,240,000
Cogeneration	Other fuels			15,000
			TOTAL	**2,255,000**

Notes: 1. Emission factor based in WBCSD calculation methods (WBCSD, 2004) to generate Gg CO_2 equivalents.

From Table 32 it can be seen that the Proposal would result in GHG emissions rising from 1,342,000 to 2,544,000 tonnes Gg CO2 equivalents if boilers are installed. The cogeneration

option would cause emissions to increase to 2,255,000 Gg CO2 equivalents, which is significantly higher than the existing refinery, but a reduction over the boiler option. The most significant GHG contribution from the refinery arises from the combustion of natural gas.

Alcoa's Greenhouse Emissions Targets

Alcoa's goal is to reduce GHG emissions under its direct control by at least 25% (from the base year of 1990) by the year 2010, irrespective of the increase in alumina and/or aluminium production capacity that may be achieved over this period. This reduction includes emissions from Alcoa-owned power generation facilities, but does not include emissions associated with the production of raw materials and electricity purchased from other sources. This target was not intended to be applied equally to all operations and Alcoa's Western Australian operations targeted a 17% reduction (from the base year of 1990). Globally Alcoa achieved the 25% reduction target by 2003 and is now working to maintain that reduction as the company expands.

Aluminium Life Cycle Assessment

Life Cycle Assessment (LCA) is a scientific tool for the evaluation of environmental effects of products and services through the complete known life cycle, from extraction of raw material, processing (i.e., refining and smelting), fabrication, transportation, use, recycling and ultimately disposal. LCA is undertaken on both the product, the energy and the ancillary materials supplied.

Aluminium is lightweight, resistant to atmospheric corrosion, conductive, ductile and unlike some other metals, is readily able to be repeatedly recycled. It is these properties that have seen aluminium used extensively in air, land and sea transport, packaging, electricity transmissions and domestic and industrial construction. In the context of LCA for aluminium, there is a significant potential to reduce GHG emissions through the increased use of recycled aluminium and from the increased use of aluminium in transport applications. Alcoa works closely with a number of vehicle manufacturers to assist in the design of components and alloys to improve vehicle weight and other properties such as crash worthiness.

Aluminium recycling generates 95% less GHG emissions than the primary production of aluminium from bauxite ore. At present, close to 40% of the global demand for aluminium is fulfilled from recycled products, primarily from the packaging, transport and construction industries, which results in significant greenhouse benefits. Alcoa's goal is to increase the global recycling rate through the sponsorship of voluntary national aluminium recycling programmes and purchasing competitively priced scrap metal as feedstock for its secondary smelters.

The average aluminium content of motor vehicles has increased over the past ten years and this trend is forecast to continue as motor vehicle manufacturers strive to meet stringent exhaust emissions standards and continue to improve fuel efficiency. A LCA published by the International Aluminium Institute found that each tonne of alumina that replaces traditionally high density materials in a vehicle can save the equivalent of 13.9 t of CO2-e over the life of the vehicle, rising by a further 9.0 t of CO2-e with the use of recycled aluminium in the manufacture of the motor vehicle. The aluminium industry is working closely with motor vehicle manufacturers to enable the easier dismantling of aluminium components from cars in order to improve the recovery of aluminium in this industry.

Alumina Industry Energy Efficiency Benchmarks

The International Aluminium Institute estimated that the world-wide weighted average for energy used per tonne of alumina produced was 11,818 MJ/t. Table 33 provides a summary of the energy efficiency statistics for the alumina industry globally.

Table 33: Energy Efficiency Statistics for the Alumina Industry

Region	Energy Used per Alumina Produced [1] (MJ/tonne of alumina)
Africa and South Asia	12,938
North America	11,957
Latin America	11,436
East Asia [2] and Australia	**11,375**
Europe	13,490
World-wide Weighted Average	11,818
Alcoa Wagerup Refinery Base Case [3]	9,195
Alcoa Wagerup Refinery Boiler Option [4]	8,758
Alcoa Wagerup Refinery Cogeneration Option [4]	7,770

Notes:
Source: International Aluminium Institute Statistics Report (IAI, 2004)
1. Statistics published by the IAI are for 2002.
2. Includes China, Japan and South Korea; however data for China and South Korea were not reported to the IAI by these counties.
3. Derived from the Wagerup refinery 2004 greenhouse gas emission inventory data.
4. Projected data supplied to ENVIRON by Alcoa on 1 April 2005.

During the 2004 calendar year the Wagerup refinery operated at an average energy efficiency of 9,195 MJ/t of alumina produced, which is a significant improvement on the World-wide weighted average. Implementation of the Proposal is projected to further improve energy efficiency to 8,758 MJ/t with the boiler option and to 7,770 MJ/t with the cogeneration option.

The Wagerup refinery is very energy efficient and is supplied by natural gas-fired generators, which have a lower GHG emission intensity than coal or diesel fired generators.

Greenhouse Emissions for the Proposal

The key components of the Proposal that will increase energy consumption at the refinery are as follows:

- additional steam requirements in the digestion and evaporation areas of the process due to the increased rate of bauxite processing and increased flow rate of liquor around the process circuit
- additional electricity consumption for the two additional ball mills for bauxite grinding and additional digestion unit, and increased flows in the precipitation and clarification areas, and
- additional natural gas combustion as a result of the increased capacity in calcination, oxalate kilns and emission controls.

These increases in energy consumption will, however, be offset by energy saving initiatives that are to be incorporated into the design of the Proposal in order to achieve an overall improvement in the GHG intensity of the Wagerup refinery.

Alcoa is currently considering two energy supply options. Either the existing gas-fired power plant will be expanded with the addition of two boilers, or a gas-fired co-generation plant will be constructed (Section 5.3.2).

Table 34 presents the overall GHG emissions impact of the Proposal with the two energy options compared to existing GHG emissions.

Table 34: Greenhouse Gas Emission Estimates for current operations and the Proposal.

Greenhouse Gas Emission Parameter	**Units**	**Existing Operations**	**Addition of two boilers**	**Cogeneration facility**
Net CO_2 emissions	t CO_2	1,342,000	2,544,000	2,255,000
Net CO_2 Emissions Intensity	Kg CO_2/t alumina	557	541	480

Note: Calculations based on the WBCSD methodology.

It can be seen from Table 34 that, depending on the power supply option selected, the Proposal is estimated to improve the greenhouse gas emissions intensity by approximately 5% to 541 kg CO2-e with the boiler option, or by approximately 15% to 480 kg CO2-e per tonne of alumina produced with cogeneration.

Greenhouse Gas Emissions Minimisation

Alcoa's actions to facilitate the preservation of native vegetation and the rehabilitation of degraded areas help to counter the effects of GHG accumulation.

Alcoa relinquished large parts of ML1SA for inclusion in the conservation estate under the System 6, Regional Forests Agreement (RFA) and Forestry Management Plan (FMP) processes. In particular, the RFA and FMP Comprehensive Adequate Representative (CAR) and CAR-informal reserve systems have been enhanced by the voluntarily actions of Alcoa to enhance the reserves system. This action has restricted Alcoa's access to areas of high mineral prospectivity and emphasises Alcoa's commitment to biodiversity conservation.

Alcoa's commitment to land rehabilitation and biodiversity conservation is clearly reflected by its support of the landcare movement and other initiatives, with over $20million provided since 1989. Alcoa is supporting and will continue to support community environmental and landcare projects, through:

- National partnerships
- State-wide programs in Western Australia and Victoria
- Regional and local projects and events
- Alcoa Foundation, and
- Alcoa's environmental partnership program.

Proposed Management

Alcoa has developed a Climate Change Policy across its global operations. The principle components of this policy are:

1. to continue to improve energy efficiency at all operations; and
2. to improve operations by implementing best practice technologies to reduce GHG emissions.

In implementing the Climate Change Plan Alcoa will:

- reduce its direct GHG emissions to 25% below the 1990 baseline on a worldwide basis by 2010 (achieved in 2003), with the potential for significant additional reductions through major technology improvements
- measure its significant GHG emissions and have its baseline data and annual inventories certified by independent third parties

- monitor and separately report on the emissions associated with electricity purchased for Alcoa's smelting operations in recognition of the importance of these emissions in the overall life cycle of aluminium
- rapidly deploy appropriate best practice technologies to reduce GHG emissions
- evaluate the effectiveness of GHG sequestration approaches and seek credit for their implementation as appropriate
- support an emissions trading regime that is efficient, global, comprehensive and utilises initial allocation procedures based on a 1990 baseline
- evaluate internal trading mechanisms to determine if such procedures will enhance GHG reduction strategies
- actively participate in discussions at national and international levels on climate change policy and provide leadership, data and recommendations
- evaluate and utilise cooperative mechanisms to reduce greenhouse gases using agreed international protocols; and in partnership with its customers, and
- identify and promote beneficial uses and recycling of its products to reduce GHG emissions in transportation, construction, packaging and other applications.

Alcoa has been directly involved with the following programmes that assist in reducing the impact of greenhouse gas emissions in Western Australia, nationally and internationally. Alcoa will continue its involvement in these programs, where appropriate, as below:

Commonwealth Government Initiatives:	• Participation in the Greenhouse Challenge, Generator Efficiency Standards and Energy Efficiency Best Practice Programmes.
Alcoa International Initiatives:	• Use of energy audits and benchmarking across Alcoa's global alumina operations.
Community Initiatives:	• support for medium-scale landscape restoration projects under the Alcoa Landcare Project and related community partnerships (e.g. Catchment Groups, Landcare Groups, Land Conservation District Committees); • support for ecological restoration and conservation projects such as the current sponsorship of the Alcoa Jarrah-Tuart Restoration Project at Kings Park Botanic Garden; and • support for renewable energy demonstration projects such as the wind turbine installation at Fairbridge Village.

Research and Development:

- research and development into refinery process efficiency and technology improvements that have significant energy and resource use efficiency benefits;
- evaluation of carbon sequestration opportunities both within Alcoa's own operations (e.g. carbonation of bauxite residue) and in broad-acre land management; and
- support for greenhouse-related research such as sponsorship of the Cooperative Research Centres on Greenhouse Accounting and Sustainable Resource Processing.

Alcoa supporting Biodiversity conservation

Greening Australia - National

The Alcoa Greening Australia partnership began in 1982, the International Year of the Tree and the first year of operation for Greening Australia. Alcoa and Greening Australia have worked together to build community capacity and knowledge about environmental issues, backed by on-ground environmental restoration projects, which have generated a range of long-term, positive community outcomes.

The partnership has contributed in a practical way to repair the Australian landscape by planting over 10 million trees in 12 years in Victoria through the Alcoa Revegetation Assistance Scheme, extensive and ongoing environmental education in the Perth metropolitan and Peel regions, improving seed supply via the Alcoa Portland Seedbank, and practical knowledge transfer through a range of publications and resources.

Landcare Australia Limited - National

Alcoa partners with Landcare Australia through its sponsorship of the Community Landcare Award in the bi-annual prestigious National Landcare Awards. Presented by the Prime Minister of Australia, the Alcoa Community Landcare Award recognises community efforts in environmental care.

Alcoa has been a long time supporter of landcare and other environmental programs in Western Australia. Some of the programs that Alcoa supports are outlined below.

Swan Alcoa Landcare Project (SALP)

In Western Australia, Alcoa's partnership with the Swan Catchment Council and the Swan River Trust has enabled the continuation of the Swan Alcoa Landcare Program (SALP). In

2004, through SALP, over $550,000 in funding was provided to 44 community environmental groups. This is an excellent example of grass roots urban landcare.

Tammin Alcoa Landcare Education Centre (TALEC)

Alcoa has continued its support of the Tammin Alcoa Landcare Education Centre (TALEC). Since its inception the centre has provided a unique opportunity for teachers and students to study various aspects of environmental management in an authentic hands-on environment. The centre is dedicated to the study of the problems of soil and water degradation and increasing awareness of these problems through education. The centre also studies the possible solutions to these problems through sustainable land management practices. In 2005 TALEC will celebrate its 15 year anniversary.

Dieback Working Group

The Dieback Working Group works with 25 local government authorities in the southwest of WA to manage Phytophthora Dieback (dieback) in their bushlands. The group liaises with over 50 community-based conservation groups to increase understanding of how to manage dieback and provides the equipment to treat bushland to minimise the spread and impact of dieback. The Dieback Working Group works with World Wildlife Fund, the Dieback Consultative Council, the Dieback Response Group and CALM to develop and implement a communication plan for dieback and also to develop educational material for schools, landholders, community groups and the general public. In addition to financial support, Alcoa's Senior Environmental Research Consultant, Dr Ian Colquhoun heads up the group.

Peel Harvey Catchment Management Authority

Alcoa's long partnership with the Peel Harvey Catchment Management Authority has included funding for community groups in the Peel-Harvey catchment for landcare activities associated with rivers, wetlands and associated habitats. Many initiatives from this collaboration have been catalysts for landholders to work together in tackling local environmental problems and in developing sustainable agricultural practices.

Western Australian Museum – Alcoa FrogWatch

Frogs are often seen as the barometer of the environment and Alcoa's partnership with the WA Museum helps build community capacity in general environmental care through frog conservation. As well as support for the popular community education program, Alcoa Frog Watch, Alcoa has also funded a scientific research project on the impact of frogs in the Kimberley region of Western Australia.

Alcoa Employees

In both Victoria and Western Australia, Alcoa employees give up their personal time to provide hands-on support to conservation activities. Tree planting events are held at site level working with local Friends and other community groups. In Western Australia an annual tree planting weekend is held involving over 100 employees and their families. In addition to providing practical support, it connects our employees to issues of environmental degradation and conservation and the ways in which they can positively contribute.

Alcoa has achieved its 25% GHG reduction target (on 1990 levels) and is working to maintain these emission reductions as the company expands. The expansion of Wagerup refinery will improve the net CO2 emission intensity from 557 to 480 kg CO2/t alumina (if cogeneration selected) and help to maintain this goal. Alcoa is a strong supporter of the community initiatives and environmental programs that assist in restoring and maintaining degraded lands throughout Western Australia.

Commitment 14

Alcoa will achieve a reduction in the greenhouse gas emissions intensity of the Wagerup refinery as a result of the Proposal by approximately 15% (based on cogeneration).

Commitment 15

Alcoa will review opportunities to improve the energy efficiency of equipment to be installed as part of the Proposal during the detailed design phase of the Proposal using a Cleaner Production review process.

Commitment 16

Alcoa will maintain its existing greenhouse gas minimisation programmes.

8.11 VEGETATION CLEARING

The EPA's objectives for the Proposal regarding flora and vegetation are to:

- *maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities; and*
- *avoid adverse impacts on biological diversity, comprising of different plants and animals and the ecosystems they form at the levels of genetic, species and ecosystem diversity.*

Potential Issues

The Wagerup operations are in the majority surrounded by paddocks, used mainly for grazing of livestock. In the vicinity of the residue area the paddocks have generally been levelled to allow even water flow and are irrigated by an extensive system of drains. Vegetation in this area consists of pasture grasses and a mixture of *Eucalyptus* spp. trees and shrubs. Some stands of native vegetation in good condition are located near the refinery but the majority of the trees located near the residue area have been planted as wind breaks and generally occur along fence lines and roads.

The installation of equipment and plant associated with refinery for the Proposal will be undertaken in and around the existing refinery. Some minor clearing of vegetation may be required for certain components within the boundary of the refinery. However, no remnant native vegetation will require clearing.

The residue area will be expanded within the current LTRMS (see Section 3.1.1) which has been endorsed by the Minster for Environment. The endorsed residue expansion is over predominantly agricultural land, with very little remnant vegetation. None of the Threatened Ecological Communities (TECs) or locally significant vegetation communities identified in the vicinity of the refinery (Section 7.7.1) will be affected (either directly or indirectly) by the expansion of the refinery or RDA.

Vegetation clearing in the mining areas is not considered within this document as clearing approvals are addressed in Alcoa's five-year Mining and Management Program (Section 4.3.1). The EPA has advised clearing for mining is outside the scope of this ERMP assessment.

Proposed Management

Alcoa will keep vegetation clearing for the Proposal to a minimum and will rehabilitate the residue area with native flora indigenous to the area, where appropriate. One of the objectives of the LTRMS (Section 3.1) is to establish a native vegetation corridor on rehabilitated residue areas and land along existing and planned drainage lines to promote re-colonisation of

these areas by native species, establish native fauna habitats, and improve the productivity of these rehabilitated communities.

8.12 FAUNA

The EPA objectives for the Proposal regarding fauna are as follows:

- *protect Specially Protected (Threatened) Fauna species and their habitats, consistent with the provisions of the Wildlife Conservation Act 1950; and*
- *avoid adverse impacts on biological diversity, comprising different plants and animals and the ecosystems they form at the levels of genetic, species and ecosystem diversity.*

Potential Issues

Section 7.8 lists fauna species recorded in the vicinity of the Wagerup refinery. Baudin's Cockatoo which is listed as Vulnerable under the Commonwealth *EPBC Act 1999* and 'Rare, or likely to become extinct' under the *WA Wildlife Conservation Act 1950* has previously been recorded in the vicinity of the refinery. The species is still relatively widespread in the jarrah forest but has declined elsewhere due to clearing.

It is not expected that changes to the refinery as a result of the Proposal will result in any additional impacts to the native fauna in the area. Fauna occurring near the residue areas may be disturbed during construction of the new RDAs during the life of the Proposal, and to a lesser extent during operation. However, this disturbance is not expected to adversely impact any fauna species as no areas of remnant vegetation will be cleared. 'Dry stacking' of residue (Section 4.2) will also minimise any pools of water occurring on the surface of the residue area that may attract native fauna.

Proposed Management

Alcoa will minimise clearing of vegetation to minimise the impact on native fauna habitats. Alcoa will establish a wildlife corridor on rehabilitated residue areas and land along existing and planned drainage lines to promote re-colonisation of these areas by native fauna, establish native fauna habitats, and increase the biodiversity of these communities.

Alcoa is a major sponsor of Operation Foxglove, which is a feral animal control program to remove the threat of foxes to small and medium sized native animals. Operation Foxglove is part of a wider feral animal control program throughout WA called Western Shield. The Western Shield program covers an area of 3 million hectares and has led to the recovery and reintroduction of a number of endangered species such as the noisy scrub bird and tammar wallaby.

8.13 WASTE MANAGEMENT

The EPA's objective for the Proposal regarding waste management is to:

- *ensure that liquid and solid wastes do not affect groundwater or surface water quality, nor lead to soil contamination; and*
- *ensure that the generation of all wastes follows consideration of waste reduction in accordance with the waste hierarchy of reduction, reuse, recycle, treatment and disposal.*

Existing Waste Management

The Wagerup refinery has an existing waste management programme within the EMS. The waste streams are grouped into the following categories, which adhere to Government regulations and internal Alcoa guidelines:

- Hazardous waste (as classified under the Australian Dangerous Goods Code 2000)
- Low hazard waste (may be contained with, or contain traces of hazardous waste)
- Putrescible waste
- Inert waste (excluding putrescible wastes)
- Special wastes (e.g. asbestos, clinical and related wastes, leaded paints, fluorescent tubes), and
- Scrap/salvage (recyclable).

The hierarchy for waste management at the Wagerup refinery is:

1. Reduce: Reduce the amount of waste generated at the site through waste minimisation and cleaner production[1] practices
2. Reuse: Re-use waste products where practicable
3. Recycle: Treat waste that is no longer useable in present form and use it to produce new products
4. Treat and/or Dispose: Appropriately treat and/or dispose of waste in a way which minimises the risk of environmental harm.

The Wagerup waste minimisation program was initiated in 1993 with the objective of characterising and quantifying waste streams and identifying waste minimisation and recycling opportunities.

[1] Cleaner production is the continuous application of an integrated preventative environmental strategy over the life cycle of processes and products so as to reduce risk to humans and the environment and promote the concept of sustainability.

Significant advances have since been made in the area of waste recycling and minimisation. The programme includes: food waste, office recyclables such as plastics and paper, waste oil, scrap metal, gloves, automobile batteries, liquid waste, laboratory wastes, ozone depleting substances, cardboard, tree clippings and timber pallets, and process material such as off-specification alumina.

Waste management at Wagerup is undertaken in accordance with the Waste Management Procedure and specific procedures written for disposal of hazardous wastes.

Non-process Wastes

Non-process waste streams at the Wagerup refinery are managed and monitored in partnership with the licensed contractor, who has responsibility for day-to-day management of these wastes.

Non-Process wastes are targets of the Operational Centres', waste minimisation teams and cleaner production practises. These wastes are targeted in the cross-site waste goal of zero non-process waste to landfill by 2008. The DoE licence stipulates that only waste meeting the acceptance criteria for Class II landfills (i.e. inert waste, putrescible waste, and certain types of special waste) and waste generated from alumina production are to be deposited at the Wagerup landfill area located in the residue area.

Clearly marked recycling bins and landfill waste bins are distributed all over the refinery and a 3-Bin recycling/disposal system has been implemented in crib rooms and office areas.

Hazardous wastes are kept segregated at all times from non-hazardous wastes and disposed of according to specific procedures and regulatory requirements. Specialist contractors are used to remove asbestos. They are required to follow procedures which comply with Australian Standards and Worksafe procedures.

Lead paint on structures is removed in accordance with *Australian Standard 4361.1: Guide to Lead Paint Management Part 1: Industrial Applications, and Worksafe procedures*. Disposal of lead paint wastes is carried out by a specialist contractor and material is sent to an appropriate landfill depending on lead content.

When a vessel or pipe is removed and contains caustic scale, it can present a hazard downstream in the recycling path. Steel items which are removed from site must have scale removed. Where an item is particularly large or has a complex structure it may not be practical to clean it sufficiently for recycling. In these cases the item will be buried on site in the landfill.

The majority of the refinery area is serviced by a sewer collection system. The sewerage is delivered to a facultative lagoon system that treats the sewerage with natural biological activity. The Operate and Maintain Sewage Treatment Facility Procedure (Doc. Number 37512) describes the facility, its operation and maintenance.

Process Wastes

Process wastes from the refinery include any waste that is derived from the refinery's Bayer process (refer to Section 4.1 for a description of the Bayer process). Process wastes at the Wagerup refinery are targets of cleaner production projects by process engineers and specialists on site.

Process wastes include (but are not limited to) the following list. These include any spill or cleanup material of the following substances:

- red scale (any material from milling, digestion, and clarification circuits that contains caustic);
- white scale (from precipitation, post-precipitation and calcination circuits);
- bauxite residue (material that is piped to the residue area); and
- spilled process chemicals.

Bauxite residue is managed in accordance with Alcoa corporate mandated bauxite residue management standards and guidelines and within the framework of the LTRMS (Section 3.1.1). Approximately 10,000 tonnes of process waste is pumped to the residue drying areas daily for dry stacking. The sand and mud fractions are separated prior to transfer. The mud is pumped to a superthickener, which removes approximately half the liquor and in doing so produces very thick mud, which is deposited on beds in thin layers for solar drying. The sand is washed to recover alkaline liquor. It is then used in the construction of dyke walls within the impoundment area and as a surface cover on the RDAs.

There are a number of projects currently being carried out into alternative uses for residue waste. Alcoa will maintain a focus on research and development programs aimed at identifying alternative safe uses for bauxite residue.

Mercury is introduced to the refinery primarily through the bauxite ore in trace amounts and is mobilised from the bauxite by the elevated temperatures in the Bayer process. Secure mercury traps, installed in the Vacuum Condensor Systems of the digestion process, allow capture and collection of the mercury. Dedicated secure storage for mercury is maintained prior to mercury being removed offsite for recycling.

Other wastes generated from alumina production and associated activities that are removed and disposed off-site by a licensed waste contractor are:

- Spent liquor burner CTO catalyst
- Asbestos materials
- Packaged laboratory chemical waste, and
- Clinical waste.

Potential Issues

Whilst an almost doubling of refinery capacity associated with the Proposal would be expected to produce an incremental increase in process waste production, waste minimisation, cleaner production mechanisms and improved spill prevention and clean up (refer to section 10 for Spill Management Plan), will be incorporated into the Proposal to reduce the incremental change in waste creation. Process wastes generated during construction and operation of the Proposal will continue to be managed in accordance with Alcoa's existing waste management programme.

During construction, waste will be generated where parts of the existing refinery require modification. The main issues which may arise are associated with the potential disturbance of asbestos containing substances , structures containing lead based paint and any redundant pipes or vessels which may contain caustic scale, making them unsafe for recycling.

Proposed Management

During construction, contractors will be expected to integrate their waste management arrangements with the on-site waste management programme. This includes using the same waste segregation and collection systems, procedures and training materials.

Waste management during construction and operation of the Proposal will continue to be in accordance with Alcoa's Waste Management Procedure (Doc. Number 5102). Management of non-process and process wastes for the Proposal will be as outlined in Table 35 following.

Table 35: Management of non-process and process waste for the Proposal.

Non-process waste	
Recyclable waste (steel, aluminium, paper, plastics [types 1, 2, 3], cardboard, glass, tyres)	• Sent off-site to recycling facility;
Putrescible waste	• Food scraps, shredded paper sent to Pinjarra Worm Farm for composting • Green waste mulched and used on-site
Paints/Solvents	• Collected by licensed contractor for disposal
Waste oil	• Collected and reused for dust suppression on the residue area (with DoE approval)
Hazardous waste	• Removed off-site by a licensed waste contractor to an approved waste disposal facility • Contaminated soil or oil - disposal determined by Environmental Department;
Non-recyclable inert non-hazardous waste or low-hazardous waste	• Disposed to a secure licensed landfill within the Wagerup refinery residue ara.
Process waste	
Bauxite	• Used for clean fill
Caustic contaminated soil	• to residue area
Heavily scaled hardware (e.g. pumps, pipes)	• to landfill
General caustic contaminated waste	• to landfill
Hydrate	• to residue area
Mercury (from bauxite)	• Collected and removed off-site for recycling
Off spec chemicals (including lime, flocculant, caustic)	• Caustic – to residue area • Lime – to landfill • Catalyst – disposed of to licensed off-site facility
Bauxite residue	• to residue area
Red scale	• to residue area
Sodium aluminate	• to residue area.

Any asbestos-containing waste materials removed from the refinery during the construction of the Proposal will be managed and disposed in the residue area in accordance with DoE licence requirements.

With the operation of the Proposal and ongoing measures to improve waste reduction, there is expected to be little increase in the volume of non-process waste from refinery operations. Non-process wastes generated during construction and operation of the Proposal will continue to be managed in accordance with Alcoa's existing waste management programme and waste reduction principles.

8.14 ABORIGINAL HERITAGE

The EPA's objective for the Proposal regarding Aboriginal heritage is to:

- *ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.*

Twenty seven Aboriginal archaeological sites were recorded within an 8 km radius of the Wagerup refinery (Table 19, Section 7.16). Of the 27 archaeological sites, one site is located immediately outside the Proposal area on the southern edge of the existing RDA.

Potential Issues

The Proposal will be constructed within the boundary of the existing refinery and will therefore not disturb any known Aboriginal heritage sites. Residue produced from the Proposal will be stored in the existing residue area, which will be expanded within the area outlined in the LTRMS (Section 3.1.1). The Proposal will be implemented in accordance with the LTRMS and will not disturb any known Aboriginal heritage sites.

Refer to Section 8.17 for a discussion of the issues associated with the wider community, including indigenous peoples.

Proposed Management

During construction and operation of the Proposal, employees and contractors will be advised of the existence and location of the Aboriginal heritage sites and advised to avoid these as they may be subject to the *Aboriginal Heritage Act 1972*.

If in the future Alcoa proposes to disturb the area to the south of the residue area where the artefact scatters are located, Alcoa will undertake detailed archaeological recording of the site, and consult with appropriate indigenous representatives and organisations, prior to any disturbance of the area.

8.15 VISUAL AMENITY

The EPA's objective for the Proposal regarding visual amenity is:

- *visual amenity of the area adjacent to the Proposal should not be significantly impacted by the proposal.*

Potential Issues

The footprint of equipment associated with the Proposal will be within the confines of the existing Wagerup Refinery. The Proposal will require expansion of the existing residue area within the proposed 30 year residue footprint, which will be to the west and north of the existing residue area in accordance with the LTRMS (refer to Section 3.1).

The most obvious difference at the residue area will be the increase in height from the existing elevation of around 20metres to 40metres above ground level, in accordance with the endorsed LTRMS. This increase in height is proposed with or without the Proposal, although the Proposal will bring forward the accumulation of residue. The banks of the stockpiles will be contoured and rehabilitated on an ongoing basis to blend in with the surrounding landscape.

To assess the potential visual impacts of the Proposal, digital photographs were taken from selected locations around the refinery to show the existing views of the refinery and residue facilities. Based on the engineering design available at this early stage of the Proposal, the additional structures required for the expansion were superimposed on these photographs to allow comparison of the visual aspects of the Proposal, and identification of practical measures to reduce visual impacts.

The potential visual impacts of the Proposal, prior to and following amelioration are outlined as follows and shown in Plates 1 to 12. A map of locations showing where these photographs were taken is shown in Figure 42 (refer to section 7.18):

View 1 (Plate 1a): This photograph was taken from Willowdale Road Lookout. From this vantage point the existing Wagerup refinery and Upper Dam holding rainwater runoff, can be seen. The existing stack for Calciner units 1, 2 and 3 is clearly visible, being 100metres in height as is the Powerhouse stack (65 high) and the lime silo. For the expansion, the old Calciner 4 stack will be removed and a new 100 metres stack for Calciner units 4, 5 and 6 erected. If the Cogeneration option is pursued, two cooling towers will be visible from this view point. Otherwise if the Boiler option is selected a 75 metre stack will be required and be visible from this view point. The refinery is most visible from View Point 1 and it is predicted that the overall visual impact after the Proposal will not be significantly greater than the existing visual impact.

View 2 (Plates 2a & 2b): The residue area is just visible through the trees looking west from the South West Highway, with the Detention Pond in the foreground. The increase in height of the residue stockpile will make it more visible through trees and it is likely to be visible above the tree line.

View 3 (Plates 3a & 3b): This photograph is taken from Bancell Road south of the residue area looking north-northwest. The existing residue stockpile is visible through a gap in the trees. Expansion of the residue area will make the facility visible through the gap in the trees and above the line of trees to the left of the photograph.

View 4 (Plate 4): This view is also taken from Bancell Road, looking northeast, on the opposite side of the refinery from view 1. The existing view shows the Calciner (1, 2, 3 unit) multiflue and the Calciner 4, with other parts of the refinery visible just above the tree line. With the Proposal, the Calciner 4 stack will be removed and the proposed 100 metre Calciner multiflue will be visible from this point.

View 5 (Plates 5a & 5b): Taken from Bancell Road south of the residue area looking north. The existing residue area is barely visible through the trees in the distance. With the Proposal, the residue area will be visible above the tree line.

View 6 (Plates 6a & 6b): From this vantage point on Somers Road, looking east, the residue stockpile is currently visible above the shrub line, with the refinery visible in the distance. The expanded residue area will be clearly visible from this view point, but apart from a second tall stack, no other changes to the refinery will be visible.

View 7 (Plates 7a & 7b): The residue area is currently visible through the paddocks from Somers Road looking southeast. The larger expanded facility will also be clearly visible when viewed from this point across the paddocks. Changes at the refinery are likely to be imperceptible from this vantage point.

View 8 (Plates 8a & 8b): The residue area is currently barely noticeable through the line of trees on the other side of the paddock when viewed from McClure Road looking south. The expanded residue drying areas will become visible just above the line of trees when viewed across the paddock (Plate 8).

View 9 (Plate 9): The existing 100 metre Calciner multliflue is visible above the tree line from this point on McClure Road looking southeast. From this distance the only noticeable change is likely to be the additional 100 metre multiflue for Calciner units 4, 5 and 6 adjacent to the existing stack.

View 10 (Plate 10): This view taken 700 metre west of Yarloop on Johnstone Road looking north-northeast shows the Calciner stack, and part of the feedstock conveyor in

the distance beyond the tree line. The only noticeable change from this vantage point is likely to be the additional multiflue for Calciner units 4, 5 and 6.

View 11 (Plate 11): The existing Calciner stack is visible above the trees when viewed from the corner of Boundary Road and South West Highway, looking north-northeast. The only noticeable change with the expansion from this view point will be the extra Calciner multiflue stack for Calciners 4, 5 and 6.

View 12 (Plate 12): This view is taken from the intersection of Kaus Road and South West Highway looking north-northeast towards the refinery. The existing Calciner stack is visible above the trees, and the additional Calciners multiflue stack will also be visible above the tree line.

In summary the Proposal may impact on the view sheds of residents living in the immediate vicinity of the operations, people travelling along surrounding roads and visitors to the area. There are no significant tourist locations adjacent to the RDA and therefore the potential impact on tourism visual amenity is reduced. The RDA and refinery may even be of interest to some tourists interested in the alumina operations.

Proposed Management

In general, changes to the Refinery when viewed from key vantage points will not significantly alter the existing viewscape of the refinery other than an additional taller multiflue for Calciner units 4, 5 and 6 and two cooling towers (if the Cogeneration Plant option is selected) or a 75 metre stack for the Boilers (if the existing Powerhouse is upgraded).

However, the expanded residue area will be clearly visible from View points 3, 6 and 7 without amelioration (see Plates 3, 6 and 7). Alcoa currently has a Visual Amenity Strategy for the Wagerup residue area which was required for planning approval for RDA 7 (June 2003) by the Waroona Shire Council. This strategy will be expanded to consider the future residue areas required for the Proposal.

The primary aspects of the Visual Amenity Strategy are to:

- enhance the vegetation screening on Alcoa's property adjacent to the surrounding public roads
- initiate trials on new outer embankments of the residue area to blend the visual appearance of the residue area into the surrounding landscape, and
- aim to rehabilitate externally facing embankments as soon as practical after construction.

The strategy applies to an area bounded by the South Western Highway to the east, Bancell Road to the South, Somers Road to the West and McLure Road to the north (Figure 42). A review of the strategy was conducted in November 2004 with local community members providing input and advice on the 2005 planting program. A similar review process will be used for expansion of the residue area for the Proposal.

The 2004 and 2005 planting programs in the Visual Amenity Strategy are focused on creating ecologically self sustaining ecosystems and improved visual amenity for the Bauxite residue area. The species types selected for each area are dependant upon the soil type, level of inundation likely during winter and reflect those species found in similar natural environments. The Bassendean and Spearwood Dune Systems for example, typically support jarrah-marri woodland (*Eucalyptus marginata, E. calophylla, Allocasuarina fraseriana*) and banksia low woodland (*Banksia attenuata, B. menziesii*). Freshwater swamps also occupy a large area and are usually bordered by paperbarks (*Melaleuca rhaphiophylla* and *M preissiana*) *Banksia littoralis, Eucalyptus rudis* and sedges. Use of these species in their natural environment will assist in promoting self sustainable ecosystems.

Trials to modify the embankments of the residue area have commenced with the aim of creating a more natural shape. To do this slopes and contours in the natural environment are measured and similar shapes incorporated into the planning phase of new residue drying areas. This proposed change in shape combined with variation in residue rehabilitation species is aimed at being more representative of the natural environment.

The Visual Amenity Strategy is an ongoing long term programme that will take into account proposed and future project development. Plantings take time to establish and it is expected that plantings undertaken in 2005 will begin to enhance the appearance of the area in 2008 onwards. With continued infill planting and regular reviews, this strategy will result in a significant enhancement to the visual amenity of the residue area.

EXISTING VIEW

CO-GENERATION

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE REFINERY LOOKING SOUTH WEST FROM THE WILLOWDALE ROAD LOOKOUT

Plate 1a

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 01a.dgn

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EXISTING VIEW

MODELLED VIEW

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE RDA LOOKING WEST FROM SOUTH WEST HWY, 750m SOUTH OF WILLOWDALE ROAD TURNOFF

Plate 2a

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 02a.dgn

REHABILITATION

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE RDA LOOKING WEST FROM SOUTH WEST HWY, 750m SOUTH OF WILLOWDALE ROAD TURNOFF

Plate 2b

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 02b.dgn

EXISTING VIEW

MODELLED VIEW

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE RDA LOOKING NORTH FROM BANCELL RD, 1400m WEST OF SOUTH WEST HWY TURNOFF

Plate 3a

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 03a.dgn

REHABILITATION

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE RDA LOOKING NORTH FROM BANCELL RD, 1400m WEST OF SOUTH WEST HWY TURNOFF

Plate 3b

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 03b.dgn

EXISTING VIEW

MODELLED VIEW

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE REFINERY LOOKING NORTH EAST FROM BANCELL RD, 1.4km WEST OF SOUTH WEST HWY TURNOFF

Plate 4

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 4.dgn

EXISTING VIEW

MODELLED VIEW

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE RDA LOOKING NORTH FROM BANCELL RD, 2.9km WEST OF SOUTH WEST HWY TURNOFF

Plate 5a

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 05a.dgn

REHABILITATION

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE RDA LOOKING NORTH FROM BANCELL RD, 2.9km WEST OF SOUTH WEST HWY TURNOFF

Plate 5b

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 05b.dgn

EXISTING VIEW

MODELLED VIEW

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

Plate 6a

VIEW OF THE REFINERY & RDA LOOKING EAST FROM SOMERS RD, 400m SOUTH OF BRISTOL RD

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 06a.dgn

REHABILITATION

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

Plate 6b

VIEW OF THE REFINERY & RDA LOOKING EAST FROM SOMERS RD, 400m SOUTH OF BRISTOL RD

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 06b.dgn

EXISTING VIEW

MODELLED VIEW

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE REFINERY & RDA LOOKING SOUTH EAST FROM SOMERS RD, 750m SOUTH OF McCLURE RD

Plate 7a

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 07a.dgn

REHABILITATION

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE REFINERY & RDA LOOKING SOUTH EAST FROM SOMERS RD, 750m SOUTH OF McCLURE RD

Plate 7b

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 07b.dgn

EXISTING VIEW

MODELLED VIEW

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE RDA LOOKING SOUTH FROM McCLURE RD, 1.7km WEST OF FAWCETT RD

Plate 8a

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 08a.dgn

REHABILITATION

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE RDA LOOKING SOUTH FROM McCLURE RD, 1.7km WEST OF FAWCETT RD

Plate 8b

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 08b.dgn

EXISTING VIEW

MODELLED VIEW

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

Plate 9

VIEW OF THE REFINERY LOOKING SOUTH EAST FROM SOMERS RD, 1.2km WEST OF FAWCETT RD

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 9.dgn

EXISTING VIEW

MODELLED VIEW

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE REFINERY LOOKING NORTH-NORTH EAST FROM JOHNSTON RD, 700m WEST OF YARLOOP

Plate 10

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 10.dgn

EXISTING VIEW

MODELLED VIEW

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE REFINERY LOOKING NORTH-NORTH EAST FROM CORNER BOUNDARY RD & SOUTH WESTERN HIGHWAY

Plate 11

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 11.dgn

EXISTING VIEW

MODELLED VIEW

Alcoa World Alumina Australia
WAGERUP REFINERY EXPANSION

VIEW OF THE REFINERY LOOKING NORTH-NORTH EAST 35m NORTH FROM KAUS RD & SOUTH WESTERN HIGHWAY INTERSECTION

Plate 12

ENVIRON

Drawn: I. Yull Date: 01/05

PINPOINT CARTOGRAPHICS (08) 9277 7763 Plate View 12.dgn

8.16 LIGHT SPILL

Potential Impacts

The Wagerup alumina refinery operates 24 hours per day and therefore requires significant outdoor lighting. Development of the Proposal will require additional lighting for the additional components of the plant and therefore has the potential to increase the obtrusive effect of lighting at the Wagerup refinery.

Obtrusive effects of outdoor lighting can be categorised as:

- glare
- spill light, and
- sky glow.

In design of the Proposal, Alcoa has focussed on the potential impacts of sky glow, as this represents the greatest potential light impact from the refinery. Sky glow is as a result of light emitted from luminaries entering the sky and reflecting off particles in the atmosphere. Light may be emitted to the sky:

- directly from a luminare which is directed above the plane of horizon, or
- indirectly by being emitted from a luminare which is directed below the plane of horizon, but is reflected from the surrounding surface towards the sky.

The impact of sky glow from lighting is therefore dependent not only on the amount of light emitted to the sky, but also the reflectance characteristics of the surrounding surface and the nature and concentration of atmospheric constituents. For example, sky glow may appear greater on a foggy night (and similarly if there is smoke or dust present in the atmosphere), or if the area being illuminated is reflective.

Proposed Management

A number of Australian and international standards and guidelines exist for control of outdoor lighting. However, with the exception of regulations regarding permissible light emissions around airports and astronomical observatories, there are no statutory requirements with regards to light pollution in Australia.

Examples of some of the measures that can be implemented to reduce sky glow are as follows:

- Direct light downwards
- Select luminaries that minimise spread of light near to, or above, the horizontal

- Keep lighting levels (illuminance) to the minimum acceptable for the intended purposes
- Keep glare to a minimum; keep main beam angle to below 70º
- Use floodlights with asymmetric beams to allow front glazing to be kept at or near parallel to surface being lit, and
- Use energy efficient low-pressure sodium (LPS) lamps (especially where perception of colour is not necessary for the lighting to be effective).

The following items will be investigated by Alcoa for inclusion in the electrical design criteria, preferred equipment list and lighting installation details for the Proposal:

- Outdoor lighting will be designed so that general, non-critical lighting may be switched off during hours of inactivity, however, safety lighting such as for stairways and walkways will be maintained
- Switching will be automatic via plant control system with manual override at the affected area
- Wherever practical outdoor lighting will be directed downward to illuminate the target area. The selected luminaries will be of the cut-off type emitting little or no light above the horizontal plane
- Minimise the upward waste light ratio (UWLR)
- Where asymmetric light distribution is required floodlights will be of the asymmetric beam type to permit the front glazing to be kept at or near parallel to the surface being lit
- Outdoor lighting will be designed so that the average maintained illuminance does not greatly exceed the minimum values recommended by the applicable Australian standards and/or IES for the intended purposes
- Outdoor lighting will be designed so that glare is kept to a minimum by ensuring that the main beam angle of all lights directed towards a potential observer is kept below 70º. This may be achieved by selecting the most suitable combination of mounting height and number of fittings
- Low-pressure sodium (LPS) lamps will be used for outdoor lighting where good colour rendering or short start-up time is not critical such as road lighting, car park lighting, stockpile lighting (LPS lamps are also much more energy efficient than incandescent lamps), and
- Illuminated surface materials will be of lowest reflectance types that are compatible with the function of the area, e.g. grass or asphaltic surfaces.

Appropriate measures for management of light spill for the Proposal will be selected in consultation with plant operations and maintenance personnel to ensure adequate lighting requirements for safe working are maintained.

8.17 SOCIO-ECONOMIC IMPACTS

Potential Issues

A socio-economic impacts study for the Proposal was undertaken by Environmental Resource Management Australia (ERM, 2005; Appendix P). The following section discusses the potential consequences of impacts of the Proposal on the local communities and possible management responses to minimise these impacts.

The key positive impacts relate to economic development in shires of Waroona and Harvey, the Peel region, the State and Australia and include:

- "Economic development of the Peel Region through local procurement and 'multiplier' effects
- Increased employment security for existing Alcoa workforce and employees of suppliers
- Increased employment opportunities in the local and wider region
- Targeted investment by Alcoa on training and development in the region
- Potential for local businesses to capitalise on the opportunity by supplying goods and services during the construction phase
- Potential for population growth in adjacent shire,; and
- Revenues from taxes and royalties to State and Commonwealth governments." (ERM, 2005)

Potential adverse impacts which may occur as a result of the Proposal are:

- "Local companies might miss opportunities due to lack of investment in their capacity to supply Alcoa's needs or under-investment by governments (eg lack of light industrial land)
- Local companies may be over-optimistic about demand for their products and services as a result of the expansion and make investment decisions that harm the ongoing sustainability of their businesses
- Second tier suppliers and local businesses may be ill-prepared in transitioning their businesses out of the expansion "boom" period, resulting in a subsequent "bust" or economically depressed period post-construction
- Additional demands on government services and infrastructure due to temporary workforce
- Labour shortages could lead to wage inflation during construction and result in increased local business costs
- Short-term accommodation may be in heavy demand during the construction phase and 'squeeze out' tourists and tourism attraction spending

- Potential for anti-social behaviour associated with the presence of temporary construction workforce, and
- Slower growth of export value from South-West region due to an appreciating Australian dollar." (ERM, 2005)

Potential impacts on amenity are discussed in other sections of this ERMP (e.g. Dust, Section 8.3.7; Odour, Section 8.3.8; Noise, Section 8.4; Traffic and Transport, Section 8.8; Public Safety, Section 8.9; Visual Amenity, Section 8.15; Light Spill, Section 8.16).

Socio-Economic impacts are discussed in Appendix P in more detail and are summarised below.

Alcoa will invest over $1.5 billion in developing the Proposal and direct expenditure in the Peel and South West region could be as high as $50 million and is likely to reach twice this amount if sub-contracts and other indirect supplies are considered. This will boost the wider economy through direct and indirect employment, supporting local services and industries and providing subcontracting opportunities. Whilst the economic benefits are expected to be strongest in the Peel Region, it is also expected to stimulate economic growth in the South-West Region, Perth, Western Australia and Australia-wide.

Economic growth in regional economies is one of the aims of the State Government's Regional Development Policy (2003): *"Regional Western Australia – a Better Place to Live*" and the WA State Sustainability Policy (2003) (see Section 8.1.1). In line with these policies the Proposal will help enhance regional investment, assist in providing skilled regional communities and improve the quality of life in these regional areas.

Direct employment during the construction phase is expected to peak at over 1500, the equivalent of 500 full time jobs per year during the construction period. The expanded Wagerup refinery operations will require an additional 150 permanent employees. The multiplier effect (e.g., increased employee and business spending as a result of the Proposal stimulating local and regional economic growth) in the Peel and South West Regions is expected to result in approximately 2000 new indirect jobs during operations and another 1000 statewide. However, with strong economic growth and several other major construction projects underway or planned in the South West, there may also be labour shortages particularly in the area of skilled and semi-skilled construction labour. This may result in some wage inflation in the sector, which potentially adds to costs for local businesses which use the same workforce pool.

The Proposal will enhance training opportunities for young people in the region. In the past Alcoa has trained more than 1100 West Australian apprentices encouraging young people to seek jobs in their local communities. The Wagerup Proposal will provide an opportunity to further Alcoa's support for local communities. In 2004 Alcoa invested over $8 million in

community partnerships in WA. These included partnerships on health, safety, diversity, the environment, community development, leadership and education, science and technology.

An increase in workforce will require an increase in available temporary accommodation during construction and permanent accommodation during operation of the Proposal. Based on previous construction projects in the Peel and South West, Reyco consultants (2005) have estimated that approximately 70% of the construction workforce (approx. 1000-1100 at peak) will be living within a 100km radius to the construction site. These workers will commute to and from their homes to the site by car. The remaining 30% (approx. 400-500 at peak) will be distance workers. These people will require local accommodation at reasonable cost, and based on Reyco's accommodation availability study, of these:

- it is anticipated 70% will choose to reside in Mandurah, and
- it is anticipated other 30% will choose seek accommodation in the towns of, Bunbury, Waroona, Harvey, Yarloop or coastal areas.

The Reyco research indicates accommodation is readily available for a peak construction workforce and therefore it will not be necessary for Alcoa to provide dedicated construction accommodation.

Increased demand for affordable accommodation and services in Mandurah and Bunbury is not expected to present a problem in these larger cities, but may result in a shortage of select accommodation (caravan parks, cabin/chalets and units) in the Shires of Murray, Waroona and Harvey, and may impact the availability of existing infrastructure and services.

The services most likely to be affected are medical and recreational services. During operations there are unlikely to be more than 150 new households and perhaps 450 residents in the local shires, which are not expected to result in significant adverse impacts on local services, such as family accommodation, education, essential council services and State social services.

For those workers temporarily relocated away from their families there is the risk of depression, social isolation, alcohol and drug abuse and effects on the family left behind including pressures on parenting roles and marital relationships.

The State will benefit from royalties paid by Alcoa from increased alumina production and payroll tax both as a result of direct employment by Alcoa and employment generated in the wider economy from subsequent spending. As a consequence this increased revenue flow from regional areas may strengthen the shires' positions in requesting provision of infrastructure and services from the State and Federal governments.

There is a risk that local businesses may over-invest during the period of strong demand during construction of the Proposal which may lead to a 'boom-bust' cycle once demand

returns to more normal levels post-construction. However, during operations the increase in permanent population is likely to make more marginal enterprises viable.

At Bunbury, the continued growth of Alcoa through the proposed expansion at the Wagerup refinery will allow the Port Authority to continue to grow and develop the Bunbury Port and job opportunities will be created as a result of the increased activity. Based on Port Authority research into multiplier effects from additional ships, the proposal will create approximately 66 new full-time jobs in and around the Port.

Alcoa is committed to ensuring that the port facility does not adversely impact its neighbours. A new $4 million ship-loader has been installed to significantly reduce dust and other methods to further reduce dust from conveyor systems are being investigated (Section 8.3.6).

Proposed Management

Alcoa already has a number of programmes in place to support the local and regional communities (Section 7.15). Alcoa will ensure that management of socio-economic impacts will be undertaken with the community, government, local industry, and non-government organisations. Alcoa will seek to ensure that partnerships developed for the benefit of the community are aimed at developing the short and long-term capacity of the adjacent areas to further improve the community's own environment and quality of life.

To this end, members of the Socio-Economic Working Group are continuing to meet to discuss opportunities for community development and Alcoa will continue to support this group, for example, by providing facilitators and strategic advice.

Alcoa will continue to implement its local procurement policy for the Proposal. Key elements of this local content policy are to invite capable local businesses to bid on every locally supplied or manufactured good or service, give preference to local business in a competitive situation and work with local interest groups to identify and utilise local suppliers. Alcoa has provided briefings to individuals, groups and organisations (i.e. Mandurah Peel Region Chamber of Commerce) to give local businesses a better understanding of Alcoa's purchasing procedures and requirements. To increase the proportion of local procurement, Alcoa, the Shires and the development commissions have worked to compile databases of local suppliers.

Alcoa will continue to provide training placements in line with predicted workforce requirements and target skilled local residents for these placements. Alcoa already has an apprenticeship programme in place and initiatives such as 'Future Women of Industry' programme.

Based on available information the construction workforce for the Proposal can be housed in existing accommodation and no construction camp is required (Reyco, 2005). The following management measures are proposed for the construction workforce:

- Accommodation - review workforce participation and accommodation availability/demand when the Proposal is further defined. This will be achieved through undertaking an additional accommodation study
- Local employment - maximise employment of local workforce first
- Social interaction - identify opportunities for distant workers to be involved in community activities through welcome events and social/sport inclusion programs. Alcoa will liaise closely with Police and community groups to help ensure anti-social behaviour is minimised, and
- Services – Alcoa will liaise with government to quantify likely demands for health, emergency and education services.

In addition to the described socio-economic components of this ERMP, Alcoa has released a document that outlines some ideas that may assist the community with Alcoa and Government, in effecting positive sustainable change for the region.

Alcoa has conducted research, listened to the ideas from the Socio-Economic Working Group members, and to others, and has developed a set of project ideas. These 'ideas' will be used to stimulate conversation and is intended as a working paper for community, Government and Alcoa to discuss how we can work together to support social and economic growth in the region. Alcoa does not have all the answers, however Alcoa has resources to assist in the progress of a positive combined future.

This document is available on Alcoa's website www.alcoa.com.au/wagerup3.

Commitment 17

Alcoa will continue to consult with the local community on environmental aspects of the Proposal through the construction and commissioning phases of the proposal