Condobolin Ethanol Production Facility Air Quality Impact Assessment Report

Final Report

for Agri Energy Limited

June 2007

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Prepared by:	*Katie Moroney*
Position:	Senior Air Quality Consultant
Signed:	
Date:	*June, 2007*
Approved by:	*Troy Powell*
Position:	Senior Consultant
Signed:	
Date:	*June, 2007*

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FINAL REPORT

Agri Energy Limited

Proposed Ethanol Production Facility, Condobolin, NSW

Air Quality Impact Assessment

June 2007

Environmental Resources Management Australia
151 Clarendon Street,
South Melbourne VIC 3206
Telephone +61 3 9696 8011
Facsimile +61 3 9696 8022
www.erm.com

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EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) has been engaged by Agri Energy Limited to prepare an air quality assessment to inform an Environmental Assessment Report for the construction and operation of an ethanol production facility at Condobolin in New South Wales (NSW). The ethanol production facility will process a range of cereal grains to produce up to 200 million litres of ethanol products annually. The site is located off Micabil Road, approximately five kilometres east of the Condobolin township.

A Level 2 impact assessment, as described by the New South Wales Department of Environment and Conservation (NSW DEC, 2005) has been carried out to determine potential impacts from the proposed development. A Level 2 assessment is a realistic and comprehensive level of assessment based on site specific input data. Information has been obtained on local meteorology, terrain, landuse, background ambient air quality and estimated emissions from the plant. Air dispersion modelling was then undertaken using AUSPLUME 6.0 to estimate air quality impacts at nearby sensitive receptors.

The key contaminants considered in this assessment are:

- *particulate matter;*
- *ethanol;*
- *combustion emissions, including nitrogen dioxide, sulphur dioxide and carbon monoxide;*
- *a range of Volatile Organic Compounds including benzene, toluene, hexane, xylenes and ethylbenzene;*
- *acetaldehyde; and*
- *methanol.*

The dispersion modelling has indicated that predicted ground level concentrations at sensitive receptors are below the NSW DEC criteria for toxicity based pollutants, odorous pollutants and carbon monoxide, sulphur dioxide, nitrogen dioxide, total suspended particulate (TSP) and particulate matter less than 10 micron (PM_{10}). Predicted ground level concentrations for odour were also below the nominated NSW DEC criteria of 2.0 odour units.

A range of mitigation measures are proposed to minimise air emissions from the site. These include paving of haul roads, the installation of dust collectors, wet scrubbing technology to reduce emissions from the fermentation process and a thermal oxidiser on the dryer emission point.

GLOSSARY

C	Degrees Celsius
AMG	Australian Map Grid
AWS	Automatic Weather Station
BoM	Bureau of Meteorology
DDGS	Dried Distillers Grain with Solubles
EPA	Environment Protection Authority
ERM	Environmental Resources Management
g	grams
GLC	Ground Level Concentration
ha	hectare
kg	kilogram
km	kilometre
LPG	Liquefied Petroleum Gas
mg/m^3	Milligrams per metre cubed
$\mu g/m^3$	Micrograms per metre cubed
NEPM	National Environment Protection Measure
NSW DEC	New South Wales Department of Environment and Conservation
PM_{10}	Particulate Matter (< 10µm size)
Project Area	A five by five kilometre area surrounding the operations area.
TSP	Total Suspended Particulates
VOC	Volatile Organic Compounds
WDGS	Wet Distillers Grain and Solubles

1 INTRODUCTION

1.1 BACKGROUND

Agri Energy Limited (AEL) seeks project approval for the development of an ethanol production facility at Condobolin, New South Wales (NSW), under Part 3A of the *Environmental Planning and Assessment Act, 1979* (EP&A Act). Environmental Resources Management Australia Pty Ltd (ERM) has been engaged by AEL to prepare an environmental assessment for the construction and operation of the ethanol production facility, inclusive of an air quality impact assessment.

The ethanol production facility will be capable of processing a range of cereal grains (such as corn, wheat, barley and sorghum), which are grown in the Central West Region of NSW, to produce up to 200 megalitres (Ml) annually. It will include several holding dams, an effluent treatment facility and an irrigation area. The irrigation area will be irrigated with process wastewater as part of a wastewater recycling scheme. The proposal will have a development cost of in excess of $30 million and is therefore a 'major project' to which Part 3A of the EP&A Act applies. As such, it will be determined by the Minister for Planning.

1.2 SCOPE OF WORKS

The scope of works for the air quality assessment is set out below;

- evaluation of the existing conditions at the proposed facility site including existing air quality, sensitive receptors in the area, site meteorology and topography. This was based on information made available by AEL or on its behalf, site visits conducted by ERM staff and information available in the public domain;

- details of the legislative and regulatory framework relevant to the proposed facility;

- review of potential air pollutant emissions and the development of an air emissions inventory for the entire development;

- assessment of the air quality impacts from construction and operation of the facility at existing and future sensitive receptors;

- a summary of possible site-specific ameliorative measures to be considered as part of the proposal based on the outcomes of the air quality assessment; and

- consultation with the NSW Department of Conservation (NSW DEC) throughout the assessment.

1.3 *GENERAL APPROACH TO THE ASSESSMENT*

A Level 2 impact assessment, as described by the NSW DEC (EPA, 2005) has been carried out to determine potential impacts from the proposed development. A Level 2 assessment was undertaken as it is a realistic and comprehensive level of assessment based on site specific input data.

A typical Level 2 air quality impact assessment study for an industrial development involves the gathering, processing and presentation of information on:

- emission source details such as types, locations, dimensions, flow characteristics and rates of contaminant release to the atmosphere. A selection of significant or potentially significant contaminants is required, based on their expected rates of release and inherent properties to potentially cause environmental harm;
- meteorological conditions, which affect the behaviour of contaminant plumes released into the atmosphere;
- local geographical details such as topography and surface characteristics including land use and vegetation types;
- the existing levels of selected contaminants in the receiving environment;
- predicted future ambient concentrations, taking into account the existing baseline conditions. The prediction of ground level concentrations requires the use of mathematical models that simulate the release and dispersion of contaminant plumes from the facility;
- a basis for determining whether predicted contaminant concentrations are acceptable. This involves the use of air quality guidelines prepared by the relevant regulatory authorities; and
- measures incorporated into the design and/or management of the proposed development to mitigate air quality impacts, and in particular to mitigate the risks of adverse impacts under abnormal operating conditions.

The key contaminants considered in this assessment are:

- particulate matter;
- ethanol;
- combustion emissions, including nitrogen dioxide, sulphur dioxide and carbon monoxide;
- a range of Volatile Organic Compounds (VOCs) including benzene, toluene, hexane, xylenes and ethylbenzene;
- acetaldehyde; and
- methanol.

2 SITE DESCRIPTION AND LAND USES

2.1 SITE LOCATION

The site of the proposed ethanol production facility is wholly within the local government area of Lachlan. It is located along Micabil Road approximately five kilometres (km) west of Condobolin. Condobolin is situated in the Central West region of NSW, approximately 460km west of Sydney and 100km west of Parkes. Condobolin township has a population of approximately 3,500 people and is located at the junction of the Lachlan River and Goobang Creek.

The site comprises one land parcel, identified as Lot 32 of Deposited Plan (DP) 752093.

A site location map is presented in *Annex A, Figure 1*.

2.2 SITE LAYOUT

The site covers a total area of 96 hectares. It comprises former agricultural cropping land and there are stands of native trees located along the property boundaries and in the south-western corner. The Orange - Broken Hill Railway line passes through the south-western corner of the site. There is also an agricultural storage area, including a farm shed toward the northern boundary. Topography is relatively flat with a gradual rise to the east.

The proposed site layout is presented in *Annex A, Figure 2*. The main components of the ethanol production facility will be located in the northern portion of the site. It will have a footprint of approximately 300m x 300m and will include:

- a bunded storage building where all chemicals and products (other than grain and ethanol) stored on the site will be kept;
- a maintenance workshop and store which also includes a crop services facility;
- two 7000 tonne grain storage silos with a maximum height of 35m (these will be the tallest buildings on the site);
- a 1300 tonne shift silo;
- a milling section including two hammermills;
- a fermentation structure;

- a liquefaction and saccharification area;
- a distillation structure and tower;
- a boiler building;
- a cooling tower;
- a two storey building which houses the ring dryer for drying WDGS to produce DDGS;
- a bunded ethanol storage area which houses two anhydrous ethanol storage tanks, an off-spec storage tank and a gasoline storage tank; and
- a bunded storage building where WDGS and DDGS are stored.

A grain storage area comprising six grain bunkers will be located adjacent to the main buildings. These bunkers will be circumnavigated by a sealed one-way road.

Site access off Micabil Road will be upgraded and internal roads will be sealed and sufficiently wide to accommodate passing vehicles. There will be a weigh bridge, a light vehicle parking area with 40 spaces and a truck standing area. An office/ administration area will be constructed adjacent to the weighbridge and will comprise a reception area, offices, meeting rooms, bathroom facilities and a first aid room. Once the plant is operational the option of rail transportation of grain and ethanol product may be investigated. This would require on-site construction of a rail siding to connect with the Orange - Broken Hill Railway.

Three dams will be constructed on the property as follows:

- *2Ml stormwater dam* – located adjacent to the production buildings to hold and evaporate runoff from the buildings and hard surface areas;
- *40Ml effluent dam* - located south of the production buildings to store process wastewater from the facility, for pumping to the irrigation area; and
- *200Ml raw water dam* – located immediately west of the production buildings to store water pumped from the Lachlan River and supply all plant raw water needs (approximately 5.06Ml per day).

A salt evaporation system will be located adjacent to the ethanol plant and effluent dam to manage process wastewater with a high salt content that is discharged from the facility.

A subsurface pipeline will be constructed from the existing water pumping station (owned and maintained by Council) adjacent to the Lachlan River, to the raw water dam on the property.

AEL proposes to establish approximately 55ha of cropping, which will be irrigated with plant wastewater. The irrigation area will provide a future crop resource and its irrigation will facilitate reuse of any plant wastewater not recycled back into the process.

2.3 *SURROUNDING LAND USES*

The site is bounded by open agricultural cropping land to the north, east and west, and Micabil Road and the Orange - Broken Hill Railway line along part of its southern boundary. There are scattered rural residences to the east, including a residence approximately 100m from the eastern site boundary. The land adjacent to the southern site boundary is occupied by a Travelling Stock Reserve (Route 17), Gum Bend Lake, which is an artificial recreational waterway located approximately 330m to the south and the Recreation Reserve associated with Gum Bend Lake. The Lachlan River is located approximately 830m south of the site. Condobolin township is located approximately 5km to the east.

3 PROCESS DESCRIPTION

3.1 INTRODUCTION

The ethanol production facilities will be capable of processing a range of locally grown cereal grains, including wheat, corn, sorghum and barley. These grains must be transported to the site and stored prior to being input into the production process. The production of ethanol involves the milling of the grain to flour followed by a cooking, fermentation and distillation process. This process converts starch which comprises up to 75 per cent of the grain seed to sugar and subsequently to ethanol.

The ethanol to be produced by the plant will be a fuel blend stock. This product is dehydrated (water removed), stored and at the time of dispatch to market is mixed with a small percentage of petrol ('denatured'). The co-products of the ethanol production process are WDGS and DDGS which are sold as stockfeed.

A detailed description of the ethanol production process is provided in the following sections.

3.2 GRAIN RECEIVAL AND STORAGE

At full capacity the ethanol production facility will process approximately 600,000 tonnes of cereal grains (such as wheat corn, sorghum and barley) per annum. Grain will be hauled to the site principally via semi-trailers and B-double trucks. Trucks will enter the site and drive onto a weighbridge, where the gross weight will be recorded and grain samples will be taken for quality control purposes. The vehicle will then proceed to one of two unloading areas where the grain will be stored prior to processing. The two unloading areas are as follows:

- a grain receival platform where the grain will be discharged into a collection hopper and conveyed to one of two 7000 tonne storage silos; and
- a grain storage area, which will consist of six separate grain bunkers, each approximately 30m wide, 200m long and up to 20m high, with a capacity of 20,000 tonnes. Once a bunker is formed, it will be covered with plastic tarpaulin to protect the grain from parasites, birds, rain and wind.

A Grain Receiving Dust Collector collects the dust from the grain unloading operation and returns it to the process ahead of the hammermill.

The ethanol production process requires a constant supply of grain. At full production of 200Ml of ethanol per year, the plant will require approximately 1600 tonnes of grain per day or 67 tonnes per hour. This grain will be fed to the plant from a small 'shift silo' with a 1300 tonne capacity. Grain is to be transported to the shift silo via two ways, dependent on whether the grain is being sourced from the grain storage silos or from the bunker storage area.

For retrieval from the storage silos, a screw feeder and elevator at the bottom of the source silo will be used to convey grain to the shift silo. This system will include dust extraction and filtering facilities to eliminate dust emissions.

For retrieval from the bunker storage area, grain will be picked up by a front-end loader and fed into a mobile dump hopper positioned over a belt conveyor. The belt conveyor will feed the grain to the main feed conveyor and on to a screening station which will include a dust collecting and filtering system to eliminate dust emissions. The grain will then be elevated to the shift silo.

3.3 *MILLING AND SLURRY PREPARATION*

As part of the production process the grain needs to be milled and then mixed into slurry via the following process:

1) grain from the shift silo will be gravity fed to the hammermill where it is milled;

2) the hammermill dust collectors extract dust by vacuum from appropriate points in the milling system circuit and direct it to a bag filter, which will collect the dust and return it to the mill discharge conveyor;

3) a monitored weight of milled grain flour will be mechanically conveyed to a pug mixer, where a 'slops mix', comprising recycled process water from the distillation and evaporation operations will be added to form a slurry of appropriate density;

4) from the pug mixer, the slurry mix will be directed to a mixing tank where additional slops or process water can be added to make up the correct slurry density and percent solids; and

5) the mixed slurry preparation (mash) will be pumped from the mixing tank to the pre-liquefaction tank via one of two discharge pumps (operating and spare) for liquefaction.

3.4 *CHEMICAL PREPARATION*

A specific area in the enclosed liquefaction and saccharification building has been designed to receive and prepare a range of chemicals used as part of the ethanol production process. The chemical preparation area consists of a series of small mixing tanks fitted with access platforms, mixing agitators (where required), dosing delivery pumps and pipe work. Packaged chemicals will be fed by forklift or manually from the bag or container into the respective mixing tank. Once prepared, the chemical mix is to be piped to the required process stage.

3.5 *LIQUEFACTION STAGE*

Liquefaction is the process of converting insoluble starch in the mash to a soluble starch mix by enzyme reaction at an elevated temperature. An enzyme mix prepared in the chemical preparation area is metered as a liquid into the pug mixer and the pre-liquefaction tank.

The mash is strained and heated, and then pumped to the liquefaction tank in the preparation building for processing of the insoluble starch. The liquefaction tank is sealed, insulated and agitated and the reaction takes up to four hours depending upon grain type.

From the liquefaction tank the mash is pumped to the pre-saccharification tank via mash coolers, which flash cool the mash with non-contact cooling water and lower its temperature to approximately 60 degrees Celsius.

3.6 *SACCHARIFICATION STAGE*

Saccharification is the enzymatic conversion of the soluble starch to glucose. The reaction occurs in the pre-saccharification tank which is also sealed, insulated and agitated, and continues in the pre- fermentor and the fermentor tanks. The reaction requires the addition of another enzyme mix, which is metered as a liquid into the pre- saccharification tank.

From the pre-saccharification tank the mash is pumped to a pre–fermentor tank via coolers which again flash cool with non-contact cooling water. Vented emissions are collected and sent to the process vent scrubber, where they are scrubbed, using chilled water. Emissions from the scrubber are discharged to the atmosphere, and the water is returned to the beer well for distillation of the dissolved alcohol.

3.7 *FERMENTATION STAGE*

Fermentation is the conversion of glucose to ethanol and carbon dioxide by the action of yeast. Propagated yeast and other chemicals that promote and sustain the reaction are added to the pre–fermentor tank. The mash containing yeast and nutrient is then pumped to one of three stainless steel fermentor tanks. Once a tank is filled, it is allowed to react for the required time to achieve maximum conversion of sugars to ethanol (around 45 to 55 hours). This process produces a fermented mash called beer which is emptied to a beer well. The empty tank is then cleaned by the addition of cold caustic soda solution. Once cleaned the tank is filled again for the next cycle. Fermentation is a batch process that occurs continuously by using all three fermentor tanks in series.

The carbon dioxide produced by the fermentation reaction is vented to a fermentation vent scrubber where water is used to scrub residual amounts of ethanol from the carbon dioxide. The cleaned, scrubbed carbon dioxide gas is emitted to atmosphere while the scrubber water is pumped into the beer well.

The beer contains about ten per cent ethanol in addition to non-fermentable grain solids. The beer well acts as a buffer tank to receive the reacted ethanol and mash mix for feed to the distillation stage.

3.8 *DISTILLATION, EVAPORATION AND DEHYDRATION STAGE*

For distillation, beer is pumped from the beer well in the fermentation area to the stainless steel mash distillation column, which will contain a number of heating trays. The column operates under a vacuum at a temperature of up to 125 degrees Celsius and is approximately 12m high. Distillation occurs in this column and involves boiling off the ethanol from the beer with steam to produce a hydrous ethanol product containing 95 per cent ethanol and five per cent water. The steam is produced from three boilers which are fuelled by natural gas.

The hydrous ethanol is then dehydrated to a fuel ethanol grade by superheating vapour and liquid from the top of the rectifier distillation column and transferring it to molecular sieve vessels, which remove any water from the ethanol product. Product ethanol is then cooled, filtered and transferred to the ethanol storage area.

Vapours from the distillation area condenser systems flow to the process vent scrubber where chilled water is used to scrub residual amounts of ethanol from the air before it is discharged from the scrubber stack to the atmosphere. The water from the scrubber is pumped to the beer well.

The by-product of distillation is slurry containing all unfermentable products, principally water and distiller's grain. This slurry is transferred from the base of the mash distillation column to a centrifuge, which removes the majority of water. The wet distiller's grain can then be extracted from the centrifuge as a wet cake.

The liquid by-product is transferred to a slops tank where approximately 60 per cent is returned to liquefaction for addition to the milled grain flour at the start of the process. The remaining 40 per cent is evaporated in a continuous evaporator to reduce the water content and thicken the product to a more concentrated form (syrup), which is pumped to a syrup collection tank. The water stream from the evaporator system is used as process water at the mixer or flows to the secondary treatment plant.

The wet cake (extracted from the centrifuge) is then combined with the syrup in a paddle mixer to form a product containing approximately 30% solids, called WDGS. Half of this product will be sold in this form. The remaining half will be transferred to a flash dryer where it is dried by steam to produce DDGS which has approximately ten per cent moisture content. The dryer exhaust passes through a Thermal Oxidizer which incinerates the emissions from the dryer and then discharges to the atmosphere. The DDGS is cooled and conveyed to the storage and loadout area.

3.9 DISTILLERS GRAIN STORAGE AND DISPATCH

WDGS and DDGS will be stored in a dual-purpose shed, which has a concrete bunded bunker for WDGS storage and open-fronted concrete bins for DDGS storage. WDGS will be pumped into B-doubles or semi trailers for trucking to market. A front end loader will be used to pick up DDGS from the bins and load B-doubles or semi trailers for trucking to market. Dust generated during the DDGS loading process is to be collected by the DDGS Loadout Dust Collector.

3.10 ETHANOL STORAGE AND DISPATCH

The cooled ethanol will flow to one of two shift storage ethanol receiver tanks in the storage area. After passing relevant quality tests it will be transferred to the product storage tanks. The product storage tanks are sized to provide between six and seven days of total ethanol storage at full flow rate (200Ml/yr). Occasionally, problems with the plant may result in production of off-spec product. If this occurs, the product will be diverted to an Off-Spec Storage Tank.

All storage tanks are vented through a vent pipe fitted with an in-line flame arrester and a breather vent valve. All vapors from the gasoline unloading and ethanol loading are collected in vapour recovery lines and sent to the road tanker or the source tank, respectively.

For the production of fuel grade ethanol, denaturant from the denaturant storage tank is to be metered continuously into the pure ethanol stream during transfer from the product storage tank to the road tanker. This will yield a finished product containing five per cent denaturant. The denaturant tank is sized to hold sufficient denaturant to cover ten days ethanol production.

Ethanol product will be transported to market via B-double trucks.

4 AIR QUALITY CRITERIA

This section details the relevant national and state air quality criteria, used in this assessment.

4.1 AIR QUALITY ISSUES

The main air quality issues associated with the proposed ethanol facility are;

- particulate matter and products of engine combustion generated during construction;
- particulate emissions from dust collectors (grain handling dust collector, DDGS loadout dust collector and milling dust collectors);
- combustion emissions from the natural gas fired boilers and dryer;
- ethanol, odour and other pollutant emissions from various stages of the process; and
- fugitive ethanol and other pollutant emissions from ethanol storage tanks.

The following sections outline the air quality pollutants assessed for this project and the regulatory framework associated with these potential emissions.

The air quality assessment was carried out in accordance with the following NSW DEC policies;

- *Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales*, NSW DEC, August 2005;
- *Technical Framework– Assessment and Management of Odour from Stationary Sources in NSW,* NSW DEC, November 2006; and
- *Technical Notes - Assessment and Management of Odour from Stationary Sources in NSW*, NSW DEC, November 2006.

4.2 NATIONAL ENVIRONMENT PROTECTION MEASURES

The National Environment Protection Measure (Ambient Air Quality) 1998 (NEPM) is a Commonwealth government initiative which aims to achieve nominated standards of air quality within ten years. Air quality standards for six major air pollutants (carbon monoxide, nitrogen dioxide, photochemical oxidants, sulfur dioxide, lead, and small airborne particles) have been set.

All states and territories including NSW have adopted the NEPM air quality goals for pollutants, outlined in *Table 4.1* below. These standards are legally binding on all levels of government. Measurement and concentration averaging periods are based on critical exposure times for health impacts and are thus different for various pollutants.

Table 4.1 NEPM (Ambient Air Quality) Standards

Pollutant	Averaging Period	Maximum Concentration	Maximum Allowable Exceedences
Carbon Monoxide	8 hours	9.0 ppm	1 day in a year
Nitrogen Dioxide	1 hour	0.12 ppm	1 day in a year
	1 year	0.03 ppm	None
Photochemical oxidants	1 hour	0.10 ppm	1 day in a year
	4 hours	0.08ppm	1 day in a year
Sulphur dioxide	1 hour	0.20 ppm	1 day in a year
	24 hour	0.08 ppm	1 day in a year
	1 year	0.02 ppm	None
Lead	1 year	0.5 μg/m^3	None
Particles as PM_{10}	24 hour	50 μg/m3	5 days in a year.

1. ppm - parts per million

In addition, the draft NEPM for particulate matter less than 2.5 microns specifies criteria of 25 μg/m^3 (24 hour average). However the NSW DEC has not formally adopted this as an impact assessment criterion. The NEPM criteria outlined above in *Table 4.1* have been incorporated into the NSW DEC impact assessment criteria (discussed below in *Section 4.3*).

Apart from criteria pollutants, there has been an increasing focus on regulating a large group of contaminants collectively known as air toxics or 'hazardous air pollutants' (HAP's). Air toxics include the following general categories of compounds: volatile and semi volatile organic compounds, polycyclic aromatic hydrocarbons, heavy metals and aldehydes. In December 2004, National Environment Protection Council (NEPC) released the Air Toxics NEPM, which contains investigation levels for five common air toxics (see *Table 4.2*). The NSW DEC has not formally adopted the Air Toxics Investigation levels as impact assessment criteria.

Table 4.2 Air Toxic NEPM Investigation Levels

Pollutant	**Averaging Period**	**Monitoring Investigation Level**	**Goal**
Benzene	Annual	0.003 ppm	8 year goal is to gather sufficient data nationally to facilitate development of a standard
Benzo(a)pyrene as a marker for Polycyclic aromatic hydrocarbons	Annual	0.3 ng/m^3	8 year goal is to gather sufficient data nationally to facilitate development of a standard
Formaldehyde	24 hours	0.04 ppm	8 year goal is to gather sufficient data nationally to facilitate development of a standard
Toluene	Annual 24 hours	1.0 ppm 0.1 ppm	8 year goal is to gather sufficient data nationally to facilitate development of a standard
Xylenes (total isomers)	Annual 24 hours	0.25 ppm 0.2 ppm	8 year goal is to gather sufficient data nationally to facilitate development of a standard

The focus of this air quality assessment has been to assess predicted air quality impacts against the NSW DEC impact assessment criteria. However, the assessment of impacts against the Air Toxic NEPM investigation levels and the Ambient Air Quality NEPM standards has been conducted where relevant.

4.3 POEO ACT AND POEO REGULATION (2002)

The Protection of the Environment Operations Act 1997 (POEO Act) is the major legislation governing environment protection in NSW. Standards of concentration are prescribed by the Protection of the Environment Operations (Clean Air) Act (2002) and it is an offence under the POEO Act for emissions of air contaminants to exceed these levels. These are stack emission limits and the maximum emissions which are permissible for an industrial stack source anywhere in NSW (NSW DEC, 2005). As these limits do not take into account meteorology and background air quality, a site specific impact assessment is needed to determine the impact of emissions from the plant on the surrounding area.

Table 4.3 Standards of Concentration - POEO Regulation (2002)

Contaminant	Activity	Concentration	
		Scheduled Premises	**Non-scheduled Premises**
Solid Particles	Dust Collectors	50 mg/m3	100 mg/m3
	DDGS Dryer	50 mg/m3	100 mg/m3
	Cooling Towers	50 mg/m3	100 mg/m3
	Boilers	50 mg/m3	100 mg/m3
Nitrogen Dioxide	Boilers	350 mg/m3	-
	Dryer – thermal oxidiser	350 mg/m3	-
VOCs	Boilers	40 mg/m3	-
	Dryer – thermal oxidiser	20 mg/m3	
Carbon monoxide	Boilers	125 mg/m3	-
	Dryer – thermal oxidiser	125 mg/m3	
Smoke	Loadout Flare	No visible emission other than for a total of period of no more than 5 minutes in any 2 hours.	
	Dryer – thermal oxidiser	Ringelmann 1 or 20% opacity	
	Boilers	Ringelmann 1 or 20% opacity	Ringelmann 1 or 20% opacity

1. VOC's – Volatile Organic Compounds

4.4 *NSW DEC IMPACT ASSESSMENT CRITERIA*

The NSW DEC publish Impact Assessment Criteria for air pollutants in their document *"Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales" (2005).* This document is referred to in Part 4: *Emissions of Air Impurities from Activities and Plant* in the Protection of the Environment Operations (Clean Air) Regulation 2002.

The impact assessment criteria relevant to the proposed ethanol facility are presented in *Table 4.4*. These are the criteria which the predicted ground level concentrations will be compared to. The criteria are applied at the nearest existing or future sensitive receptor.

Table 4.4 NSW DEC Impact Assessment Criteria

Pollutant	Averaging Period	Concentration
Carbon Monoxide	15 mins	100 mg/m^3
	1 hour	30 mg/m^3
	8 hours	10 mg/m^3
Nitrogen Dioxide	1 hour	246 µg/m^3
	Annual	62 µg/m^3
PM_{10}	24 hours	50 µg/m^3
	Annual	30 µg/m^3
Sulphur Dioxide	10 mins	712 µg/m^3
	1 hour	570 µg/m^3
	24 hours	228 µg/m^3
	Annual	60 µg/m^3
Total Suspended Particulates	Annual	90 µg/m^3

1. Source: *"Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (NSW DEC, 2005)*

4.4.1 *Individual Toxic Air Pollutants*

The impact assessment criteria for relevant individual toxic air pollutants are detailed below in *Table 4.5*. Ground level concentrations must be minimised to the maximum extent achievable and the impact assessment criteria are applied at and beyond the site boundary of the facility.

Table 4.5 Toxicity Impact Assessment Criteria

Pollutant	Averaging Period	Concentration (mg/m^3)
Benzene	1 hour	0.029
Cyclohexane	1 hour	19
Formaldehyde	1 hour	0.02
n-Hexane	1 hour	3.2
PAHs	1 hour	0.0004

1. Source: *"Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (NSW DEC, 2005)*
2. *PAHs – Polycyclic Aromatic Hydrocarbons*

4.4.2 *Odorous Air Pollutants*

The NSW DEC impact assessment criteria for relevant odorous pollutants are detailed below in *Table 4.6*. The criteria are applied at the nearest existing or future sensitive receptors.

Table 4.6 ***Odour Impact Assessment Criteria***

Pollutant	Averaging Period	Concentration (mg/m^3)
Acetaldehyde	1 hour	0.042
Ethanol	1 hour	2.1
Methanol	1 hour	3.0
Toluene	1 hour	0.36

1. Source: "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" *(NSW DEC, 2005)*

Presently odour strength is measured under laboratory conditions by taking field samples of potentially odorous air, diluting these samples with clean air and subsequently subjecting the samples to a panel of qualified people. The number of dilutions of the sample with clean air to reach the threshold of detection by panel members is recorded in a procedure known as "dynamic olfactometry".

The NSW DEC odour criteria for complex mixtures of odour take into account the range of sensitivity to odours within a community to develop a statistical approach based on a function of population size. The criteria are applied at the nearest existing or future off site receptor. The impact assessment criteria for odour are detailed below in *Table 4.7*.

Table 4.7 ***NSW DEC Odour Impact Assessment Criteria***

Pollutant	Population of affected community	Odour performance criteria (O.U)
Odour	**Urban ($\geq$ 2000)**	**2.0**
	~ 500	3.0
	~ 125	4.0
	~ 30	5.0
	~ 10	6.0
	Single residence ($\leq$ ~ 2)	7.0

1. O.U. – Odour Unit
2. Source: "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" *(NSW DEC, 2005)*

The estimated population of the town of Condobolin is approximately 3,500. Although the area around the proposed facility encompasses a much smaller population than this, a conservative odour performance criterion of 2 OU has been used to assess odour impacts from the Condobolin facility.

4.5 *NSW DEC ACTION FOR AIR*

Action for Air is the NSW Government's 25 year air quality management plan. It primarily targets smog and particle pollution in the Greater Metropolitan Region (GMR) of NSW. There are no specific requirements in the document that relate to the proposed facility.

4.6 *BUFFER DISTANCE*

Buffer distances are a means of separating industrial, residential and other sensitive land uses thereby minimising any potential adverse air emission impacts.

Buffer distances are usually implemented to protect the immediate area from ongoing emissions and accidental emissions that may occur due to equipment failure, accidents and abnormal weather conditions.

The Lachlan Shire Council does not specify any buffer zone criteria for industry within the shire.

5 EXISTING ENVIRONMENT

This section details the existing air quality environment of the project area. It also details the prevalent meteorological conditions at the proposed ethanol facility and the existing background air quality.

5.1 GENERAL METEOROLOGICAL CONDITIONS

The site meteorology plays a major role in determining the location and the degree of offsite impacts of activities proposed to be carried out at the ethanol production facility. Air dispersion modelling requires information about the dispersion characteristics of the area. In particular, data is required on wind direction, wind speed, temperature, atmospheric stability and mixing height.

A meteorological file suitable for modelling using AUSPLUME has been prepared for ERM by PDS Consulting. The meteorological file utilised data on wind speed, wind direction and ambient temperature from an Automatic Weather Station (AWS) at Condobolin Airport, located approximately 8km east of the site. Data coverage for the meteorological file is 99.5%, and all four seasons are well represented.

Information as to the development of the meteorological file is included in *Annex B.*

5.2 CLIMATE

Long term climate data is available from a Bureau of Meteorology (BoM) AWS located at Condobolin Agricultural Research Centre, approximately 4km east of the site.

Table 5.1 presents temperature, humidity and rainfall data from this AWS, which consists of monthly averages of 9am and 3pm readings. Monthly averages of maximum and minimum temperatures are also presented. Rainfall data consists of mean monthly rainfall and the average number of raindays per month.

Temperature

On average, January is the warmest month in Condobolin with a mean daily maximum of 33.5°C. The coolest month is July with a mean daily minimum temperature of 2.6°C.

Rainfall

The mean annual rainfall at Condobolin is 464.7mm. The mean number of rain days annually over this period is 79.8 days. On average, October is the wettest month with a mean monthly rainfall of 51.8mm, while June is the driest month with an average of 26.3mm.

Table 5.1 Climate Data for Condobolin Agricultural Research Station (1954 – 2004)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Maximum Temperature													
Mean (°C)	33.5	32.8	29.3	24.5	19.5	15.7	14.9	16.8	20.1	24.5	28.3	31.8	24.2
Daily Minimum Temperature													
Mean (°C)	17.9	18.1	14.8	9.8	6.8	3.8	2.6	3.5	5.8	9.2	12.7	15.7	10.0
9 am Mean													
Temperature (°C)	24.5	23.6	21.3	17.3	12.5	8.7	7.8	10.0	13.9	18.0	20.6	23.5	16.8
Humidity (%)	49	52	55	60	75	83	81	75	64	53	49	46	62
3 pm Mean													
Temperature (°C)	31.7	31.2	28.0	24.9	18.9	14.2	13.8	15.3	19.0	22.8	26.5	-	20.6
Humidity (%)	29	24	37	39	52	60	57	52	44	39	34	-	46
Rainfall													
Mean (mm)	51.7	41.6	39.0	33.4	38.6	26.3	37.6	36.6	31.7	51.8	36.7	39.8	464.7
Raindays													
Mean (Number)	5.5	5.0	4.8	5.1	7.5	8.0	9.3	8.4	7.4	7.3	6.0	5.4	79.8

1. Station number 050052; Latitude 33.0664 S; Longitude 147.2283 E
2. Source - Bureau of Meteorology, Commonwealth of Australia.

5.3 *WINDROSE SUMMARY*

Wind speed and direction information is available from data collected at the BoM Condobolin Airport AWS, located approximately 8km east of the site. On an annual basis, winds are predominantly from the southwest and north, with smaller contributions from the west. Calm conditions are evident approximately 5% of the time. Windrose diagrams are presented in *Annex C*.

- During summer, predominant winds are from the southwest, with smaller contributions from the north and north-east.
- During autumn, predominant winds are from the east and southwest, with smaller contributions from the west.
- During winter, predominant winds are from the north, with smaller contributions from the west.
- During spring, predominant winds are from the southwest and west, with smaller contributions from the north.

5.4 *STABILITY CLASS*

Stability class is used to determine the rate at which a plume disperses by turbulent mixing. Each stability class is associated with a dispersion curve, which is used by a dispersion model to calculate plume dimensions and odour concentrations downwind of the source.

Stability classes are categorised from A to F. Stability class A refers to highly unstable conditions, class D refers to neutral conditions and stability class F refers to stable conditions. The intermediate classes not mentioned refer to conditions between those described above.

Table 5.2 shows the frequency of occurrence of the different stability categories expected in the area. The data in this table indicates that the atmosphere is quite stable (stability classes D, E, F) for a large percentage of the time (79%). This indicates that poor dispersion conditions may occur in the Condobolin area.

Table 5.2 Frequency of Stability Classes

Stability Class	Percentage (%)
A	1
B	7
C	12
D	40
E	14
F	25

1. Source: PDS Consulting

5.5 BACKGROUND CONCENTRATIONS

5.5.1 *General*

Background air quality is a measure of the existing air quality in the project area. The background air quality is due to sources (natural or man made) other than the site. This is important when considering cumulative impacts on sensitive receptors in the area.

A review of the State of the Environment Report (SOE) for Condobolin for the year 2001 indicates that the Lachlan Shire Council did not undertake any air monitoring within the reporting period and therefore definitive statements on ambient air quality within the region cannot be made.

A desktop review of the National Pollutant Inventory (NPI) of reported emissions from fixed and mobile sources in the vicinity of the site was also undertaken to obtain an indication of existing industries in the project area. The NPI shows that there is no other significant industry in the Condobolin area, based on those facilities required to report to the NPI. While there are additional contributors to background air quality, such as agricultural activities and traffic, the proposed facility is likely to have the potential to be the major contributor of odour and air emissions in the area. As such, background contributions have not been included in the assessment.

5.5.2 *Air Toxics*

The NSW DEC (then the NSW EPA) undertook a sampling program of 17 dioxins, 41 organic compounds, 11 polycyclic aromatic hydrocarbons (PAHs) and 12 heavy metals at 25 sites within NSW. The EPA study found that for most organic compounds ambient levels were very low, and well below the current international standards or benchmarks. This, combined with the lack of heavy industry in the Condobolin area, indicates that background concentrations of air toxics in the Condobolin area are likely to be very low and the proposed ethanol facility has the potential be the major contributor of these pollutants in the area.

The compounds identified by the study as of most concern in NSW were benzene, 1-3 butadiene and PAHs. Of these pollutants only benzene is proposed to be emitted from the operations at the Condobolin facility. Sampling in the urban fringe areas of Sydney indicated that levels of benzene were below 1 part per billion by volume (ppbV). As Condobolin is located in a rural setting with lower volumes of traffic, levels of benzene are likely to be less than this value. As such, background levels of this pollutant are not considered to be significant and have not been included in this impact assessment.

6 POTENTIAL EMISSIONS – CONSTRUCTION PHASE

The potential emission sources from the construction phase of the ethanol production facility are described below.

6.1 CONSTRUCTION IMPACTS

Emissions to the atmosphere from construction activities are primarily particulate matter. Potential impacts from particulate matter during short term construction activities are often nuisance related rather than health related. Combustion emissions such as carbon monoxide, carbon dioxide, particulate matter and nitrogen oxides from the movement of trucks and vehicles onsite are also likely to occur.

Particulate emissions from the site may occur during the construction phase from construction equipment, earthworks and unsealed exposed surfaces. Dust generating activities may include road construction, plant construction and truck movements.

Particulate matter mitigation measures will be implemented to minimise particulate emissions during the construction phase. These will include the watering of exposed surfaces when necessary and the minimisation of dust generating activities on days of high risk dust generation. It is expected that particulate emissions during the construction phase of the project will be minimal because:

- the proposed works do not require large areas of land to be exposed; and
- the main access road is to be sealed, therefore minimising the generation of dust from truck movements.

It is expected that particulate matter impacts will be minimal, short-term in duration and limited to the localised area of the site. As such, particulate matter from construction activities has not been included in the dispersion modelling assessment.

Particulate and other combustion exhaust emissions from mobile equipment are expected to be a minor contributor of overall particulate emissions from the site, due to the small fleet onsite. As such, emissions from combustion engines have not been included in the modelling assessment.

7 *POTENTIAL EMISSIONS - OPERATIONAL PHASE*

The potential emission sources from the operation phase of the ethanol production facility are described below

7.1 *BACKGROUND*

Potential emissions from the ethanol facility have been estimated based on the design estimate of a maximum yearly production of 200Ml of ethanol.

The major emissions to the atmosphere expected from the operational phase of the proposed plant include:

- ethanol emissions from various stages of the process, which have the potential to be odorous;
- dust from the milling operations; and
- combustion emissions from the natural gas fired boiler and dryer.

A diagram indicating the major sources of emissions is presented in *Annex A, Figure 3.*

7.2 *PARTICULATE EMISSIONS*

Particulate matter emissions will be generated as a result of the operation of the ethanol facility from three main sources:

- wheel generated particulate matter as a result of truck movements onsite;
- emissions as a result of grain receival, storage and processing; and
- emissions as a result of blow down of the cooling tower.

Minimisation of particulate matter emissions on the site is an important part of the ethanol production process, in order to maintain the purity of the ethanol product and mitigate the risk of explosion as a result of the ignition of grain dust. As such, dust mitigation measures will be put in place to reduce particulate emissions as far as practicable. These mitigation measures are discussed further in *Section 10.2.1*.

Although emissions of particulate matter are likely to be low as a result of the measures outlined above, particulate emissions as a result of emissions from the dust collection systems have been included in the modelling assessment. The estimation of these emission sources is outlined below. Emissions have been estimated for Total Suspended Particulate (TSP), which is a nuisance indicator, and particulate matter less than 10 microns (PM_{10}).

7.2.1 *Dust Extraction System*

Four dust collectors are proposed for the facility, which will incorporate fabric filter technology. The dust collectors will service grain handling and receival, hammermill operations, and DDGS loadout.

Two dust collectors will service the milling operations, they will discharge to air from exhaust stacks approximately 12.2m above the ground, with a velocity of 17.3 metres per second (m/s) and a flowrate of 15,300 m^3/hour.

The receival dust collector will discharge to air from an exhaust stack approximately 9.14m above the ground, with a velocity of 25.3 m/s and a flowrate of 81,600 m^3/hour.

The DDGS loadout dust collector will control emissions associated with loading DDGS into transportation for removal from the site. This dust collector will discharge to air from an exhaust stack approximately 12.2m above the ground, with a velocity of 18.2 m/s and a flowrate of 8,500 m^3/hour.

The dust collectors have been included in the model as point sources. Discharge from each dust collector has been conservatively modelled as occurring 24 hours a day. Emission estimations have been based on information supplied by the vendor. The PM_{10} emission rate has been assumed to be 50% of the TSP rate[1]. Predicted emissions from the dust collector source are presented below in *Table 7.1.*

Table 7.1 Estimated Particulate Emissions - Dust Collectors

Source	Quantity	Emission (kg/hr)		Total Emissions (g/sec)	
		TSP	PM_{10}	TSP	PM_{10}
Dust Collector – Grain Handling	24 hours	0.93	0.47	0.26	0.13
Dust Collector – DDGS loadout	24 hours	0.095	0.048	0.027	0.013
Dust Collectors – Milling operations	24 hours	0.35	0.18	0.097	0.049

1. Emissions for one dust collector

7.2.2 *Particulate Emissions from Cooling Towers*

During the process of cooling tower blowdown, which is anticipated to occur once per week, particulates will be emitted into the air with fine water droplets. It is anticipated that these water droplets will evaporate and the particles will remain in the air.

[1] US EPA AP 42 Section 9.9.1 Grain Elevators and Processes, April 2003.

Estimates of the emissions of particles from this activity have been provided by AEL and are based on a drift loss of 0.005% of the recirculation rate of the cooling tower. Estimated emissions are provided below in *Table 7.2*. Information is not available as to the percentage of the TSP that is emitted as PM_{10}. Therefore the full TSP emission rate has conservatively been used to assess PM_{10} concentrations. It has been conservatively estimated that this activity occurs for 12 hours a day, five days a week, however emissions have been modelled as occurring on a constant basis. Emissions will occur from two cooling tower cells.

Table 7.2 Estimated Particulate Emissions – Cooling Tower Blowdown

Source	Quantity	Emission (kg/hr)		Total Emissions (g/sec)	
		TSP	PM_{10}	TSP	PM_{10}
Coo.ling Towers	60 hours per week	1,778	1,778	0.158	0.158
1. Emissions are total emissions from both cooling tower cells.					

7.3 COMBUSTION EMISSIONS FROM BOILERS

Two boilers will be installed at the ethanol plant and will exhaust through two stacks, at a height of 13.7m above ground level and an exit velocity of 20.2m/s. The boilers will burn natural gas in order to provide steam to be used in the process.

Emissions from the boilers have been estimated using the National Pollutant Inventory Combustion in Boilers Emission Estimation Tool. This is a database which uses information such as the predicted annual fuel usage in each boiler and the type of boiler to predict emissions.

Fuel use has been estimated at maximum boiler capacity of 8,992 tonnes per year for each boiler. The US EPA AP 42 Section 1.5: Liquified Petroleum Gas Combustion states that for natural gas, all PM is less than 10 microns in diameter' (US EPA, 1996). Therefore TSP emissions have been assumed to be equal to PM_{10}. Emissions predicted from the boiler source are presented below in *Table 7.3*.

Table 7.3 *Estimated Emissions from Boilers*

Contaminant	Predicted Emission (kg/year)	Predicted Emissions (g/s)
Benzene	0.8	0.000025
Carbon monoxide	32,000	1.01
PAHs	0.26	0.0000082
Formaldehyde	28	0.00089
n-Hexane	680	0.021
Oxides of nitrogen	52,000	1.65
Particulate Matter as PM_{10}	2,800	0.089
Sulphur dioxide	196	0.0062
Toluene	1.26	0.000040
Total Suspended Particulates (TSP)[2]	2,800	0.089

1. Predicted emissions are total emissions from the two boilers.
2. TSP emissions were estimated assuming PM_{10} = 100% of TSP.

It has been assumed for modelling purposes that 100% of the nitrogen oxide emissions are nitrogen dioxide. This is conservative, as in reality this percentage is likely to be much lower.

7.4 *EMISSIONS FROM THE FERMENTATION STAGE*

All of the emissions from the fermentation process will be directed through a wet scrubber (herein the fermentation scrubber). The emissions from the distillation and evaporation processes will be directed through a wet scrubber (herein the process vent scrubber). These two scrubbers will vent through one stack which will be located in the fermentation plant. Emissions from the scrubbers will consist of mainly carbon dioxide, with a smaller quantity of VOCs such as ethanol, aldehydes and methanol. There is no NSW DEC impact assessment criteria for carbon dioxide, as it is considered to be primarily a greenhouse gas indicator. As such, carbon dioxide has not been assessed in the air quality assessment.

The removal efficiency of the fermentation scrubber has been provided by the vendor at 99.4% for ethanol, 17% for aldehydes and 100% for methanol. The process vent scrubber has an efficiency of 97.6% for ethanol, 50% for aldehydes and 100% for methanol.

Emissions from these sources have been based on design specifications and are presented in *Table 7.4* and *Table 7.5.* It should be noted that the combined emissions from these scrubbers vent out one stack.

Table 7.4 Estimated Emissions – Fermentation Scrubber

Contaminant	Predicted Emission (kg/hr)	Predicted Emissions (g/s)
Ethanol	2.39	0.66
Aldehydes[2]	0.68	0.19
Methanol	0	0

1. Carbon dioxide has not been assessed as there is no assessment criterion for this pollutant.
2. It has been assumed for the purposes of modelling that 100% of the aldehyde emissions are acetaldehyde.

Table 7.5 Estimated Emissions – Process Vent Scrubber

Contaminant	Predicted Emission (kg/hr)	Predicted Emissions (g/s)
Ethanol	0.46	0.128
Aldehydes[2]	0.23	0.064
Methanol	0	0

1. Carbon dioxide has not been assessed as there is no assessment criterion for this pollutant.
2. It has been assumed for the purposes of modelling that 100% of the aldehyde emissions are acetaldehyde.

7.5 ODOUR EMISSIONS

VOC emissions from the fermentation process, storage and handling of WDGS and the storage and disposal of wastewater have the potential to be odorous.

It is assumed that there will be negligible odour emissions from the DDGS stack. Previous experience at similar plants in the US, and indeed the use of incinerators or thermal oxidisers in Australia (in use at many different facilities), indicates that a VOC destruction efficiency of 98% is likely to be achieved.

7.5.1 Fermentation Process

Limited data is available as to odour emissions from ethanol plants. An odour emission rate for a CO_2 scrubber has been derived from values used by Holmes Air Sciences (2006) for an air quality assessment of a proposed 300Ml per annum ethanol plant in Coleambally, NSW. The data used in this assessment was estimated from an ethanol plant in the United States which used grain as a feedstock. It has been assumed that the odour emission rate is proportional to plant throughput, therefore the odour emission rate used by Holmes has been adjusted to reflect the smaller throughout of the proposed Condobolin facility.

The predicted odour emission rates must be adjusted to accurately simulate atmospheric dispersion of odours and the instantaneous perception of odours by the human nose. Peak-to–mean ratios, as outlined in Table 6.1 of the NSW DEC modelling guidelines (2005), vary with stability class and are applied to odour emission rates to ensure that a peak concentration of odour is able to be predicted from dispersion modelling results. These peak-to-mean ratios are presented in *Table 7.6*.

Table 7.6 ***Peak to Mean Ratios***

Source Type	Pasquill-Gifford stability class	Near-field (P/M60)	Far field (P/M60)
Area	A,B, C, D	2.5	2.3
	E, F	2.3	1.9
Line	A-F	6	6
Surface wake free point	A, B, C	12	4
	D,E,F	25	7
Tall wake free point	A, B,C	17	3
	D,E,F	35	6
Wake affected point	A-F	2.3	2.3
Volume	A-F	2.3	2.3
1. Source: NSW DEC, 2005			

For the fermentation scrubber source, the ratio for a wake affected point has been used, with far field factors. Far field factors have been used as all receptors are located outside the near field zone, which is 'typically 10 times the largest source dimension, either height or width' (NSW DEC, 2005). The near field zone can be identified as approximately 270m from the location of the fermentation scrubber.

Predicted odour emissions from the fermentation scrubber are presented in *Table 7.7.*

Table 7.7 ***Estimated Odour Emissions – Fermentation Scrubber***

Stability Class	Actual Odour Emission Rate (OU.m^3/s)	PM Ratio (far field)	Emission Rate (ou.m^3/s)
A – F	2,977	2.3	6,846

7.5.2 *Storage and Handling of WDGS*

Fugitive emissions of odour have the potential to occur from the storage and handling of WDGS. Due to the short shelf life of the product (less than a week), WDGS will be transported off-site at least weekly. On-site storage of WDGS will be provided by a concrete bunker within an enclosed shed before being either loaded via a pump and piping to trucks for transport offsite as livestock feed, or to the drier for drying to DDGS. Due to enclosure of the wet product and the limited storage time, it is not expected that WDGS will be a major source of odour.

7.5.3 *Wastewater Treatment*

A secondary anaerobic digestion treatment system will be included within the plant to facilitate reuse of the majority of wastewater within the production process. This treatment system will be fully enclosed. The treatment process will include filtration to remove solids from the waste stream, softening of the water using a zeolite softener and demineralisation.

The evaporator and distillation condensate from the ethanol plant is being reprocessed in the secondary treatment plant which incorporates an anaerobic treatment step to reduce BOD significantly. The wastewater that is not reused in the process will be stored in an effluent dam on the site. The predicted biological oxygen demand (BOD) levels of this wastewater are 33mg/L.

The effluent dam will have a capacity of approximately 40Ml and surface dimensions of approximately 200m x 200m. The inflow to the pond is estimated to be approximately 1.15Ml/day, with a balance storage of approximately 35 days.

It is anticipated that given the quality of the water being discharged to the effluent dam (following wastewater secondary anaerobic digestion treatment) with a low BOD, and the proposed size and retention time of the effluent dam, odour impacts from this source would not be expected.

The wastewater ponds will have the capacity to be fitted with aerators if wastewater monitoring indicates that the expected BOD levels are not able to be maintained. The use of aerators represents an additional mitigation measure to ensure that there are no adverse impacts at sensitive receptors.

7.6 DDGS DRYER EMISSIONS

A natural gas fired dryer will be used to reduce the moisture content of half of the WDGS, prior to being transported off site as DDGS. Emissions from this source will be directed through a 13.7m stack. Emissions of VOC's and carbon monoxide will be controlled by a thermal oxidiser, while particulate emissions will be controlled by a wet electrostatic precipitator. It has been assumed for modelling purposes that all of the VOC's being emitted as a result of the drying of WDGS are ethanol. Emissions from this source have been provided by AEL and are based on vendor specifications, engineering estimates and United States National Department of Environmental Quality (NDEQ) recommended emission factors. The major emissions associated with the dryer are presented in *Table 7.8*.

Table 7.8 Estimated Emissions – DDGS Dryer

Contaminant	Predicted Emission (kg/year)	Predicted Emission (g/sec)
Nitrogen dioxide	3,338	0.10
Ethanol	10,954	0.35
Carbon monoxide	6.8	0.00021
Sulphur dioxide	49.9	0.0016
Benzene	0.34	0.000011
Hexane	294	0.0093
PM_{10}	7,207	0.23
SO_2	50	0.0016
Acetaldehyde	16	0.0005
Formaldehyde	32	0.001
Methanol	6.4	0.0002
TSP	7,207	0.23

1. 100% of the nitrogen oxide emissions are assumed to be nitrogen dioxide.

7.7 FUGITIVE EMISSIONS

Storage and Handling of Wet Distillers Grain

Fugitive emissions of ethanol and other VOC's will occur from the storage and handling of WDGS. WDGS will only be stored for a short period of time before being dried to DDGS, or transported offsite as livestock feed.

Emissions have been estimated using NDEQ emission factors developed for a similar facility in the USA, and are presented in *Table 7.9.*

Table 7.9 Estimated Emissions – WDGS Storage and Handling

Contaminant	Emission Factor kg/tonne of WDGS	Quantity tonne of WDGS/year	Emissions	
			kg/year	g/sec
Acetaldehyde	5.545×10^{-5}	288300	15.9	0.0005
Formaldehyde	1.102×10^{-4}	288300	31.8	0.001
Methanol	2.216×10^{-5}	288300	6.4	0.0002
Ethanol	4.150×10^{-3}	288300	1,196	0.038

Fugitive Emissions from Tanks

Fugitive emissions from tanks can be categorised into working and standing losses. Working losses are defined as the combined loss from the filling and emptying of the tank. As the liquid level increases, the pressure inside the tank increases and vapours are expelled from the tank. Losses during emptying occur when air drawn into the tank becomes saturated with organic vapour and expands. Standing losses occur through the expulsion of vapour from a tank due to the vapour expansion and contraction as a result of changes in temperature and barometric pressure (NPI, 2004).

There will be four storage tanks at the Condobolin facility. These will be:

- one storage tank for the gasoline denaturant;
- one tank for ethanol product that is out of specification; and
- two ethanol product storage tanks.

All of these tanks will be vertical, fixed roof tanks. Both standing and working emissions from each tank have been estimated using the TANKS 4.09b program. This program was developed by the American Petroleum Institute to estimate air emissions from organic liquids in storage tanks. Information about the tank (dimensions, design, paint condition), the liquid contents (chemical composition) and the location of the tank (nearest town or city) are entered to generate an estimation of air emissions for that substance or mixture of substances. Estimated fugitive emissions for the tank sources are given below in *Table 7.10.*

Emissions from the gasoline storage tank have not been assessed as emissions from this single tank source are not considered to be significant.

Table 7.10 Fugitive Ethanol Losses from Tanks

Tank	Standing Losses (kg/year)	Working Losses (kg/year)	Total Losses (kg/year)	Total Losses (g/sec)
Off Spec Ethanol Storage Tank	1472	641	2112	0.067
Ethanol Storage Tanks	11,248	1578	12826	0.407

1. Emissions have been estimated using the TANKS 4.09 program.

7.8 LOADOUT FLARE

A loadout flare will be installed to control emissions from the loading of ethanol trucks. Emissions from this flare have been estimated using emission factors from the United States AP- 42 Compilation of Air Pollutant Emission Factors, Transportation and Marketing of Petroleum Liquids, 1995 and Section 13.5.2 Industrial Flares, 1995. Data used to estimate emissions was supplied by the vendor. Estimated major emissions are given in *Table 7.11* below.

Table 7.11 Estimated Emissions – Loadout Flare

Contaminant	Predicted Emission (kg/year)	Predicted Emission (g/sec)
Nitrogen dioxide	218	0.0069
Ethanol	5,010	0.159
Carbon monoxide	10,015	0.317

1. Emission estimates have been provided by AEL and estimated from US EPA AP-42.

The dispersion model does not characterise flaring due to the increased buoyancy effects of the plume. Therefore, the loadout flare plume rise has been manually calculated, so that the emission plume can be accurately represented in the dispersion model. The methodology used to calculate plume rise includes:

- calculation of the total heat release from the flare based on gas composition and flowrates;
- assumed radiation losses of 25%;
- calculation of the flame height and the buoyancy factor of the combusted gas plume from the flare stack; and
- modelling of the flare as a point source with the same buoyancy.

The calculated plume centreline height of the loadout flare is 17m. Therefore, at this height, it is anticipated that the plume has no velocity and is subject to dispersal by meteorological conditions. The flare source has been represented as a stack 17m high with a velocity of 0.1 metres per second and a diameter of 10 m.

8 *DISPERSION MODELLING ASSESSMENT*

8.1 *MODELLING METHODOLOGY*

In this assessment the dispersion model AUSPLUME v6.0 has been used to model emissions from the proposed ethanol facility operations.

The AUSPLUME model is described in Environment Protection Authority of Victoria Publication No. 264 of 1986 *"The AUSPLUME Gaussian Plume Dispersion Model"*. AUSPLUME's mathematical basis was derived from a modified version of the US Environmental Protection Agency ISC model. It is described in the Victorian EPA "*State Environment Protection Policy (Air Quality Management)*".

The NSW DEC approve this model in their guidance document *"Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW"*, 2005.

The AUSPLUME configuration files employed for the modelling have been provided for this report in electronic format.

8.2 *MODELLING PARAMETERS*

8.2.1 *Roughness Height*

The surface roughness of the area over which the plume is dispersing will affect the surface-generated turbulence and hence the vertical and, to a lesser extent, the horizontal dimensions of the plume.

Surface roughness is characterised by the term 'roughness height' and varies from zero metres over ice to one metre in pine forests or cities. The roughness height selected for the purpose of the modelling is that of rolling rural. This parameter was selected based on the fact that the proposed facility is located in an area of predominantly agricultural land. AUSPLUME allows the user to simulate this by the choice of a roughness height of 0.4m.

8.2.2 *Meteorological Data*

A meteorological data file suitable for modelling using AUSPLUME was complied by PDS Consultancy using data from an Automatic Weather Station (AWS) at Condobolin Airport. This station is located approximately 8km east of the Condobolin site and is considered representative of the meteorological conditions in the area. A further discussion of local meteorology is presented in *Section 5.1*.

8.2.3 *Terrain*

The terrain of the local area is flat to slightly undulating. Accordingly, it is not considered that terrain will influence the dispersion of pollutants from the site, and as such, terrain effects have not been included in the model. In addition, AUSPLUME cannot account for terrain effects from volume or area sources

8.2.4 *Wind Profile Exponents*

Irwin Rural wind profile exponents were utilised in the modelling. This profile is for rural regions such as Condobolin.

8.2.5 *Model Receptors*

A Cartesian grid has been set-up with the southwest corner positioned at 505082E, 63381354N and grid receptors at regularly spaced intervals of 100m, covering an area of 6km by 6km.

The discrete receptors have been chosen to represent nearby potential residences, Gum Bend Lake Recreation Reserve and site boundaries. A detailed list of discrete receptors is presented in *Table 8.1* and the locations of these receptors are shown in *Annex A, Figure 2*.

Table 8.1 Sensitive Receptor Locations

Receptor Number	Description	AMG Coordinates
1	Rural residence – west of site	506514, 6340704
2	Recreational Area – Gum Bend Lake	508918, 6339960
3	Rural Residence – east of site	508830, 6341371
4	Rural Residence – east of site	509205, 6341455
5	Rural Residence – east of site	509463, 6341394
6	Rural Residence – east of site	509611, 6341279
7	Rural Residence –north east of site	510384, 6341997
8	Rural Residence –north east of site	510759, 6341071
9	Rural Residence – east of site	511056, 6341683
10	Western Site Boundary	507375, 6340923
11	Southern Site Boundary	508139, 6340741
12	Northern Site Boundary	507845, 6341364
13	Eastern Boundary Point 1	508633, 6341625
14	Eastern Boundary Point 2	508803, 6341036

1. AMG Australian Map Coordinates

8.2.6 *Background Concentrations*

The major land use surrounding the site is rural. A discussion of background concentrations has been given in *Section 5.5*.

8.2.7 *Building Wakes*

Building wake effects are flow lines that cause a plume to be forced downwards much sooner than it would have had the building not been there. This can result in higher ground level concentrations on the leeward side of obstructions. AUSPLUME contains algorithms to determine the effects of building downwash on plume dispersion. For this assessment the PRIME algorithm was selected.

The position and dimensions of all structures in the vicinity of the source that may affect the plume dispersion have been included in the model. The AUSPLUME Building Profile Input Program (BPIP) was used to input the height and coordinates of all relevant buildings.

8.3 *MODEL INPUT DATA*

The following information was collected for the point source discharge points:

- location coordinates;
- exhaust gas velocity and temperature;
- source diameter;
- discharge height above ground level;
- dimensions of any buildings in the vicinity of the source; and
- contaminant emission rates.

The following information was collected for area and volume sources;

- source location coordinates;
- source length, width and height; and
- contaminant emission rates.

Table 8.2 – 8.5 provide summaries of the model input data used for this assessment.

Table 8.2 Model Input Data – Point Sources

Contaminant	Point Source	Height (m)	Diameter (m)	Velocity (m/s)	Temp (°C)	Source Coordinates 1 (AMG)	Source Coordinates 2 (AMG)	Emission Rate (g/s)
Benzene	Boiler	13.7	1.22	20.2	193	507922, 6341271	507929, 6341261	0.000013
Carbon monoxide	Boiler	13.7	1.22	20.2	193	507922, 6341271	507929, 6341261	0.51
PAHs	Boiler	13.7	1.22	20.2	193	507922, 6341271	507929, 6341261	0.000004
Formaldehyde	Boiler	13.7	1.22	20.2	193	507922, 6341271	507929, 6341261	0.00044
Hexane	Boiler	13.7	1.22	20.2	193	507922, 6341271	507929, 6341261	0.0107
Nitrogen dioxide	Boiler	13.7	1.22	20.2	193	507922, 6341271	507929, 6341261	0.82
PM_{10}	Boiler	13.7	1.22	20.2	193	507922, 6341271	507929, 6341261	0.044
Sulphur dioxide	Boiler	13.7	1.22	20.2	193	507922, 6341271	507929, 6341261	0.003
Toluene	Boiler	13.7	1.22	20.2	193	507922, 6341271	507929, 6341261	0.00002
TSP	Boiler	13.7	1.22	20.2	193	507922, 6341271	507929, 6341261	0.044
Acetaldehyde	Fermentation Scrubber	26.8	0.61	1	32	507924, 6341183	N/A	0.19
Ethanol	Fermentation Scrubber	26.8	0.61	1	32	507924, 6341183	N/A	0.66
Odour	Fermentation Scrubber	26.8	0.61	1	32	507924, 6341183	N/A	6,846[2]
Acetaldehyde	Process Vent Scrubber	26.8	0.61	1	32	507924, 6341183	N/A	0.064
Ethanol	Process Vent Scrubber	26.8	0.61	1	32	507924, 6341183	N/A	0.13
PM_{10}	Cooling Towers	9.1	4.57	0.95	32	507962, 6341250	507969, 6341241	0.079
TSP	Cooling Towers	9.1	4.57	0.95	32	507962, 6341250	507969, 6341241	0.079
PM_{10}	Grain Handling Dust Collector	9.1	1.07	25.3	21	507846, 6341276	N/A	0.13
TSP	Grain Handling Dust Collector	9.1	1.07	25.3	21	507846, 6341276	N/A	0.26
PM_{10}	DDGS Loadout Dust Collector	12.2	0.41	18.2	32	507837, 6341264	N/A	0.027
TSP	DDGS Loadout Dust Collector	12.2	0.41	18.2	32	507837, 6341264	N/A	0.013
PM_{10}	Milling Dust Collector	12.2	0.56	17.3	21	507848, 6341268	N/A	0.097
TSP	Milling Dust Collector	12.2	0.56	17.3	21	507848, 6341268	N/A	0.049
Ethanol (VOC)	DDGS Dryer	13.7	1.22	10	99	507815, 6341204	N/A	0.35
Sulphur Dioxide	DDGS Dryer	13.7	1.22	10	99	507815, 6341204	N/A	0.0016
Carbon monoxide	DDGS Dryer	13.7	1.22	10	99	507815, 6341204	N/A	0.00021

Contaminant	Point Source	Height (m)	Diameter (m)	Velocity (m/s)	Temp (°C)	Source Coordinates 1 (AMG)	Source Coordinates 2 (AMG)	Emission Rate (g/s)
Acetaldehyde	DDGS Dryer	13.7	1.22	10	99	507815, 6341204	N/A	0.0005
Formaldehyde	DDGS Dryer	13.7	1.22	10	99	507815, 6341204	N/A	0.001
Methanol	DDGS Dryer	13.7	1.22	10	99	507815, 6341204	N/A	0.0002
Nitrogen Dioxide	DDGS Dryer	13.7	1.22	10	99	507815, 6341204	N/A	0.11
PM_{10}	DDGS Dryer	13.7	1.22	10	99	507815, 6341204	N/A	0.23
TSP	DDGS Dryer	13.7	1.22	10	99	507815, 6341204	N/A	0.23
Hexane	DDGS Dryer	13.7	1.22	10	99	507815, 6341204	N/A	0.009
Benzene	DDGS Dryer	13.7	1.22	10	99	507815, 6341204	N/A	0.000011

1. N/A – Not applicable
2. Odour emission rate is in OUV/m^3

Table 8.3 Model Input Data – Point Sources (continued)

Contaminant	Point Source	Plume Height (m)	Plume Diameter (m)	Plume Velocity (m/s)	Temp (°C)	Source Coordinates (AMG)	Emission Rate (g/s)
Carbon monoxide	Loadout Flare	10	10	0.1	100	507716, 6341203	0.32
Nitrogen Dioxide	Loadout Flare	10	10	0.1	100	507716, 6341203	0.16
Ethanol	Loadout Flare	10	10	0.1	100	507716, 6341203	0.0069
Acetaldehyde	Loadout Flare	10	10	0.1	100	507716, 6341203	0.0000023
Methanol	Loadout Flare	10	10	0.1	100	507716, 6341203	0.0000034
Hexane	Loadout Flare	10	10	0.1	100	507716, 6341203	0.0055
Toluene	Loadout Flare	10	10	0.1	100	507716, 6341203	0.00039
Benzene	Loadout Flare	10	10	0.1	100	507716, 6341203	0.000019

Table 8.4 Model Input Data – Area Sources

Contaminant	Area Source	X length (m)	Y length (m)	Height (m)	Initial Vertical Spread (m)	Source Coordinates (SW corner)	Emission Rate (g/s/m²)
Ethanol	Wet Cake Storage	22.9	35.4	0	3	507793, 6341182	4.7×10^{-5}
Acetaldehyde	Wet Cake Storage	22.9	35.4	0	3	507793, 6341182	6.2×10^{-7}
Formaldehyde	Wet Cake Storage	22.9	35.4	0	3	507793, 6341182	1.2×10^{-6}
Methanol	Wet Cake Storage	22.9	35.4	0	3	507793, 6341182	2.5×10^{-7}

1. Scientific Notation has been used ie 6.2×10^{-4} is 0.00062

Table 8.5 Model Input Data – Volume Sources

Contaminant	Volume Source	Initial Vertical Spread (m)	Initial Horizontal Spread (m)	Height (m)	Source Coordinates (SW corner)	Emission Rate (g/s)[1]
Ethanol	Ethanol Storage Tank 1	4.9	3.4	19.8	507743, 6341183	0.41
	Ethanol Storage Tank 2	4.9	3.4	19.8	507726, 6341173	0.41
	Off Spec Ethanol Storage Tank	2.2	2.7	8.8	507742, 6341167	0.067

1. Source: Tanks 4.09b

9 *PREDICTION OF AIR QUALITY IMPACTS*

The dispersion model AUSPLUME has been used to assess air quality impacts from the proposed ethanol facility on nearby sensitive receptors. The results of this assessment are presented in *Table 9.1 to 9.4*.

The POEO standards of concentration have been calculated based on the plant design. These concentration limits are presented in *Table 9.5*.

Concentration contours are presented in *Annex D*. Due to the large number of pollutants and averaging times, a selection of concentration contours has been presented to provide an illustration of the dispersal of pollutants from the emission sources.

Table 9.1 Predicted Ground Level Concentrations, 100th Percentile

Receptor	Predicted Ground Level Concentration (µg/m³)													
	Carbon Monoxide			Nitrogen Dioxide		PM_{10}		Sulphur Dioxide				TSP
	15 min	**1 hr**	**8 hr**	**1 hr**	**Annual**	**24 hr**	**Annual**	**10 min**	**1 hour**	**24 hr**	**Annual**	**Annual**
1. Rural residence	0.015	0.013	0.0071	13	0.21	4.9	0.18	0.046	0.036	0.007	0.0011	0.26
2. Recreational area	0.011	0.010	0.0042	14	0.24	3.0	0.11	0.059	0.046	0.0064	0.00033	0.16
3. Rural residence	0.012	0.012	0.0051	19	0.57	4.1	0.42	0.053	0.040	0.0094	0.0021	0.57
4. Rural residence	0.013	0.014	0.0053	17	0.50	3.0	0.31	0.041	0.030	0.0076	0.0014	0.42
5. Rural residence	0.013	0.015	0.0067	17	0.46	3.3	0.27	0.045	0.038	0.0051	0.0012	0.37
6. Rural residence	0.013	0.011	0.0067	12	0.43	2.9	0.26	0.051	0.039	0.0061	0.0011	0.36
7. Rural residence	0.012	0.025	0.0064	35	0.35	2.1	0.16	0.030	0.021	0.0043	0.00057	0.21
8. Rural residence	0.012	0.0096	0.0051	12	0.33	2.4	0.16	0.036	0.027	0.0048	0.00056	0.22
9. Rural residence	0.011	0.019	0.0075	26	0.31	1.9	0.13	0.028	0.020	0.0033	0.00048	0.18
10. Western Site Boundary	0.012	0.019	0.0072	29	0.50	5.6	0.36	0.052	0.042	0.0092	0.0029	0.49
11. Southern Site Boundary	0.011	0.035	0.0095	57	0.77	5.5	0.33	0.14	0.13	0.023	0.0016	0.44
12. Northern Site Boundary	0.026	0.030	0.013	48	1.37	11	0.71	0.12	0.12	0.048	0.013	0.88
13. Eastern Boundary Point 1	0.013	0.015	0.0045	24	0.51	4.9	0.47	0.043	0.037	0.0062	0.0022	0.64
14. Eastern Boundary Point 2	0.012	0.0090	0.0060	10	0.58	5.5	0.39	0.088	0.078	0.013	0.0018	0.54
CRITERIA (µg/m³)	**100,000**	**30,000**	**10,000**	**246**	**62**	**50**	**30**	**712**	**570**	**228**	**60**	**90**

Table 9.2 Predicted Ground Level Concentrations – Toxic Air Pollutants, 99.9 Percentile

Receptor	Predicted ground level concentrations (mg/m³)				
	Benzene	**Cyclohexane**	**Formaldehyde**	**n-hexane**	**PAHs**
1. Rural residence	1.4×10^{-7}	1.9×10^{-6}	1.4×10^{-4}	0.00029	2.2×10^{-8}
2. Recreational area	3.2×10^{-7}	1.9×10^{-6}	7.2×10^{-5}	0.00038	4.8×10^{-8}
3. Rural residence	3.0×10^{-7}	6.9×10^{-6}	1.8×10^{-4}	0.00032	7.9×10^{-8}
4. Rural residence	2.7×10^{-7}	6.9×10^{-6}	1.1×10^{-4}	0.00028	7.1×10^{-8}
5. Rural residence	3.2×10^{-7}	6.9×10^{-6}	1.2×10^{-4}	0.00035	6.1×10^{-8}
6. Rural residence	2.6×10^{-7}	6.9×10^{-6}	1.1×10^{-4}	0.00033	3.9×10^{-8}
7. Rural residence	5.6×10^{-7}	9.0×10^{-6}	4.9×10^{-5}	0.00030	1.0×10^{-7}
8. Rural residence	2.4×10^{-7}	9.0×10^{-6}	4.8×10^{-5}	0.00027	4.1×10^{-8}
9. Rural residence	4.2×10^{-7}	7.8×10^{-6}	4.9×10^{-5}	0.00041	8.9×10^{-8}
10. Western Site Boundary	3.1×10^{-7}	7.3×10^{-6}	7.0×10^{-4}	0.00040	8.4×10^{-8}
11. Southern Site Boundary	1.2×10^{-6}	1.6×10^{-5}	4.2×10^{-4}	0.00071	1.8×10^{-7}
12. Northern Site Boundary	6.9×10^{-7}	1.1×10^{-5}	1.7×10^{-3}	0.00068	1.2×10^{-7}
13. Eastern Boundary Point 1	7.1×10^{-7}	7.5×10^{-6}	2.3×10^{-4}	0.00028	8.6×10^{-8}
14. Eastern Boundary Point 2	2.3×10^{-7}	2.7×10^{-6}	1.9×10^{-4}	0.00046	3.1×10^{-8}
Criteria (mg/m³)	**0.029**	**19**	**0.02**	**3.2**	**0.0004**

1. Scientific notation has been used ie 1.1x10-4 is equivalent to 0.00011.
2. N/A - Not applicable as odorous pollutants are assessed at sensitive receptors

Table 9.3 Predicted Ground Level Concentrations – Odorous Air Pollutants, 99.9 percentile

Receptor	Predicted ground level concentrations (mg/m³)			
	Acetaldehyde 1 hour	Ethanol 1 hour	Methanol 1 hour	Toluene 1 hour
1. Rural residence	0.011	0.091	3.9×10^{-5}	8.3×10^{-6}
2. Recreational area	0.0075	0.063	2.2×10^{-5}	7.1×10^{-6}
3. Rural residence	0.013	0.17	5.9×10^{-5}	9.2×10^{-6}
4. Rural residence	0.011	0.16	3.7×10^{-5}	8.3×10^{-6}
5. Rural residence	0.012	0.13	3.8×10^{-5}	8.9×10^{-6}
6. Rural residence	0.010	0.11	3.4×10^{-5}	7.9×10^{-6}
7. Rural residence	0.0061	0.049	1.5×10^{-5}	5.9×10^{-6}
8. Rural residence	0.0054	0.047	1.4×10^{-5}	5.5×10^{-6}
9. Rural residence	0.0053	0.05	1.5×10^{-5}	6.2×10^{-6}
10. Western Site Boundary	N/A	N/A	N/A	N/A
11. Southern Site Boundary	N/A	N/A	N/A	N/A
12. Northern Site Boundary	N/A	N/A	N/A	N/A
13. Eastern Boundary Point 1	N/A	N/A	N/A	N/A
14. Eastern Boundary Point 2	N/A	N/A	N/A	N/A
Criteria (mg/m3)	**0.042**	**2.1**	**3.0**	**0.36**

1. Scientific notation has been used ie 1.1x10-4 is equivalent to 0.00011
2 N/A - Not applicable as odorous pollutants are assessed at sensitive receptors

Table 9.4 Predicted Ground Level Concentrations – Odour, 99.9 percentile

Receptor	Predicted ground level concentrations (OU)
1. Rural residence	0.15
2. Recreational area	0.18
3. Rural residence	0.53
4. Rural residence	0.31
5. Rural residence	0.30
6. Rural residence	0.33
7. Rural residence	0.11
8. Rural residence	0.12
9. Rural residence	0.13
10. Western Site Boundary	N/A
11. Southern Site Boundary	N/A
12. Northern Site Boundary	N/A
13. Eastern Boundary Point 1	N/A
14. Eastern Boundary Point 2	N/A
CRITERIA (OU)	**2.0**

Table 9.5 POEO Regulation – Standards of Concentration

Pollutant	Source	Emission Rate (g/s)	Emission Concentration - Actual (mg/m³)	Emission Concentration – Normal (mg/m³)[5]	Regulation Limit
Solid Particles (TSP)	Dust Collector – Grain Handling	0.26	11	15[1]	50 mg/m³
	Dust Collector – DDGS Loadout	0.027	11	15[1]	
	Dust Collector - Milling	0.097	23	27[1]	
	DDGS Dryer	0.23	6.1	22[2]	50 mg/m³
	Boiler 1	0.044	1.9	3.6	50 mg/m³
	Boiler 2	0.044	1.9	3.6	
Nitrogen Dioxide	Boiler -1	0.82	35	66	350 mg/m³
	Boiler -2	0.82	35	66	
	DDGS Dryer	0.11	2.8	10[2]	350 mg/m³
VOCs	Boiler - 1	0.031	1.3	2.6	40 mg/m³
	Boiler - 2	0.031	1.3	2.6	
	DDGS Dryer	0.35	9.1	33[2]	40 mg/m³
	Fermentation Scrubber	0.85	15	33[4]	40 mg/m³
	Process Vent Scrubber	0.19	2.2	5[4]	
Carbon monoxide	Boiler -1	0.51	21	41	125 mg/m³
	Boiler -2	0.51	21	41	
	DDGS Dryer	0.0002	0.057	0.02[2]	125 mg/m³

1. This has been based on an assumption of 15% moisture (from US EPA AP42 Compilation of Emission Factors Grain Processes and Elevators).
2. This has been based on an assumed gas moisture content of 65%.
3. This has been based on an assumed gas moisture content of 17% (typical measured gas moisture for boiler emissions)
4. This has been based on an assumed gas moisture content of 50% (a typical gas moisture of effluent gas at an ethanol facility - Minnesota Pollution Control Agency Environmental Bulletin 2006).
5. In all cases gas pressure has been assumed as ambient.

10 DISCUSSION AND CONCLUSIONS

10.1 SUMMARY OF RESULTS

The air emissions from all emission sources at the Condobolin facility have been assessed, with plume dispersion modelling undertaken in accordance with regulatory requirements to predict ground level concentrations at the site boundary and nearby sensitive landuses.

A summary of dispersion modelling results (predicted ground level concentrations) for the relevant receptors identified as experiencing the highest concentration of each contaminant is presented in *Table 10.1* below.

Table 10.1 *Summary of Results*

Pollutant	Averaging Time	Maximum Concentration	Receptor	Criteria	% of Criteria
Carbon monoxide	15 minutes	0.026 µg/m³	12. Northern Boundary	100,000 µg/m³	0.00002%
	1 hour	0.035 µg/m³	11. Southern Boundary	30,000 µg/m³	0.00011 %
	8 hours	0.013 µg/m³	12. Northern Boundary	10,000 µg/m³	0.00013 %
Nitrogen Dioxide	1 hour	57 µg/m³	11. Southern Boundary	246 µg/m³	23%
	Annual	1.4 µg/m³	12. Northern Boundary	62 µg/m³	2.3%
PM_{10}	24 hour	11µg/m³	12. Northern Boundary	50 µg/m³	22%
	Annual	0.71 µg/m³	12. Northern Boundary	30 µg/m³	2.4 %
Sulphur Dioxide	10 minutes	0.14 µg/m³	12. Northern Boundary	712 µg/m³	0.019%
	1 hour	0.13 µg/m³	12. Northern Boundary	570 µg/m³	0.023%
	24 hours	0.048 µg/m³	12. Northern Boundary	228 µg/m³	0.021%
	Annual	0.013 µg/m³	12. Northern Boundary	60 µg/m³	0.022 %
TSP - Annual	Annual	0.88 µg/m³	12. Northern Boundary	90 µg/m³	0.98%
Benzene	1 hour	1.2×10^{-6} mg/m³	11. Southern Boundary	0.029 mg/m³	0.0041%
Formaldehyde	1 hour	1.7×10^{-3} mg/m³	12. Northern Boundary	0.02 mg/m³	8.5%
n-Hexane	1 hour	0.00071 mg/m³	11. Southern Boundary	3.2 mg/m³	0.022%
PAH	1 hour	1.8×10^{-7}	11. Southern Boundary	0.0004 mg/m³	0.05%
Acetaldehyde	1 hour	0.013 mg/m³	3. Rural Residence	0.042 mg/m³	31%
Ethanol	1 hour	0.17 mg/m³	3. Rural Residence	2.1 mg/m³	8.1%
Methanol	1 hour	5.9×10^{-5} mg/m³	3. Rural Residence	3.0 mg/m³	0.0019%
Toluene	1 hour	9.2×10^{-6} mg/m³	3. Rural Residence	0.36 mg/m³	0.0020%
Cyclohexane	1 hour	1.6×10^{-5} mg/m³	11. Southern Boundary	19 mg/ m³	0.00008 %
Odour	1 hour	0.53 OU	3. Rural Residence	2.0 OU	18%

10.1.1 *Toxic Air Pollutants*

Results of the dispersion modelling indicate that predicted 99.9 percentile ground level concentrations at the site boundary and sensitive receptors are well below the relevant NSW DEC criteria.

10.1.2 *Odorous Air Pollutants*

Results of the dispersion modelling indicate that predicted 99.9^{th} percentile ground level concentrations at all sensitive receptors are below the NSW DEC criteria at all sensitive receptors.

10.1.3 *Odour*

Odour modelling has indicated that predicted 99.9 percentile ground level concentrations of odour are below the NSW DEC criteria of 2.0 odour units at sensitive receptors.

10.1.4 *Other Pollutants*

Dispersion modelling has indicated that predicted ground level concentrations for carbon monoxide, total suspended particulates (TSP), particulate matter less than 10 micron (PM_{10}), nitrogen dioxide and sulphur dioxide are below the relevant NSW DEC criteria.

10.1.5 *POEO Regulation - Standards of Concentration*

Concentrations of contaminants emitted from the proposed emission points were calculated and all contaminants from all relevant sources were below the POEO Regulation standards of concentration. The standards of concentration have been calculated based on conservative emission estimations, design specifications and assumptions as to stack parameters. These values should be treated as indicative only and actual values will be confirmed by stack testing of the relevant emission points on commissioning. The results of this testing will provide actual values of concentration which will be assessed against the POEO standards of concentration to ensure compliance and set emission limits which can be maintained on an ongoing basis.

10.2 DISCUSSION

10.2.1 *Mitigation Measures*

A number of mitigation measures are proposed to ensure that air emissions as a result of the ethanol facility do not have an adverse effect on nearby areas. These measures are briefly discussed in the following sections.

Odour Minimisation

Odour emissions from the process will be minimised by the use of wet scrubbing technology, as discussed below, and by enclosing potential odour sources such as WDGS storage. Regular water quality monitoring of the wastewater stored onsite will take place to ensure that BOD levels are kept at a low level, thus reducing the risk of odorous emissions. If BOD levels are not able to be kept at a low level with the current wastewater treatment, an aerator may be installed in the effluent dam.

The facility will comply with the legislative requirement to not cause or permit the emissions of any offensive odour from the premises (Section 129 of the POEO Act). An odour management plan will be implemented, potentially as part of the Operational Environmental Management Plan to be developed for the facility, and will include a contact number for nearby residents to notify the facility if an offensive odour is detected.

Dust Minimisation

Dust minimisation measures to be employed at the site include;

- paving all access roads, the car park and heavy vehicle standing area and most exposed surfaces on-site;
- watering paved roads when necessary;
- covering all truck loads to reduce windblown dust and spillage;
- all grain storage piles will be covered by tarpaulin to reduce wind blown dust emissions;
- maintenance of dust extraction and filtration systems at grain unloading areas;
- maintenance of dust extraction and filtration systems at grain storage silos; and
- maintenance of fabric filter dust collection systems at grain screening and milling operations and DDGS loadout.

Pollution Control Equipment

A number of pollution control systems are proposed at the Condobolin facility to ensure that emissions to air are minimised as far as possible. A brief outline of the proposed technologies is given below.

Dust Collectors

Plant design includes the installation of fabric filters to control particulate emissions from grain handling, milling and DDGS loadout. The dust bearing gas is passed through fabric in such a manner that the dust particles are retained on the 'dirty' gas side of the fabric, while the clean air passes through the fabric to the clean gas side, where it is exhausted to atmosphere. A cleaning method such as shaking or pulsing is used to clean the dirty fabric, with the dust cake generally falling into a collection device below the bag, from where it can be removed.

Wet Scrubbers

Wet scrubbers will be installed on the fermentation plant to remove carbon dioxide and VOCs emissions from the fermentation process. The basic process of wet scrubbing involves the contacting of a polluted gas stream with a scrubbing liquid. The liquid absorbs the pollutants from the gas stream, thus allowing discharge to the atmosphere of the clean (scrubbed) gas. The scrubbing liquid may be water, a chemical solution, or both.

Paved Roads/Watering of exposed surfaces

All haul routes and most exposed surfaces on the site will be paved to reduce the generation of dust from vehicles and wind erosion. Paved roads will be watered when necessary to further reduce dust emissions.

Thermal Oxidiser

VOC and CO emissions will be controlled from the DDGS Dryer by the installation of a thermal oxidiser (TO). Thermal oxidisers are a system of fans, heat exchangers and burners that remove pollutants from gaseous waste streams by burning or oxidising them.

10.2.2 *Maintenance of Pollution Control Equipment*

Regular maintenance of pollution control equipment is critical to ensure the system is functioning at optimal performance and achieving maximum capture/removal efficiencies. For this purpose, it will be necessary to provide sampling points and easy access points to the equipment when it is installed and a full set of operating conditions and parameters recorded at start up, or while the unit is clean.

To ensure this occurs a maintenance schedule which sets out weekly, monthly and annual checks will be documented and implemented for all pollution control equipment on the site, as part of an *Operational Environmental Management Plan*. These checks should include, but not be limited to:

- visual checks for leaks, damage or corrosion;
- tests to ensure the proper airflow is being maintained in the case of dust collectors;
- checks to ensure the cleaning system is working adequately and the dust collector filter bags are not overloaded; and
- liquid flow tests, pressure and temperature tests for wet scrubbers.

REFERENCES

C.J Schneider Engineering Co (2006) *Air Permit Application Amendment for Australian Ethanol.*

EPA Victoria, (1986), Publication No. 264 "The AUSPLUME Gaussian Plume Dispersion Model", Victorian Government Printer.

Holmes Air Sciences (2006) 'Air Quality Assessment Report, Coleambally Ethanol Plant and Intensive Dairy.

NSW DEC, (2005) "Approved Methods and Guidance: For the Modelling and Assessment of Air Pollutants in New South Wales" NSW DEC.

NSW DEC, (2006a) "Draft Policy: Assessment and Management of Odour from Stationary Sources in New South Wales" NSW DEC.

NSW DEC, (2006b) "Technical Notes – Draft Policy: Assessment and Management of Odour from Stationary Sources in New South Wales" NSW DEC.

NSW DEC (2004) Quarterly Air Quality Monitoring Reports - Quarter 1, Quarter 2, Quarter 3 and Quarter 4 (2004)

NSW Minerals Council (2000) *Technical Paper, Particulate Matter and Mining Interim Report*

National Pollution Inventory website, www.npi.gov.au, Commonwealth of Australia.

National Pollutant Inventory (2001) *Emission Estimation Technique Manual for Mining* Version 2.3, December 2001.

National Pollutant Inventory (2001) *Combustion in Boilers Emission Estimation Tool.*

National Pollutant Inventory (2004) *Tanks and Organic Liquid Storage,* October 2004.

US EPA (2003) *Grain Elevators and Processes*, Chapter 9.1.1 of the Compilation of Air Pollutant Emission Factors AP-42 Fourth Edition, United States Environmental Protection Agency.

US EPA (1996) *Liquified Petroleum Gas Combustion*, Chapter 1.5 of the Compilation of Air Pollutant Emission Factors AP-42 Fourth Edition, United States Environmental Protection Agency

Annex A

Figures

Legend

Site Boundary

Figure 1

Site Location

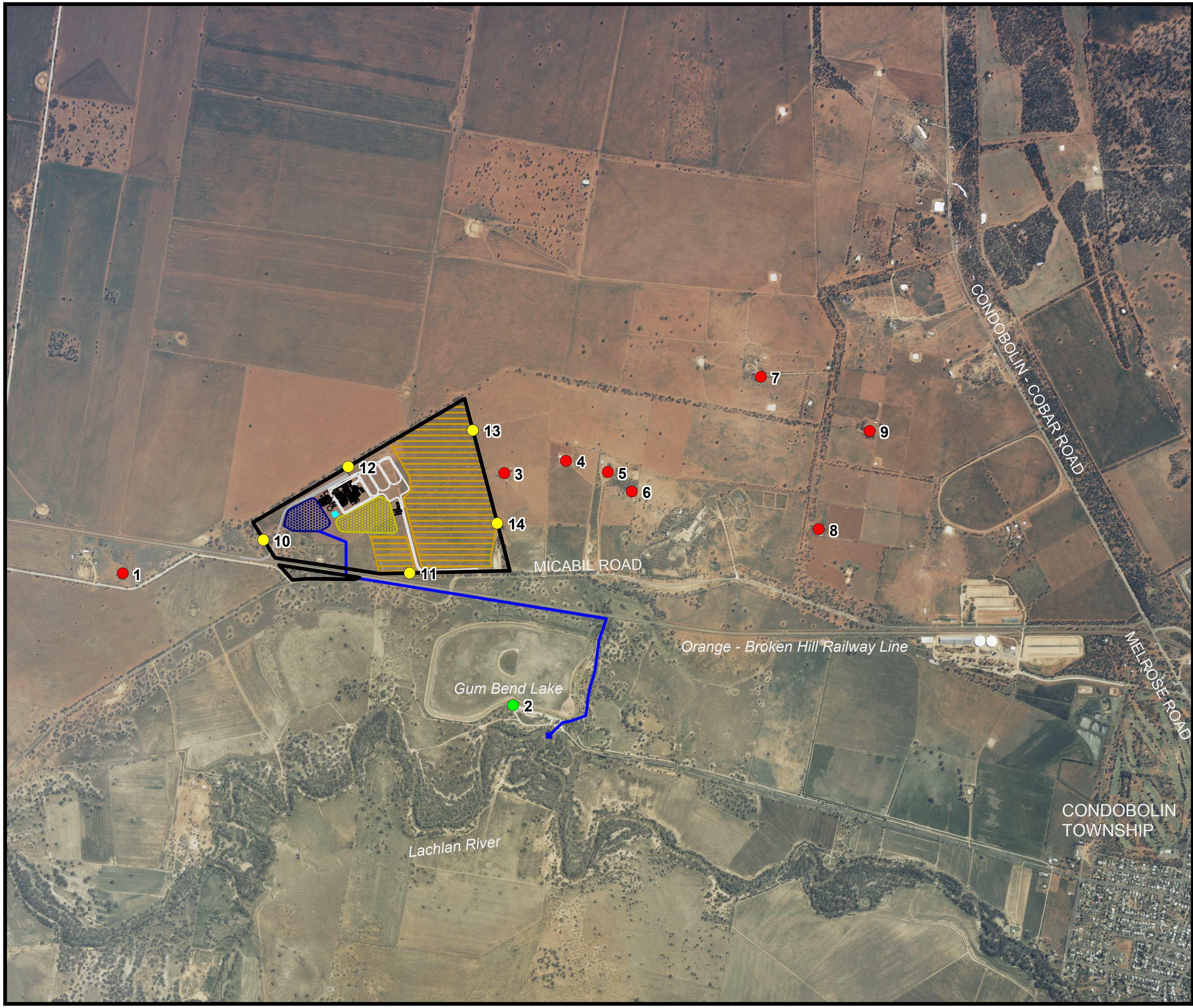
Client:	Agri Energy Limited
Project:	Condobolin Ethanol Production Facility
Drawing No:	0056132_CN_AQ_02
Date:	16.02.2007 Drawing Size: A4
Drawn By:	ML Reviewed By: -
Source:	Department of Lands NSW
Scale:	Refer to Scale Bar

N

0 500 1000m

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM



Legend

- 200Ml Raw Water Dam
- 2Ml Stormwater Dam
- 40Ml Effluent Dam
- Irrigation Area
- Water Pump Station (existing) & Pipeline
- Site Boundary
- Internal Access Road
- Future Rail Siding
- Recreational
- Residence - occupied
- Site Boundary

Figure 2

Proposed Site Layout and Sensitive Receptor Locations

Client:	Agri Energy Limited
Project:	Condobolin Ethanol Production Facility
Drawing No:	0056132_AQ_GIS01
Date:	19.02.2007 — Drawing Size: A4
Drawn By:	DH — Reviewed By: -
Source:	Aerial: Department of Lands NSW Plant Layout: PDF DWG No: M06075-0311
Scale:	Refer to Scale Bar

N

0 500 1000m

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ERM

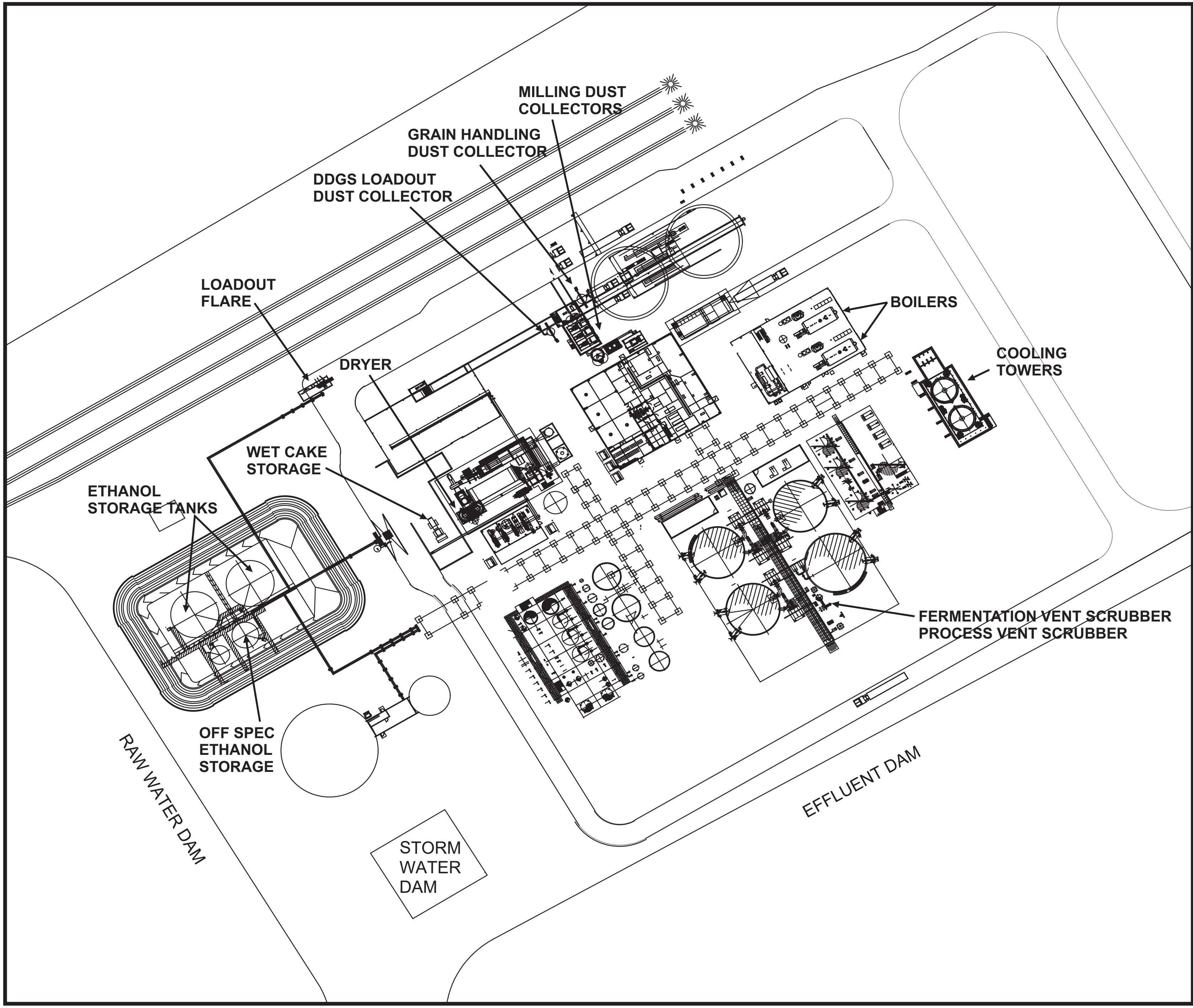

Figure 3

Emission Points

Client:	Agri Energy Limited		
Project:	Condobolin Ethanol Production Facility		
Drawing No:	0056132_CN_AQ_01		
Date:	08.02.2007	Drawing Size:	A4
Drawn By:	ML	Reviewed By:	-
Source:	Plant Design: PDF DWG No: M06075-0311		
Scale:	Refer to Scale Bar		

N

0 30 60m

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ERM

Annex B

Meteorological File Development

pDs **MultiMedia & Consultancy Service**

AUSPLUME MetFile

Input Meteorological Data file for Condobolin (NSW)

Exclusively prepared

for

ERM, Australia.

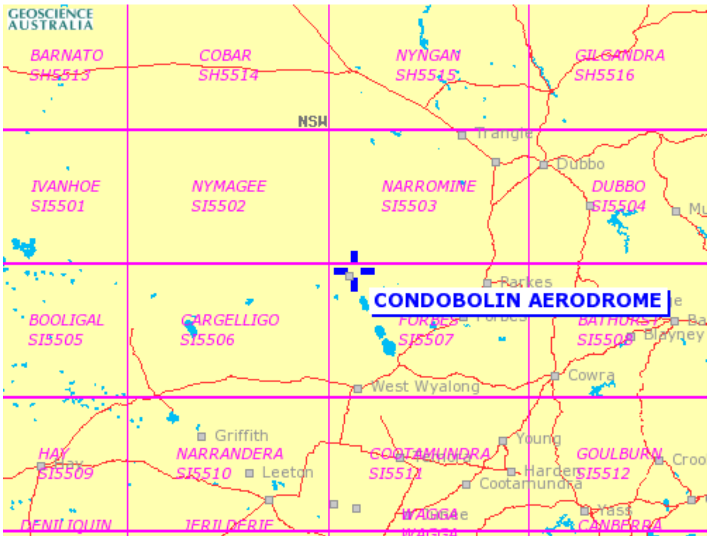
By

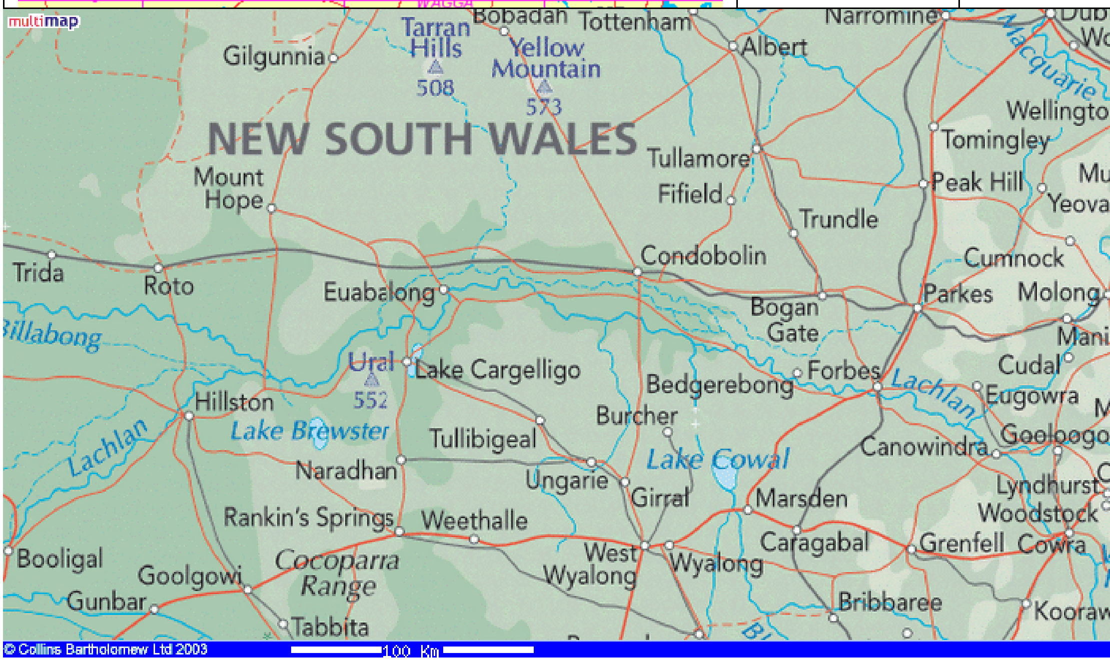
pDs Consultancy

MultiMedia & Consultancy

AUSPLUME input Meteorological Data File for Condobolin (NSW)

Condobolin-New South Wales, Australia

	LATITUDE:	-33.07 S
	LONGITUDE:	147.21 E
	EASTING:	519000
	NORTHING:	6341000



pDs Consultancy

metfile@tpg.com.au

Data Source

1. Condobolin Airport AWS Data- BoM, NSW (Regional Office).

-

2. WagaWaga Cloud data and Vertical temperature Profiles –National Climate Centre- Bureau of Meteorology, Melbourne.

Land use category: Urban
Surface Roughness: **0.3 m**
Anemometre Height **:10m**

Input Information

- Onsite (**Condobolin**) parameters

    a. Wind speed (km/h)
    b. Wind direction
    c. Ambient Temperature (C)
    d. Dew point
    e. Surface Pressure

    Wind was measured at 10m (Anemometer Height), surface roughness assumed to be 0.3m

Offsite

- **WagaWaga (NSW)**

    Cloud cover (Total amount)

- **WagaWaga (NSW)**

    a. Vertical temperature profiles; Temperature, Dewpoint (1 profile per day)

DATA Processing

Mandatory data such as wind direction; speed and ambient temperature were obtained from NSW regional office of the Bureau of Meteorology

QA/QC on Raw data

This data set was treated as follows

- Incomplete days removed
- Suspected wind stalls (both wind direction and speed) carefully examined interpolation done following a very conservative way where necessary.
- Wind Speed converted to m/s from km/h (The speed was recorded for the nearest km/h).
- Wind Direction found to be recorded in 10-degree resolution. The last digit of the wind direction has been randomised to meet air quality standard.
- Temperature and Dewpoint were checked for unusual values
- Pressure and cloud amount were checked for unusual values

WagaWaga (BoM) Vertical Temperature Profiles

- Gaps in vertical temperature profiles were filled with previous or following day data for the completeness.

99% data recovered for 2004.

Important Notes:

1. Sensitivity of Anemometers (not known) may not be up to air quality standard.
2. Zero wind speed is allowed, which may not be acceptable to older versions of AUSPLUME.

Standard Analysis

Data Coverage

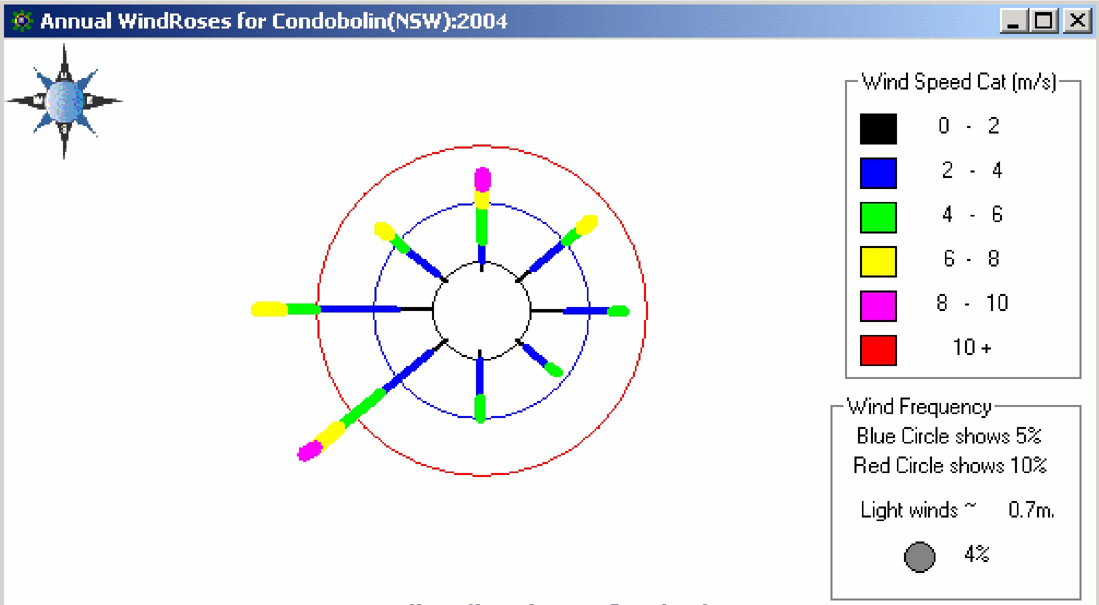
Summer	:89	days
Autumn	:92	
Winter	:92	
Spring	:91	
Number of days covered :364	% Coverage :99.5%	

All 4 seasons are well represented.

Stability Distribution

Stability Category	% Distribution	Avg Wind Speed	Avg Temperature	Avg Mixing Height
A	1	1.9	24.3	1118
B	7	3.2	23.1	1321
C	12	4.3	21.2	1359
D	40	5.5	18.1	1335
E	14	3.4	15.9	796
F	25	1.7	12.5	422

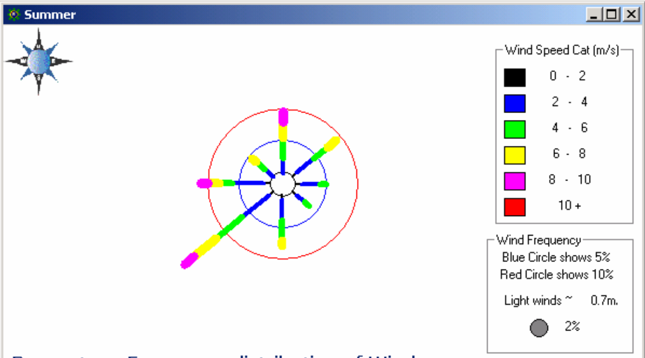
Annual Wind Roses



Percentage Frequency distribution of Winds

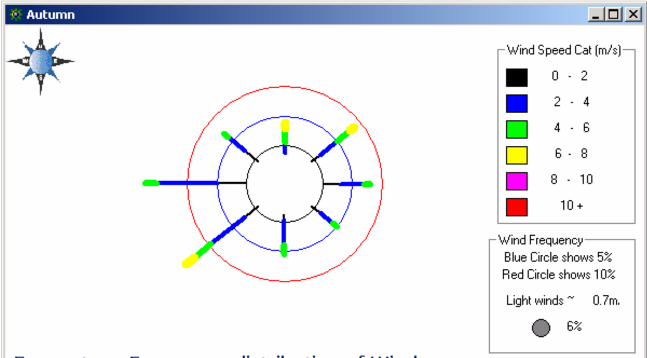
Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	2.3	3.5	1.9	1.4	2.2	3.9	1.9	1.1	**18%**
2 - 4	4.8	4.7	3.4	5.0	6.5	7.8	4.3	2.7	**39%**
4 - 6	3.0	1.2	1.6	2.8	5.2	3.3	2.3	4.4	**24%**
6 - 8	1.2	0.5	0.4	0.8	3.5	2.1	1.3	3.0	**13%**
8 - 10	0.2	0.0	0.1	0.2	1.3	0.9	0.4	1.5	**5%**
10 +	0.0	0.0	0.0	0.1	0.4	0.4	0.2	0.5	**2%**
Total Dir Freq	**12%**	**10%**	**7%**	**10%**	**19%**	**18%**	**10%**	**13%**	

Seasonal Wind Roses



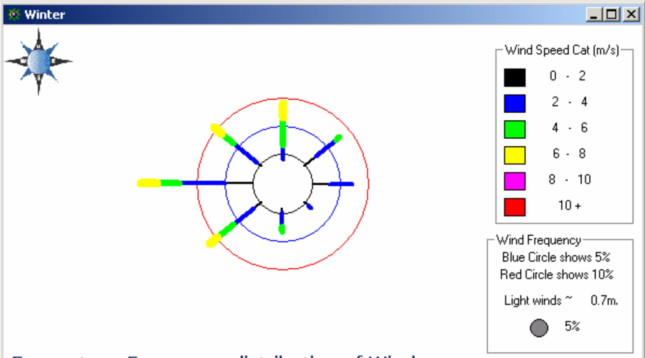
Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	1.8	1.3	1.3	1.3	1.4	1.4	0.9	0.9	10%
2 - 4	4.8	3.2	2.9	4.8	6.6	5.3	2.7	3.4	34%
4 - 6	3.9	1.6	1.8	4.4	6.4	3.0	2.2	4.3	28%
6 - 8	2.2	0.7	0.9	1.6	5.7	2.3	1.4	3.6	18%
8 - 10	0.4	0.1	0.0	0.5	2.8	1.2	0.3	2.4	8%
10 +	0.0	0.0	0.0	0.1	0.7	0.4	0.1	0.7	2%
Total Dir Freq	13%	7%	7%	13%	24%	14%	8%	15%	



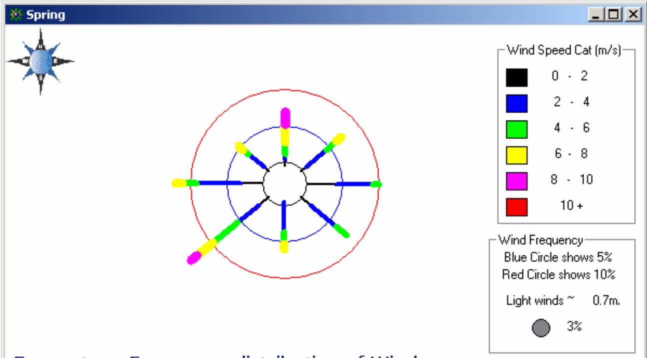
Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	2.4	3.8	2.1	2.0	3.1	5.7	3.6	1.0	24%
2 - 4	4.1	4.9	3.0	5.8	9.0	10.9	4.7	2.6	45%
4 - 6	3.9	1.4	1.7	2.5	4.9	2.9	1.0	3.4	22%
6 - 8	1.1	0.7	0.1	0.1	2.4	0.9	0.3	1.4	7%
8 - 10	0.1	0.0	0.0	0.0	0.5	0.5	0.2	0.6	2%
10 +	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	%
Total Dir Freq	12%	11%	7%	11%	20%	21%	10%	9%	



Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	3.1	3.8	2.0	1.4	2.1	5.1	1.9	1.0	20%
2 - 4	5.3	4.7	1.9	3.7	5.3	9.0	6.7	3.0	40%
4 - 6	1.5	0.4	0.2	1.4	4.0	4.7	3.9	6.8	23%
6 - 8	0.6	0.2	0.0	0.4	2.2	3.6	2.4	3.7	13%
8 - 10	0.0	0.0	0.0	0.0	0.4	1.0	0.7	0.7	3%
10 +	0.0	0.0	0.0	0.0	0.1	0.5	0.1	0.6	1%
Total Dir Freq	11%	9%	4%	7%	14%	24%	16%	16%	



Percentage Frequency distribution of Winds

Speed Cat/Dir	NE	E	SE	S	SW	W	NW	N	Total Speed Freq
0 - 2	1.8	5.0	2.0	1.0	2.0	3.3	1.2	1.4	18%
2 - 4	4.9	5.8	5.7	5.5	4.9	6.1	3.1	2.0	38%
4 - 6	2.6	1.4	2.7	2.8	5.7	2.7	1.9	2.9	23%
6 - 8	1.0	0.3	0.7	1.0	3.7	1.6	1.3	3.3	13%
8 - 10	0.3	0.1	0.2	0.3	1.6	1.0	0.4	2.2	6%
10 +	0.0	0.0	0.0	0.2	0.6	0.7	0.7	0.5	3%
Total Dir Freq	11%	13%	11%	11%	18%	15%	9%	12%	

Secondary parameters

Vertical Stability

Solar Radiation for daytime and Modified Pasquill Stability Class outlined in the reference, Davis and Singh, Jl of Hazardous Materials, 11 was used to determine night-time stability class. Solar radiation was theoretically calculated using off site cloud observations.

Table 1 for daytime and part of Table 2 for night-time were used.

Table 1: Stability Classification for Daytime Using Solar Radiation and Wind Speed

	Solar Radiation (W/m^2)			
Wind Speed(m/s)	≥925	≥675	≥175	< 175
< 2	A	A	B	D
< 3	A	B	C	D
< 5	B	B	C	D
< 6	C	C	D	D
≥ 6	C	D	D	D

Note: Calculated Global Exposure (TSR) was used.

Table 2: Modified Pasquill stability calsses

Surface Wind Speed m/s at 10m	Daytime incoming solar radiation				Within 1 h before sunset or after sunrise	Night-time cloud amount(Oktas)		
	Strong (>600)	Moderate (300-600)	Slight (<300)	Overcast		0-3	4-7	8
≤ 2	A	A-B	B	C	D	F	F	D
≤ 3	A-B	B	C	C	D	F	E	D
≤ 5	B	B-C	C	C	D	E	D	D
≤ 6	C	C-D	D	D	D	D	D	D
> 6	C	D	D	D	D	D	D	D

Mixing height

Definition:

The mixing height, the depth of the surface mixed layer is the height of the atmosphere above the ground, which is well mixed due either to mechanical turbulence or convective turbulence. The air layer above this height is stable.

The mixing height was determined by using the methodology of Benkley and Schulman (Journal of Applied Meteorology, Volume 18, 1979,pp 772-780). **WagaWaga** upper air observation containing temperature and moisture profiles were used to determine daytime mixing height.

Surface wind speeds and roughness are used to calculate the depth of the mechanically forced boundary layer during the night time

$MixH_m = 0.185 * Ustar / Cterm$

Where $Ustar = .35 * Usfc / Ln\ (Ht_{anemo} / Z_0)$

$Cterm$ = Coriolis Term $= 2\ \Omega\ Sin(\phi)$

Where Ω is the angular velocity of the earth
ϕ is the latitude

Ht_{anemo} = Anemometer Height, Z_0 is the roughness

Height of the convective boundary layer was determined using daytime temperature sounding (Vertical temperature and dewpoint profiles) in between sunrise and sunset. Larger value of the mechanical turbulence or convective turbulence was taken as Mixing height for the daylight hours.

Statistics of Condobolin (NSW) input Meteorological data file-2004

Stability	Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
A	Max of Temp	40.0	38.0	29.0	28.0	15.0		13.0	21.0	24.0	28.0	37.0	31.0	40.0
	Min of Temp	22.0	24.0	18.0	17.0	14.0		13.0	11.0	8.0	16.0	21.0	23.0	8.0
	Average of Temp	30.4	33.1	23.9	21.0	14.5		13.0	15.8	16.3	21.1	28.7	27.1	24.3
	Max of WS	2.5	2.5	2.5	1.4	1.4		1.4	1.4	2.5	2.5	2.5	2.5	2.5
	Min of WS	1.1	2.2	0.6	0.6	0.6		1.4	0.6	1.1	0.6	1.1	1.4	0.6
	Average of WS	2.1	2.3	1.7	1.1	1.0		1.4	1.2	1.7	2.2	2.1	2.1	1.9
	Max of MixH	1923	2230	1689	1506	615		872	1043	1602	2034	2268	1862	2268
	Min of MixH	256	855	360	422	500		872	555	273	411	858	644	256
	Average of MixH	1193	1485	942	854	558		872	784	798	983	1650	1389	1118
B	Max of Temp	41.0	41.0	33.0	28.0	18.0	10.0	16.0	24.0	26.0	33.0	39.0	36.0	41.0
	Min of Temp	19.0	18.0	17.0	12.0	8.0	5.0	2.0	7.0	3.0	12.0	13.0	20.0	2.0
	Average of Temp	30.1	32.2	26.0	21.5	13.9	7.3	9.1	14.7	15.9	22.0	24.5	28.0	23.1
	Max of WS	4.7	4.7	4.7	4.7	4.7	1.4	3.1	4.7	4.7	4.7	4.7	4.7	4.7
	Min of WS	1.1	2.2	1.1	0.6	0.6	1.1	0.6	0.6	0.6	1.1	1.4	1.4	0.6
	Average of WS	3.8	4.0	3.4	3.0	2.2	1.3	1.3	2.8	2.8	3.5	3.7	3.7	3.2
	Max of MixH	2732	2825	2792	2670	1307	947	1160	1922	2170	2698	2574	2676	2825
	Min of MixH	564	756	327	233	238	275	150	314	183	564	582	646	150
	Average of MixH	1663	1400	1409	1152	699	492	586	954	1031	1496	1649	1641	1321
C	Max of Temp	43.0	43.0	34.0	33.0	22.0	19.0	18.0	23.0	28.0	33.0	39.0	38.0	43.0
	Min of Temp	17.0	17.0	15.0	11.0	6.0	6.0	5.0	6.0	6.0	14.0	13.0	15.0	5.0
	Average of Temp	28.0	31.8	26.3	23.4	14.9	12.4	11.3	13.6	17.2	22.6	25.2	26.7	21.2
	Max of WS	12.2	9.7	7.2	5.8	5.8	5.8	5.8	5.8	7.8	8.6	10.3	12.8	12.8
	Min of WS	1.4	2.2	2.2	2.2	1.1	1.1	1.1	2.2	0.6	2.2	2.2	2.2	0.6
	Average of WS	5.4	5.1	3.9	3.6	3.5	3.7	3.4	3.6	3.5	5.1	4.6	5.5	4.3
	Max of MixH	2780	2879	2319	2763	1812	1766	1738	2029	2405	2963	2931	2797	2963
	Min of MixH	709	675	465	419	448	390	320	529	319	483	407	680	319
	Average of MixH	1636	1637	1473	1279	925	900	916	1013	1265	1769	1762	1625	1359
D	Max of Temp	43.0	43.0	34.0	33.0	22.0	20.0	18.0	25.0	33.0	36.0	43.0	39.0	43.0
	Min of Temp	12.0	15.0	9.0	3.0	0.0	0.0	-3.0	-2.0	-1.0	7.0	7.0	10.0	-3.0
	Average of Temp	25.4	27.8	23.0	18.7	13.5	11.0	9.7	11.8	14.9	18.8	22.3	23.8	18.1
	Max of WS	13.3	11.4	10.3	11.7	10.3	10.3	10.8	13.3	11.7	13.9	14.4	13.9	14.4
	Min of WS	0.6	0.6	0.6	0.6	0.6	1.1	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Average of WS	6.2	6.0	4.9	4.6	4.6	5.0	4.4	5.7	5.2	6.0	6.3	6.5	5.5
	Max of MixH	2940	2793	2605	2445	2262	2326	2274	3094	2430	3070	2989	3035	3094
	Min of MixH	256	301	227	140	140	256	140	186	140	279	186	233	140
	Average of MixH	1569	1466	1242	1115	1078	1152	1011	1340	1267	1491	1576	1602	1335
E	Max of Temp	38.0	38.0	32.0	32.0	21.0	17.0	17.0	22.0	24.0	29.0	35.0	32.0	38.0
	Min of Temp	13.0	14.0	14.0	5.0	0.0	3.0	0.0	0.0	0.0	8.0	9.0	11.0	0.0
	Average of Temp	22.5	22.7	21.3	18.6	11.0	10.0	8.2	9.2	11.9	15.4	19.0	20.1	15.9
	Max of WS	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
	Min of WS	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2

	Average of WS	3.6	3.4	3.7	3.3	3.4	3.4	3.0	3.2	3.2	3.5	3.8	3.7	3.4
	Max of MixH	1303	1256	1279	1175	1128	1175	1146	1111	1192	1175	1564	1256	1564
	Min of MixH	465	465	483	372	419	419	419	355	372	372	355	500	355
	Average of MixH	834	802	858	748	767	798	702	741	743	805	892	862	796
F	Max of Temp	33.0	37.0	31.0	31.0	20.0	14.0	14.0	22.0	25.0	26.0	30.0	34.0	37.0
	Min of Temp	11.0	13.0	10.0	3.0	0.0	0.0	-3.0	-1.0	1.0	3.0	6.0	11.0	-3.0
	Average of Temp	20.5	23.5	18.2	13.4	7.4	6.4	5.1	6.7	8.7	12.2	16.4	20.2	12.5
	Max of WS	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Min of WS	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Average of WS	1.9	1.7	1.6	1.6	1.7	1.7	1.6	1.7	1.7	1.7	1.8	2.0	1.7
	Max of MixH	855	919	872	919	744	826	791	773	663	744	890	1064	1064
	Min of MixH	140	140	140	140	140	140	140	140	140	140	140	186	140
	Average of MixH	469	428	409	401	407	425	382	431	417	417	446	511	422

Disclaimer

Compilation of input meteorological data file for AUSPLUME was done under the supervision of qualified and experienced meteorologists. Although all due care has been taken, we cannot give any warranty, nor accept any liability (except that required by law) in relation to the information given, its completeness or its applicability to a particular problem. These data and other material are supplied on the condition that you agree to indemnify us and hold us harmless from and against all liability, losses, claims, proceedings, damages, costs and expenses, directly or indirectly relating to, or arising from the use of or reliance on the data and material which we have supplied.

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Bibliography

Benkley, C.W,& Schulman L.L 1979 :Estimating Hourly Mixing Depths from Historical Meteorological Data :Jl of Applied Meteorology Vol 1 page 772-780

Dewundege, P.,2002, Comparison of Some Feasible Schemes For Atmospheric Stability Determination: A Case Study. *Proceedings of the 15th International Clean Air and Environment Conference, Christchurch, NZ, 2002*, Clean Air Society of Australia & New Zealand

Lorimer, G.S and Godfrey, J.J 1998, Plume Models: Techniques for better usage. *Proceedings of the 13th International Clean Air and Environment Conference, Adelaide, 1996*, Clean Air Society of Australia & New Zealand, pp 507-512

Mohan, M and Siddiqi, T. A. 1998, Analysis of various schemes for the estimation of atmospheric stability classification*. Atmospheric Environment* ***Vol 32****, No. 21, pp. 3775-3781*

Turner, D.B. 1970, Workbook of atmospheric dispersion estimates, Office of Air Program Pub. No. AP-26, EPA,USA

USEPA, 2000, *Meteorological Monitoring Guidance for Regulatory Modelling Applications*, EPA-450/R-99-005. United States Environmental Protection Agency, Washington DC, USA.

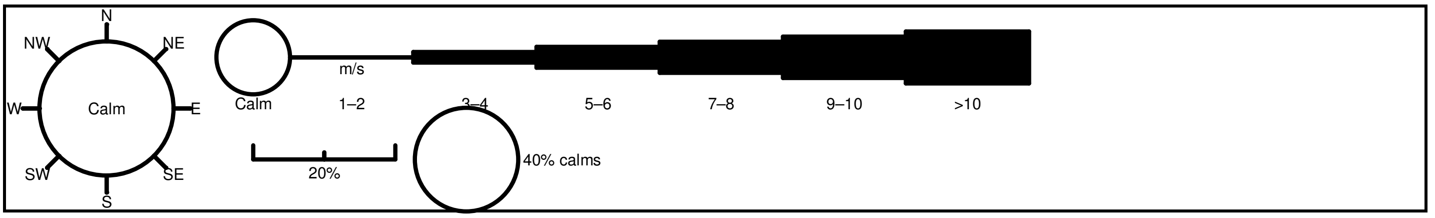
Annex C

Windroses

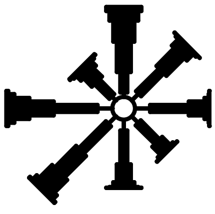
Wind Roses using data between Oct 1993 and Sep 2006 for

Condobolin Airport AWS

Site Number 050137 • Locality: Condobolin • Opened May 1993 • Still Open • Latitude 33°04'06"S • Longitude 147°12'48"E • Elevation 192.6m



All times 37116 observations



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Prepared by the Bureau of Meteorology's Tasmania and Antarctica Climate Services Centre. Contact us by phone on (03) 6221 2043, by fax on (03) 6221 2045, or by email on climate.tas@bom.gov.au
 Prepared on 4 October 2006

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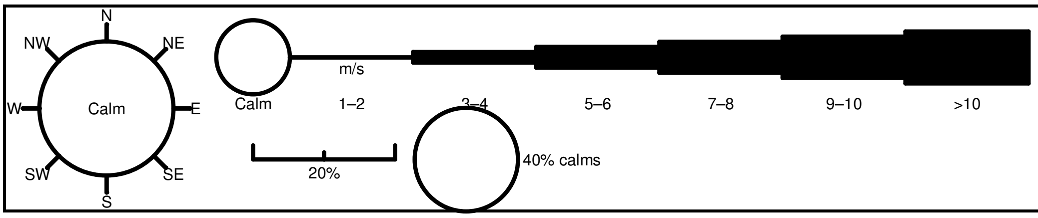
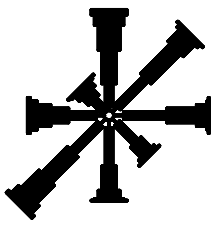
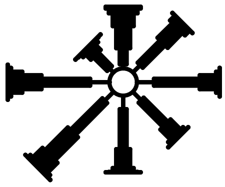


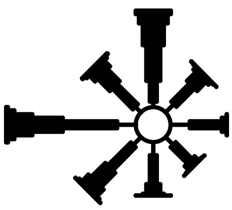
Summer 9144 observations



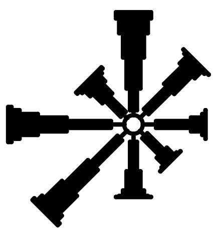
Autumn 9386 observations



Winter 9374 observations



Spring 9212 observations



Australian Government
Bureau of Meteorology

Prepared by the Bureau of Meteorology's Tasmania and Antarctica Climate Services Centre. Contact us by phone on (03) 6221 2043, by fax on (03) 6221 2045, or by email on climate.tas@bom.gov.au
 Prepared on 4 October 2006

Annex D

Concentration Contours

Legend

Site Boundary

Assessment Location

Figure D.1

Predicted Acetaldehyde GLCs (mg/m³)

Client:	Agri Energy Limited		
Project:	Condobolin Ethanol Production Facility		
Drawing No:	0056132_AQ_GIS03		
Date:	19.02.2007	Drawing Size:	A4
Drawn By:	DH	Reviewed By:	-
Source:	Aerial: Department of Lands NSW		
Scale:	Refer to Scale Bar		

N

0 500 1000m

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Legend

Site Boundary

Assessment Location

Figure D.2

Predicted CO 15min GLCs ($\mu g/m^3$)

Client:	Agri Energy Limited		
Project:	Condobolin Ethanol Production Facility		
Drawing No:	0056132_AQ_GIS04		
Date:	19.02.2007	Drawing Size:	A4
Drawn By:	DH	Reviewed By:	-
Source:	Aerial: Department of Lands NSW		
Scale:	Refer to Scale Bar		

N

0 500 1000m

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Site Boundary

Assessment Location

Figure D.3

Predicted Ethanol GLCs (mg/m³)

Client:	Agri Energy Limited		
Project:	Condobolin Ethanol Production Facility		
Drawing No:	0056132_AQ_GIS05		
Date:	19.02.2007	Drawing Size:	A4
Drawn By:	DH	Reviewed By:	-
Source:	Aerial: Department of Lands NSW		
Scale:	Refer to Scale Bar		

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0 500 1000m

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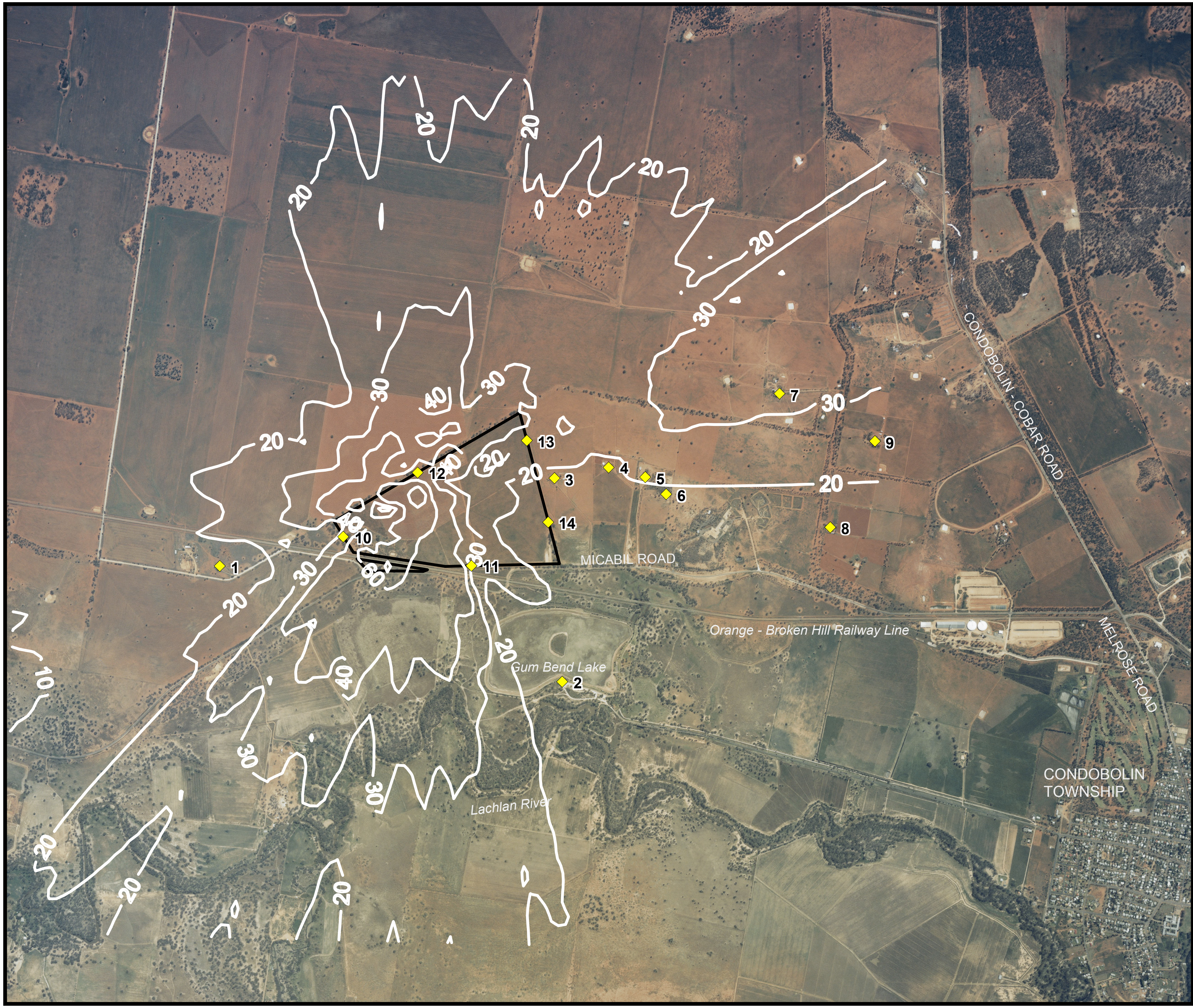

Legend

- Site Boundary
- Assessment Location

Figure D.4

Predicted NO2 1hr GLCs ($\mu g/m^3$)

Client:	Agri Energy Limited		
Project:	Condobolin Ethanol Production Facility		
Drawing No:	0056132_AQ_GIS06		
Date:	19.02.2007	Drawing Size:	A4
Drawn By:	DH	Reviewed By:	-
Source:	Aerial: Department of Lands NSW		
Scale:	Refer to Scale Bar		

N

0 500 1000m

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Legend

Site Boundary

Assessment Location

Figure D.5

Predicted NO2 Annual GLCs ($\mu g/m^3$)

Client:	Agri Energy Limited		
Project:	Condobolin Ethanol Production Facility		
Drawing No:	0056132_AQ_GIS07		
Date:	19.02.2007	Drawing Size:	A4
Drawn By:	DH	Reviewed By:	-
Source:	Aerial: Department of Lands NSW		
Scale:	Refer to Scale Bar		

N

0 500 1000m

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Legend

Site Boundary

Assessment Location

Figure D.6

Predicted Odour GLCs (O.U)

Client:	Agri Energy Limited
Project:	Condobolin Ethanol Production Facility
Drawing No:	0056132_AQ_GIS08
Date:	19.02.2007 — Drawing Size: A4
Drawn By:	DH — Reviewed By: -
Source:	Aerial: Department of Lands NSW
Scale:	Refer to Scale Bar

N

0 500 1000m

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Legend

Site Boundary

Assessment Location

Figure D.7

Predicted PM10 24hr GLCs ($\mu g/m^3$)

Client:	Agri Energy Limited		
Project:	Condobolin Ethanol Production Facility		
Drawing No:	0056132_AQ_GIS09		
Date:	19.02.2007	Drawing Size:	A4
Drawn By:	DH	Reviewed By:	-
Source:	Aerial: Department of Lands NSW		
Scale:	Refer to Scale Bar		

N

0 500 1000m

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Legend

Site Boundary

Assessment Location

Figure D.8

Predicted PM10 Annual GLCs ($\mu g/m^3$)

Client:	Agri Energy Limited
Project:	Condobolin Ethanol Production Facility
Drawing No:	0056132_AQ_GIS10
Date:	19.02.2007 Drawing Size: A4
Drawn By:	DH Reviewed By: -
Source:	Aerial: Department of Lands NSW
Scale:	Refer to Scale Bar

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Legend

- Site Boundary
- Assessment Location

Figure D.9

Predicted SO2 1hr GLCs ($\mu g/m^3$)

Client:	Agri Energy Limited		
Project:	Condobolin Ethanol Production Facility		
Drawing No:	0056132_AQ_GIS11		
Date:	19.02.2007	Drawing Size:	A4
Drawn By:	DH	Reviewed By:	-
Source:	Aerial: Department of Lands NSW		
Scale:	Refer to Scale Bar		

N

0 500 1000m

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Legend

Site Boundary

Assessment Location

Figure D.10

Predicted TSP Annual GLCs ($\mu g/m^3$)

Client:	Agri Energy Limited		
Project:	Condobolin Ethanol Production Facility		
Drawing No:	0056132_AQ_GIS12		
Date:	19.02.2007	Drawing Size:	A4
Drawn By:	DH	Reviewed By:	-
Source:	Aerial: Department of Lands NSW		
Scale:	Refer to Scale Bar		

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Building C, 33 Saunders St, Pyrmont, NSW 2009
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Environmental Resources Management Australia
Building C, 33 Saunders Street
Pyrmont NSW 2009
Telephone (02) 8584 8888
Facsimile (02) 8584 8800