Appendix F

Air Quality and Odour Impact Assessment Report

Kwinana Waste To Energy Project

Public Environmental Review

PHOENIX ENERGY

COVANTA ENERGY

MITSUBISHI HEAVY INDUSTRIES
ENVIRONMENTAL & CHEMICAL ENGINEERING CO., LTD.

John Holland

Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment

Prepared for:
Phoenix Energy Australia

Prepared by:
ENVIRON Australia Pty Ltd

Date:
23 May 2014

Project Number:
AS110691

ENVIRON

Prepared by:		**Authorised by:**	
Name:	Ruth Peiffer	Name:	Brian Bell
Title:	Manager	Title:	Principal
Phone:	+61 8 9225 5199	Phone:	+61 8 9225 5199
Email:	rpeiffer@environcorp.com.au	Email:	bbell@environcorp.com.au
Signature:	Date: 23 May 2014	Signature:	Date: 23 May 2014

This document is issued in confidence to Phoenix Energy Australia for the purposes of assessing the air quality impacts associated with Phoenix Energy's proposed Waste to Energy Project, located within the Kwinana Industrial Area. It should not be used for any other purpose.

Whilst reasonable attempts have been made to ensure that the contents of this report are accurate and complete at the time of writing, ENVIRON Australia Pty Ltd disclaims any responsibility for loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of this report.

VERSION CONTROL RECORD

Document File Name	Date Issued	Version	Author	Reviewer
AS110691 Phoenix Energy Kwinana WTE Project - Air Quality Assessment_131128_D1.docx	28 November 2013	External Draft 1	Ruth Peiffer/ Martin Parsons	Brian Bell
AS110691 Phoenix Energy Kwinana WTE Project - Air Quality Assessment_131202_Final.docx	2 December	Final	Ruth Peiffer/ Martin Parsons	Brian Bell
AS110691 Phoenix Energy Kwinana WTE Project - Air Quality Assessment_130206_R1.docx	6 February	Revised Final 1	Ruth Peiffer	Miles Sowden
AS110691 Phoenix Energy Kwinana WTE Project - Air Quality Assessment_130207_R2.docx	7 February	Revised Final 2	Ruth Peiffer	Brian Bell
AS110691 Phoenix Energy Kwinana WTE Project - Air Quality Assessment_140424_R3.docx	24 April	Revised Final 3	Ruth Peiffer	Brian Bell
AS110691 Phoenix Energy Kwinana WTE Project - Air Quality Assessment_140505_R4.docx	5 May	Revised Final 4	Ruth Peiffer	Brian Bell
AS110691 Phoenix Energy Kwinana WTE Project - Air Quality Assessment_140523_R5.docx	23 May	Revised Final 5	Ruth Peiffer	Brian Bell

Contents

List of Figures

List of Tables

List of Appendices

1 Introduction

1.1 Background

Phoenix Energy Australia (Phoenix Energy) is proposing to construct a 36 MW Waste to Energy (WtE) facility at a site located within the Kwinana Industrial Area (KIA) (Figure 1). The proposed facility will consist of two fully automated Martin grate (stoker) furnaces with a design capacity to accept up to 400,000 tonnes per annum (tpa) of residual Municipal Solid Waste (MSW). The MSW feedstock will be combusted in order to provide base load electricity to the South West Interconnected System (SWIS). The proposed WtE facility will also include a brick making plant, which will convert all solid residues into bricks, pavers and/or aggregate suitable for building applications.

Phoenix Energy has requested that ENVIRON Australia Pty Ltd (ENVIRON) undertake an air quality assessment of the atmospheric emissions associated with the proposed WtE facility. The air quality assessment has been completed in support of the Public Environmental Review (PER) for the proposed WtE facility, as required by the Environmental Protection Authority (EPA).

1.2 Purpose of this Report

This report presents the assessment of the potential air quality impacts arising from atmospheric emissions associated with the proposed WtE facility, including the approach, methodology and results of the air dispersion modelling.

The following compounds have been considered in the air dispersion modelling assessment:

- Particulates;
- Nitrogen dioxide (NO_2);
- Sulphur dioxide (SO_2);
- Carbon monoxide (CO);
- Hydrogen fluoride (HF);
- Hydrogen chloride (HCl);
- Heavy metals;
- Dioxins and furans; and
- Odour.

The cumulative impact of SO_2 emissions from the proposed WtE facility and other existing sources within the KIA have been evaluated using the DISPMOD air dispersion model developed by the Department of Environment Regulation (DER) for the Kwinana area. The cumulative impacts of the other pollutants considered in this report have been assessed at nominated receptors where ambient air quality monitoring data are available.

2 Site and Project Description

2.1 Site Description

The proposed WtE facility will be located within the KIA, approximately 40 km south of Perth (Figure 1). The proposed facility will encompass an area of approximately 3.5 ha and will be situated on Leath Road, Kwinana (Figure 2). A layout of the site is provided as Figure 3 highlighting the locations of the emission sources considered in this assessment.

2.2 Process Summary

The proposed WtE facility will consist of two fully automated, state-of-the-art Martin grate (stoker) furnaces. The moving grate stoker technology is the most prevalent WtE technology in the market and the majority (approximately 400 WtE plants globally) use Martin GmbH technology. The proposed WtE facility will be designed to accept up to 400,000 tpa of residual MSW. Phoenix Energy is currently planning to have the Kwinana WtE plant operational by late 2016.

MSW supplied by local governments will be the primary fuel source for the proposed WtE facility. Waste vehicles will enter the site, be weighed, screened for radioactive contamination and proceed to the tipping hall if no radiation is detected. The enclosed tipping hall will be equipped with fast acting roller doors and trucks will unload into a bunker within a fully enclosed building. The bunker will be sized to provide the storage capacity required to allow the plant to operate continuously (24 hours a day, 7 days a week), and also to provide additional capacity to accommodate both planned and unplanned maintenance events.

Based on the design capacity of 400,000 tpa, Phoenix Energy have estimated that 90 trucks will be received at the proposed WtE facility over a typical 2-hour shift. The roller doors are expected to open for 30 seconds as each truck enters and 30 seconds as each truck exits the tipping hall. The entry and exit doors are therefore expected to be open for a total of 90-minutes per 2-hour shift. The tipping hall will operate under slightly negative air pressure in order to minimise odour emissions escaping from the building.

The waste material will flow under gravity down through the furnace on the inclined moving Martin grate stoker. The ash remaining at the base of the grate after 60 to 70 minutes of combustion will be collected and cooled using a water quench within a water sealed ash discharger, which is integral to each grate/line. The water seal in the ash discharger facilitates removal of the bottom ash from the grate system, whilst maintaining the negative air pressure under which the combustion chamber operates. The ash discharger feeds the ash into a cement lined bottom ash bunker equipped with a grab crane to load the ash onto a conveyor. The conveyor transports the residue to a metals recovery area where it is subjected to magnetic separation of ferrous metal followed by separation of non-ferrous metals via an eddy current separation system. The residual bottom ash is then conveyed to the brick plant via an enclosed conveyor.

Hot flue gases leaving the combustion chamber pass through a standard water wall boiler where superheated high pressure steam is generated through heat recovery. The high pressure steam is sent to a standard steam turbine generator, to generate the electricity required to operate the plant with the balance available for export to the grid. An illustration of a typical WtE facility employing the Martin grate technology is provided in Figure 4.

It is estimated that the proposed WtE facility, which will be classified as a renewable energy generator, will export an estimated 32 MW of electricity when operating at full capacity. The facility will be connected to the SWIS and Phoenix Energy will enter into one or more long term power purchase agreements for the electricity generated.

2.3 Atmospheric Emission Controls

Phoenix Energy will employ Best Available Air Pollution Control Technologies and will ensure the proposed WtE facility meets the most stringent of air emission regulations applied internationally, namely the European Directive 2000/76/EC on the incineration of waste (also known as the Waste Incineration Directive or WID) (note the WID is being incorporated into the European Directive 2010/75/EU on industrial emissions, known as the Industrial Emissions Directive [IED]).

The cooled flue gases leaving the boiler will be passed through a series of scrubbing and cleaning processes. Lime will be injected into the system to neutralize acidic components in the flue gas. Activated carbon will be added to remove dioxins, furans and heavy metals such as mercury and lead. The lime reaction products, activated carbon and any residual particulate material will be collected in a baghouse filter.

Selective Catalytic Reduction (SCR) technology will be utilised to reduce NO_x emissions in the flue gases. This will involve injecting liquid ammonia or urea into the flue gas in the presence of a catalyst, contained in the SCR vessel. The liquid ammonia or urea reacts with the NO_x in the flue gas, while passing through the catalyst and reduces the NO_x to inert nitrogen.

The cleaned flue gases will be drawn by an induced draft fan and released into the atmosphere via a single multi-flue stack, with one flue per line. Each Martin grate line will be equipped with a dedicated Continuous Emission Control System (CEMS), for continuous online monitoring of flue gas composition, in conjunction with periodic stack sampling and testing. For the pollutants for which online measurement is not currently feasible or sufficiently accurate, a sampling and testing regime will be established as part of the plant standard operating procedures, to ensure that the plant is constantly in compliance with its environmental obligations.

An illustration of the material flows and application of emissions control technologies associated with a typical WtE plant utilizing the moving grate combustion process is provided in Figure 5.

All waste accepted into the proposed WtE facility will be managed in a fully enclosed building containing a tipping hall and waste bunker. The waste bunker will be equipped with a series of automatic doors, which will act to reduce emissions from the bunker. Combustion air for the Martin grate stoker will be drawn from the tipping hall by inlet ducts above the waste bunker, thus maintaining a slight negative air pressure in the tipping building to help prevent the escape of dust and odour. Odours drawn into the grate furnace will be destroyed at high temperatures. This configuration makes it difficult for odours to escape from the building as it will maintain the building under negative pressure.

Phoenix Energy have advised that atmospheric emissions associated with the brick plant are expected to be negligible. The residual ash used in the brick making process will be conveyed to the brick plant as a wet product via an enclosed conveyor. The ash will be

mixed with quick lime, hydrated lime or lime kiln dust (10-12%) and water, and blended in a high intensity mixer. Pigments will be added as necessary (depending on the requirements of the finished product) and the raw material mix will be inserted into a metal die and pressed using a hydraulic or mechanical press. The raw material is then removed, stacked on a pallet and cured in an autoclave for six hours. This curing process forms tobermorite (a hydrated cement paste of calcium silicate hydroxide hydrate) crystals, which tightly bond with the ash to create a strong, weather resistant building product.

Phoenix Energy will utilise steam from the WtE plant as the heat sources for the autoclave and as such, the only atmospheric emissions will be ventilation air which will pass through a baghouse prior to emission.

3 Air Quality Criteria

3.1 Kwinana Environmental Protection (Atmospheric Wastes) Policy

The Environmental Protection (Kwinana) (Atmospheric Wastes) Policy (Kwinana EPP) established ambient air quality criteria for SO_2 and Total Suspended Particulate (TSP), in order to maintain acceptable air quality within and around the KIA. The Kwinana EPP defines three Policy Areas (A, B and C), described as follows:

- Area A is the area of land on which heavy industry is located;
- Area B is outside area A and is zoned for industrial purposes from time to time under a Metropolitan Region Scheme or a town planning scheme; and
- Area C is beyond Areas A and B, predominantly rural and residential.

The location of each Policy Area boundary is presented in Figure 1, overlain on an aerial photograph.

Ambient air quality criteria have been set for each Policy Area, increasing in stringency from Area A to Area C, with the criteria set for Area C being the most stringent due to the residential land use within that area. Limits and Standards for SO_2 and TSP have been defined for each Policy Area; Limits refer to the ambient concentrations which are not to be exceeded, while Standards refer to the ambient concentrations which are desirable not to be exceeded.

A summary of the Kwinana EPP ambient air quality criteria for SO_2 and TSP are presented in Table 1.

Table 1: Kwinana EPP Standards and Limits for SO_2 and TSP

Compound	Averaging Period		Concentration (µg/m^3)[1]		
			Area A	Area B	Area C
SO_2	1-hour	Standard	700	500	350
		Limit	1,400	1,000	500
	24-hour	Standard	200	150	125
		Limit	365	200	200
	Annual	Standard	60	50	50
		Limit	80	60	60
TSP	15-minute	Limit	1,000	1,000	1,000
	24-hour	Standard	150	90	90
		Limit	260	260	150

Notes
1. Referenced to 0ºC, and 1013.25 hPa.

For the purposes of determining compliance against the SO_2 criteria, the maximum predicted 1-hour average ground-level concentration (GLC) is compared to the Limit, and the predicted 9th highest (or 99.9th percentile) 1 hour average GLC is compared to the Standard.

For the purposes of determining compliance against the Standards and Limits for TSP, the most conservative 24-hour average criteria of 90 µg/m^3 (24-hour average) has been applied. In order to assess the short-term model predictions, which are based on a minimum time step of one hour, the 15-minute average Limit for TSP has been converted to an equivalent 1 hour average using a standard peak-to-mean algorithm (Hanna *et. al*., 1982), as per Equation 1.

$$\text{1-hour standard} = X * (T_1/T_2)^{0.2} \qquad \textit{Equation 1}$$

Where:

X = standard value for a period of less than 1-hour

T_1 = number of minutes of the short-term standard averaging period (e.g. 15-minutes)

T_2 = number of minutes of averaging period required (in this case the 60-minutes)

Based on Equation 1, the Limit for TSP specified in the Kwinana EPP of 1,000 µg/m^3 (15-minute average), equates to an equivalent 1-hour average concentration of 758 µg/m^3.

3.1.2 Maximum Permissible Quantities of SO_2

The Kwinana EPP also required the DER to document the mechanism for setting the Maximum Permissible Quantities of the emissions of SO_2 from individual industries in Kwinana, which are given effect through individual facility License conditions. The Kwinana EPP provides for a redetermination of the Maximum Permissible Quantities of the emissions of SO_2 from industry in Kwinana as and when required (e.g. to accommodate new industries or variations to existing industry emissions).

As the expected SO_2 emissions from the proposed WtE facility are above the threshold rate of 2 g/s, it is likely that a redetermination of the Maximum Permissible Quantities would be required to be undertaken. Any redetermination would be undertaken in accordance with the following principles:

1. All Maximum Permissible Quantities are to be determined in accordance with the principle of waste minimisation (as specified in the Environmental Protection Act 1986) which states that all reasonable and practicable measures should be taken to minimise the generation of waste and its discharge to the environment.
2. All Maximum Permissible Quantities must be in accordance with any relevant approvals and associated conditions under Part IV of the Environmental Protect Act 1986.
3. Maximum Permissible Quantities that are in accordance with principles 1 and 2 and represent the reasonable needs of an industry, with allowance for variability as appropriate to that industry, will be considered to be a secure allocation (not to be reduced to make room for new sources).

4. The capacity of the airshed to accommodate additional emissions beyond secure allocations (as per principle 3) will be reserved for future uses, as per clause 7(2) of the Kwinana EPP.
5. Any emission permits in excess of a secure allocation will have a specified end date and will not be a secure allocation.
6. Ambient SO_2 monitoring can reduce only to the extent that licensed emissions limits reduce, thereby reducing the likelihood of an exceedance.

The most recent redetermination of the Maximum Permissible Quantities was published by the DER in 2009 (DER, 2009b). This publication presents background information on the history of the Kwinana EPP, the legislative framework, monitoring results, principles and procedures applied in the redetermination, the modelling approach and results, and the current Maximum Permissible Quantities. The approach, methodologies and Maximum Permissible Quantities applied for the most recent redetermination have been used for this assessment, and the reader is referred to the DER (2009b) report for full details.

3.2 National Environment Protection Measure (NEPM)

In June 1998 the National Environment Protection Council (NEPC) set uniform standards for ambient air quality to allow for the adequate protection of human health and wellbeing. This was achieved via the creation of the National Environmental Protection (Ambient Air Quality) Measure (NEPM) (NEPC, 2003) which defined ambient air quality standards for criteria pollutants, including CO, NO_2, photochemical oxidants (as ozone), lead and particulates (as particles less than 10 µm in equivalent aerodynamic diameter [PM_{10}]). Amendments were made to the Ambient Air Quality NEPM in 2003 to include advisory reporting standards for particles less than 2.5 µm in equivalent aerodynamic diameter ($PM_{2.5}$).

The Western Australian State Government has recommended the adoption of the NEPM standards for ambient air quality as part of the draft State Environmental (Ambient Air) Policy 2009 (Government of WA, 2009). The NEPM standards applied in this assessment and are presented in Table 2.

Table 2: NEPM Ambient Air Quality Standards and Goals

Pollutant	Averaging Period	Standard (µg/m^3)[1]	Goals[2]
CO	8-hour	11,254	1 day a year
NO_2	1-hour	246	1 day a year
	Annual	62	none
Lead	Annual	0.5	none
PM_{10}	24-hour	50	5 days a year
$PM_{2.5}$[3]	24-hour	25	na
	Annual	8	na

Notes
1. Referenced to 0ºC, and 1013.25 hPa.
2. Maximum number of allowable exceedences (applicable from June 2008).
3. Advisory reporting standards.

It should be noted that the NEPM standards for SO_2 have not been applied in this assessment, with preference given to the Kwinana EPP criteria, in line with the recommendations of the draft State Environmental (Ambient Air) Policy 2009 (SEP) (Government of WA, 2009, 2009). The draft SEP advises that where an EPP exists for a particular pollutant, the environmental quality criteria for than pollutant (i.e. NEPM standards) will not be applied over the area specified by the EPP on the basis that the area specific EPP would have appropriate management mechanisms in place to ensure the intent of the SEP is achieved (Government of WA, 2009). Furthermore, analysis undertaken as part of the WA Environmental Protection Authority"s (EPA) review of the Kwinana EPP indicates that the Kwinana EPP criteria applied within Area C (i.e. rural and residential zone) are currently more stringent than the NEPM standards for SO_2 (EPA, 2009).

3.3 Additional Ambient Air Quality Criteria

Where compounds are not covered by the Kwinana EPP or NEPM Standards, ambient air quality criteria and health protective guidelines have been sourced from other reputable authorities for the purposes of this assessment. These include the World Health Organisation (WHO), Californian Office of Environmental Health Hazard Assessment (OEHHA, 2013) and NSW Office of Environment and Heritage (OEH) (formerly NSW Department of Environment and Conservation (DEC)) and the Australian and New Zealand Environment Conservation Council (ANZECC).

The WHO guidelines provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants of air that are known or likely to be hazardous to human health and well-being. The WHO guidelines are intended to provide information for use in making assessments of risk, rather than strict standards. They aim to provide a basis for setting standards or limit values for air pollutants by setting levels below which exposure for a given period of time does not constitute a significant health risk.

The OEHHA guidelines are typically based upon values published by other reputable authorities, rather than being developed from first principles based on results of actual toxicological studies. However, the OEHHA guidelines are considered useful for this assessment in that they are one of the few sources that publish health protective guidelines for acute (i.e. short-term) exposure for a wide list of substances.

Similarly, the NSW OEH have published impact assessment criteria for a wide range of toxic air pollutants against which the predicted impacts from air dispersion modelling assessments can be assessed (NSW OEH, 2005). The NSW OEH impact assessment criteria relevant to this assessment have been based on Design Criteria established by the Victorian State Environment Protection Policy (SEPP), which are in turn derived from the National Occupational Health and Safety Commission"s (NOHSC) exposure standards for atmospheric contaminants in the occupational environment (Vic EPA, 2001). The Vic SEPP criteria are also designed to protect against adverse health effects.

The ANZECC *National Goals for Fluoride in Ambient Air and Forage* (ANZECC, 1990) are designed to protect plants and grazing animals against injury from fluoride. The goals provide two sets of acceptable concentrations of HF in ambient air, these being for General Land Use, including residential (designed to protect most of the sensitive species in the natural environment); and Specialised Land Use (designed to protect commercially valuable

plants which are demonstrated to be very sensitive to fluoride). As HF in air is potentially injurious to plants at concentrations well below the levels at which human health effects have been observed (DER, 2003), the ANZECC (1990) national ambient air goals for HF established for vegetation protection, are also protective of human health.

In addition to the above, ambient guideline values for a number of heavy metals as provided by the WA Department of Health (DoH) have also been applied in this assessment. The DoH have advised that these guidelines have been developed following review of the NSW OEH impact assessment and Victorian SEPP design criteria.

Table 3: Additional Ambient Air Quality Criteria

Pollutant	Averaging Period	Guideline (µg/m^3)[1]	Source
HF	1-hour	262	OEHHA
	24-hour	1.5[2]/2.9[3]	ANZECC
	7-days	0.8[2]/1.7[3]	ANZECC
	30-days	0.4[2]/0.84[3]	ANZECC
	90-days	0.25[2]/0.5[3]	ANZECC
HCl	1-hour	153	NSW OEH
	Annual	10	OEHHA
Cadmium	1-hour	0.0196	DoH
	24-hour	0.022	DoH
	Annual	0.011	DoH
Mercury	1-hour	0.65	DoH
	Annual	0.22	DoH
Antimony	1-hour	0.98	DoH
	Annual	0.033	DoH
Arsenic	1-hour	0.098	DoH
	24-hour	0.033	DoH
	Annual	0.0033	DoH
Copper	1-hour	20	NSW OEH
	24-hour	1.1	DoH
Chromium VI	1-hour	0.098	NSW OEH
	24-hour	0.33	NSW OEH
	Annual	0.00022	DoH
Manganese	1-hour	20	NSW OEH

Table 3: Additional Ambient Air Quality Criteria

Pollutant	Averaging Period	Guideline (µg/m^3)[1]	Source
Manganese	24-hour	0.16	DoH
Nickel	1-hour	0.19	DoH
	24-hour	0.15	DoH
	Annual	0.0033	DoH
Dioxins and Furans	1-hour	0.0000022	NSW OEH

Notes
1. Referenced to 0ºC and 1013.25 hPa, in line with reference conditions for model outputs.
2. Specialised land use criteria, including all areas sensitive to fluoride.
3. General land use criteria, including residential areas and designed to protect most of the sensitive species in the natural environment.

3.4 Incremental Carcinogenic Risk

Guidelines for carcinogenic compounds are expressed as Unit Risk Factors (which represent the incremental carcinogenic risk per microgram per cubic meter of exposure to a pollutant). In order to calculate an acceptable standard, the USEPA recommends that a *de minimus* (i.e. so small as to be considered negligible) risk value of 1 x 10^{-6} (i.e. one in a million) be used to develop a standard that represents an acceptable level of risk. The calculated concentration represents the concentration at which one in a million people may be expected to develop cancer from lifetime exposure to the atmospheric concentrations of the carcinogenic compound. The annual average concentrations associated with an excess lifetime risk for the pollutants relevant to this assessment have been determined from the applicable Unit Risk Factors and are presented in Table 4.

Table 4: Incremental Carcinogenic Risk Factors

Pollutant	Unit Risk Factor[1]	Annual Average[2,3]	Source
Cadmium	3.3E-06 per µg/m^3	0.3 µg/m^3	WHO
Arsenic	1.5E-03 per µg/m^3	0.0007 µg/m^3	WHO
Lead	1.2E-05 per µg/m^3	0.091 µg/m^3	OEHHA
Chromium VI	4.0E-02 per µg/m^3	0.000027 µg/m^3	WHO
Nickel	3.8E-04 per µg/m^3	0.00287 µg/m^3	WHO
Dioxins	3.8E+01 per µg/m^3	2.8E-08 µg/m^3	OEHHA
Furans	3.8E+00 per µg/m^3	2.8E-07 µg/m^3	OEHHA

Notes
1. Incremental carcinogenic risk per microgram per cubic meter of exposure to a pollutant.
2. Referenced to 0ºC, and 1013.25 hPa.
3. Annual average concentration associated with an excess lifetime risk of one in a million.

3.5 Odour Criteria

WA EPA has repealed its Guidance Statement for the Assessment of Odour Impacts from New Proposals (Guidance Statement No. 47).

Previous advice from the DER (pers. comm. David Griffiths, 9 May 2013) is that the Queensland Environmental Protection Agency"s (QLD EPA) Odour Impact Assessment Guidelines (QLD EPA, 2004) with some adjustments should be applied in preference to the withdrawn EPA"s interim guidance. The guideline values are defined in odour units (ou), which represent the number of times the sample must be diluted to reach the detection threshold of the panel of humans using their noses as odour detectors.

The Queensland guidelines are as follows:

- 0.5 ou, 1-hour average, 99.5th percentile for tall stacks;
- 2.5 ou, 1-hour average, 99.5th percentile for ground-level sources and plumes from short stacks; and
- for facilities that do not operate continuously, the 99.5th percentile must be applied to the actual hours of operation.

4 Ambient Air Quality

The DER conduct ambient air quality monitoring within the Kwinana region for SO_2, NO_2 , PM_{10}, $PM_{2.5}$ and ozone and the results are reported annually. The most recently published monitoring results, as reported in the 2011 Western Australia Air Monitoring Report (DER, 2012), are summarised in the following sections.

The DER also carried out a Background Air Quality Study (BAQS) between 2005 and 2010, which included monitoring of Volatile Organic Compounds (VOCs), carbonyls, heavy metals and Polycyclic Aromatic Hydrocarbons (PAHs) and ammonia within the Kwinana region (DER, 2011a).

Summaries of the results of ambient air quality monitoring for compounds relevant to this assessment are presented in the following sections. The locations of the relevant monitoring stations are highlighted in Figure 1.

4.1 Sulphur Dioxide

The results of ambient air quality monitoring within the Kwinana region for SO_2 at Rockingham and Wattleup are summarised in Table 5. The Rockingham monitoring station is located within the residential Area C (as defined in the Kwinana EPP), and the Wattleup monitoring station is located within the buffer zone Area B (as defined in the Kwinana EPP).

Table 5: Summary of Ambient SO_2 Monitoring in Kwinana

Daily Peak Concentration of SO_2 (µg/m^3) [1,2]				
Location	**Rockingham**		**Wattleup**	
Year	**1-hour**	**24-hour**	**1-hour**	**24-hour**
Standard[3]	350	125	500	150
Limit[4]	500	200	1,000	200
2002	100	17	231	23
2003	74	14	177	17
2004	111	17	217	26
2005	117	26	**343**	**40**
2006	114	20	177	26
2007	117	**34**	171	29
2008	**226**	20	220	31
2009	91	23	169	23
2010	106	20	163	29
2011	114	23	191	23

Notes

1. Data sourced from DER (2012).
2. The highest concentration of SO_2 measured at each location over the past decade is shown in bold (and shaded) for each of the criteria

Table 5: Summary of Ambient SO_2 Monitoring in Kwinana				
Daily Peak Concentration of SO_2 ($\mu g/m^3$) [1,2]				
Location	Rockingham		Wattleup	
Year	1-hour	24-hour	1-hour	24-hour

3. Kwinana EPP Area C Standards applies at the Rockingham monitoring station, and the Area B Standards applied at the Wattleup monitoring station.
4. Kwinana EPP Area C Limits applies at the Rockingham monitoring station, and the Area B Limits applied at the Wattleup monitoring station.

The ambient air quality monitoring results within the Kwinana region for SO_2 indicate that the Kwinana EPP Standards and Limits have not been exceeded over the most recently reported decade of air monitoring. The highest daily peak 1-hour concentration of SO_2 was measured at the Wattleup monitoring station during 2005 (343 $\mu g/m^3$) and easily complies (34%) with the relevant Kwinana EPP Limit. The highest daily peak 24-hour concentration of SO_2 was also measured at the Wattleup monitoring station during 2005 (40 $\mu g/m^3$) and complies (20%) with the relevant Kwinana EPP Limit. The Wattleup monitoring station is located closest to the proposed WtE facility, within approximately 3.5 km (Figure 1).

The 2011 Western Australia Air Monitoring Report (DER, 2012) does not report the 9th highest (or 99.9th percentile) statistic, required for comparison to the Kwinana EPP 1-hour Standards. Notwithstanding, the ambient air quality monitoring results within the Kwinana region for SO_2 indicate that the highest peak 1-hour and 24-hour concentrations of SO_2 measured at the Wattleup and Rockingham monitoring stations comply with the Kwinana EPP Standards.

4.2 Nitrogen Dioxide

Monitoring of ambient nitric oxide (NO) and NO_2 concentrations within the Kwinana region has been carried out by the DER for a number of years. Long-term monitoring stations established in the mid-1990"s as part of the Perth Photochemical Smog Study and the Perth Haze Study were located at Hope Valley and North Rockingham (Figure 1). Monitoring at the Hope Valley site, located within approximately 1.2 km of the proposed WtE facility, began in 1994 and continued until 2009 when the station was decommissioned. Monitoring at the Rockingham site, located within approximately 6 km of the proposed WtE facility, began in 1995 and is currently ongoing.

Two additional NO_2 monitoring sites were established in the Kwinana region in 2009 as part of the DER"s Background Air Quality Study (BAQS). These were located at the Calista Primary School, 4.8 km southeast of the proposed WtE facility; and the Hillman Child Health Centre, 4.9 km southeast of the proposed WtE facility (Figure 1). Continuous monitoring was carried out at these two sites for a 12-month period between May 2009 and June 2010.

A summary of the maximum 1-hour and annual average NO_2 concentrations recorded at the Hope Valley, North Rockingham, Calista and Hillman monitoring stations is presented in Table 6. These data show that no exceedences of the NEPM NO_2 1-hour standard of 0.12 ppm or annual standard of 0.03 ppm have been recorded at any of the monitoring sites.

Table 6: Summary of Maximum Monitored NO_2 Concentrations within Kwinana

Monitoring Site	1-hour Average			Annual Average		
	ppm	µg/m^3[1]	% of NEPM	ppm	µg/m^3[1]	% of NEPM
Standard	0.12	226		0.03	56	
Hope Valley	0.084[2]	158	70%	0.005[3]	9.4	17%
North Rockingham	0.055[4]	103	46%	0.008[5]	15	27%
Callista	0.049[6]	92	41%	0.005[6]	9.4	17%
Hillman	0.043[6]	81	36%	0.006[6]	11	20%

Notes

1. Referenced to 25ºC, and 1013.25 hPa.
2. Recorded in 2007.
3. Recorded in 1999, 2000, 2001, 2002, 2003 and 2004.
4. Recorded in 2004.
5. Recorded in 2000.
6. Recorded between May 2009 and June 2010.

The highest maximum 1-hour NO_2 concentration monitored at any of the Kwinana monitoring stations is 0.084 ppm (70% of the NO_2 NEPM) and was recorded in 2007 at the Hope Valley site. The highest maximum 1-hour NO_2 concentration monitored at the North Rockingham site is 0.055 ppm (46% of the NO_2 NEPM) and was recorded in 2004.

The highest maximum 1-hour NO_2 concentrations recorded at the Calista and Hillman monitoring stations between May 2009 and June 2010 were 0.049 ppm and 0.043 ppm respectively, representing no more than 41% of the NO_2 NEPM standard. Assessment of pollution roses for the Calista and Hillman monitoring sites does not indicate any particular direction as a dominant source of NO_2 (DER, 2011b). The DER found this result was not unexpected as the major contributor to NO_2 levels in populated regions is expected to be from vehicle exhaust (DER, 2011b).

The annual average NO_2 concentrations measured at the Hope Valley, North Rockingham, Callista and Hillman monitoring stations also remain well below the annual NEPM standard of 0.03 ppm, the highest annual mean recorded at any site being 0.008 ppm (27% of the annual NO_2 NEPM).

4.3 Particulate Matter

Monitoring of ambient PM_{10} and $PM_{2.5}$ concentrations within the Kwinana region is carried out by the DER at the South Lake monitoring station, located some 12 km north-northeast of the proposed WtE facility. Monitoring of PM_{10} began in 2000 and monitoring of $PM_{2.5}$ began in 2004, with both ongoing. However, as South Lake is located outside the modelled domain, historical PM_{10} monitoring data were sourced from the Kwinana Industries Council (KIC) operated air quality monitoring station at Abercrombie Road, located approximately 2.8 km east-southeast of the proposed WtE facility (Figure 1).

Ambient PM_{10} concentrations were measured at the Abercrombie site between January 1997 and March 1998. The DER has indicated that monitoring data collected over the last 10 years shows a general decrease in PM_{10} concentrations in the region, and that the

monitoring data available from Abercrombie Road is appropriate to determine background PM_{10} concentrations for the region (ENVIRON, 2011).

In addition to the South Lake monitoring site, $PM_{2.5}$ monitoring has also been undertaken at the Kwinana Town Centre, 4.8 km southeast of the proposed WtE facility; and the Rockingham Shopping Centre, 9 km south of the proposed WtE facility (Figure 1). This monitoring was carried out between September 2005 and September 2006 as part of the DER"s Background Air Quality Study (BAQS). Further $PM_{2.5}$ monitoring was also undertaken as part of the BAQS at the Calista and Hillman monitoring stations between May 2009 and June 2010.

A summary of the maximum ambient PM_{10} and $PM_{2.5}$ concentrations measured within the Kwinana region is presented in Table 7.

Table 7: Summary of Maximum Monitored PM_{10} and $PM_{2.5}$ Concentrations within Kwinana

Monitoring Site	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)			
	24-hour Average	% of NEPM[1]	24-hour Average	% of NEPM	Annual Average	% of NEPM
Standard	50		25		8	
South Lake	66[1]	132%	48[1]	192%	8.7[2]	109%
Abercrombie[3]	63[4]	126%	nd	nd	nd	nd
Kwinana[5]	nd	nd	32[6]	128%	7.5	94%
Rockingham[5]	nd	nd	30[6]	120%	7.5	94%
Calista[7]	nd	nd	57[8]	228%	8.7	109%
Hillman[7]	nd	nd	61[8]	244%	9.0	113%

Notes
1. Recorded in November 2011. Attributed to smoke haze.
2. Recorded in 2006 and 2010.
3. Operational between January 1997 and March 1998.
4. Recorded in December 1997. NEPM goal of no more than 5 exceedances per year was met.
5. Operational between September 2005 and September 2006.
6. Recorded in June 2006. Attributed to smoke haze.
7. Operational between May 2009 and June 2010.
8. Recorded in May 2010. Attributed to smoke haze.

The maximum 24-hour average PM_{10} concentration measured by the DER at the South Lake monitoring site between 2000 and 2011 was 66 µg/m^3, as recorded in November 2011 (DER, 2012). Four similar exceedences were also reported in 2010 (DER, 2011b) and three in 2005 (DER, 2006). Single exceedances of the PM_{10} NEPM standard were recorded in 2001, 2002, 2004, 2007 and 2008. The NEPM goal of no more than 5 exceedances was met during each of these years. Smoke haze has been identified as the contributing factor to the majority of the exceedance events at South Lake.

Similar trends were evident from the historical data collected at the Abercrombie Rd site. Two exceedances of the PM_{10} NEPM standard were recorded during 1997. A 24-hour average PM_{10} concentration of 50.3 µg/m^3 was measured on the 9 December and a 24-hour average PM_{10} concentration of 63 µg/m^3 measured on the 30 December. However, the

NEPM goal of no more than 5 exceedances per year was met for that year. A total of four exceedances of the PM_{10} NEPM standard were recorded between January and April 1998. The 24-hour average PM_{10} concentration measured at Abercrombie Rd on the 27 January was 51 µg/m^3 and on the 28 January was 54 µg/m^3. Consecutive exceedances of 52 µg/m^3 and 67 µg/m^3 were also measured on the 6 and 7 of March 1998.

The maximum 24-hour average $PM_{2.5}$ concentration measured at the South Lake monitoring site between 2004 and 2011 was 48 µg/m^3, recorded concurrently with the maximum PM_{10} concentration in November 2011 (DER, 2012). Two exceedances of the 24-hour average advisory reporting standard for $PM_{2.5}$ were also recorded in 2010 and three were recorded in 2009. A single exceedance was recorded in 2008 and 2006. Smoke haze was identified as the contributing factor to each of the recorded exceedances at the South Lake site.

The maximum 24-hour average $PM_{2.5}$ concentrations recorded at the Kwinana Town Centre and Rockingham Shopping Centre between September 2005 and September 2006 were 32 µg/m^3 and 30 µg/m^3 respectively. The maximum 24-hour average $PM_{2.5}$ concentrations recorded between May 2009 and June 2010 at the Calista and Hillman monitoring sites were 57 µg/m^3 and 61 µg/m^3 respectively. Each of these exceedences were attributed to smoke haze (DER, 2011b).

The highest annual average $PM_{2.5}$ concentration recorded between 2004 and 2011 at the South Lake site was 8.7 µg/m^3 (as recorded for 2006 and 2008). An annual average $PM_{2.5}$ concentration of 7.5 µg/m^3 was recorded at both the Kwinana Town Centre and Rockingham Shopping Centre sites over the 2005 to 2006 monitoring campaign. The annual averages recorded at the Calista and Hillman sites over the 2009 to 2010 monitoring campaign were 8.7 µg/m^3 and 9.0 µg/m^3 respectively, exceeding the long-term advisory reporting standard.

4.4 Heavy Metals

Sampling for heavy metals was conducted by the DER as part of the Kwinana Background Air Quality Study (BAQS) at the Hope Valley monitoring site between February 2005 and February 2006 and at the Calista and Hillman monitoring sites between June 2009 and June 2010. Samples were collected using TSP High Volume (HiVol) Samplers which were run for 24-hours on a six-day rotational cycle (DER, 2011a). The filter papers were analysed for TSP and a suite of heavy metals including arsenic, antimony, cadmium, chromium, copper, lead, manganese, mercury and nickel (as relevant to this assessment).

A summary of the results of each monitoring campaign (as presented by the DER) are presented in Figure 6. The maximum 24-hour average for each of the measured elements remains well below the recommended guideline values adopted for the BAQS by the DER at each of the monitoring sites. Of those compounds relevant to this assessment, the maximum 24-hour and annual average measured concentrations represent less than 10% of the corresponding guideline value.

5 Air Dispersion Modelling and Methodology

5.1 Air Dispersion Model

The Gaussian dispersion models DISPMOD (Versions 1997 and 2005) and the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) (Version 12060) were both used in this study to predict the air quality impacts from the proposed WtE facility. The use of DISPMOD is required by the DER for assessing compliance with the Kwinana EPP Limits and Standards for SO_2. AERMOD is one of the current United States Environmental Protection Agency (USEPA) recommended air dispersion models and was specially designed to support the USEPA"s regulatory modelling programs.

Further details regarding the two models are presented in Sections 5.1.1 and 5.1.2. Samples of the DISPMOD and AERMOD input files are included as Appendix A and B respectively.

5.1.1 DISPMOD

The air dispersion model DISPMOD was developed by the DER specifically for application within the Kwinana region. DISPMOD is a Gaussian air dispersion model that includes the effects of the Thermal Internal Boundary Layer (TIBL) and Mechanical Internal Boundary Layer (MIBL). The TIBL has been demonstrated to have a significant impact on plume dispersion in the Kwinana region via a process known as shoreline fumigation and therefore its correct parameterisation within the model is a very important component.

For the most recent Kwinana EPP redetermination (DER, 2009), two versions of DISPMOD were applied as follows:

- DISPMOD97 – developed from earlier versions of DISPMOD and includes the findings from a major field experiment conducted at Kwinana in 1995. Rayner and Blockley (2000) describe the changes incorporated into DISPMOD97; and
- DISPMOD05 – developed from DISPMOD97 and includes a number of changes and modifications to incorporate:
  - AUSPLUME convective dispersion formulation;
  - AERMOD plume lofting scheme;
  - Draxler lateral dispersion scheme; and
  - alternative schemes for plume trapping or penetration through temperature inversions.

DISPMOD was used to assess the impacts of all of the modelled pollutants, with the exception of odour (which was undertaken using AERMOD). A cumulative assessment of the impacts of SO_2 emissions from the proposed WtE facility and from other SO_2 sources within the KIA has been undertaken utilising the emissions inventory developed for the most recent Kwinana EPP redetermination.

In the absence of detailed emissions inventories for other modelled compounds, a cumulative assessment of the impacts of the proposed WtE facility has been undertaken for compounds where ambient monitoring data is available (i.e. NO_2, PM_{10}, $PM_{2.5}$, and heavy metals (i.e. lead, cadmium, mercury, antimony, arsenic, copper, chromium VI, manganese and nickel) as described in Section 4), by adding the maximum GLCs predicted at the

nominated receptors to the maximum ambient concentrations of the measured pollutants at each site (refer to Section 6.3). It is noted that this assessment is extremely conservative for the short term (i.e. 1-hour and 24-hour) averaging times as it is assumed that the maximum predicted GLCs for the proposed WtE facility operations occur at the same time as the maximum ambient concentrations measured at the monitoring sites, which is not expected to occur in reality.

5.1.2 AERMOD

AERMOD is a current-generation air dispersion model that incorporates concepts such as planetary boundary layer theory and advanced methods for handling complex terrain and was developed to replace the Industrial Source Complex Model-Short Term (ISCST3) as the USEPA"s preferred model for most local scale regulatory applications. AERMOD was used to assess the impacts of odorous emissions from the proposed WtE facility in isolation, as DISPMOD is limited in its capability to account for fugitive emissions from volume sources, such as the tipping hall doors.

5.2 Meteorological Data

5.2.1 DISPMOD

Meteorological datasets used in DISPMOD were developed by the DER for the 1980, 1995 and 1996 calendar years, consistent with the approach used for the most recent redetermination (DER, 2009). Previous studies conducted by the DER have determined that these years are considered representative of meteorology in the region.

5.2.2 AERMOD

AERMET, the meteorological pre-processor for AERMOD, was used to process measured meteorological data from the Alcoa mudlakes meteorological monitoring station, located approximately 3 km east of the proposed WtE facility. Measured 10-minute averages of the following parameters were provided by the KIC for the 2011 calendar year:

- wind speed;
- wind direction;
- standard deviation of wind direction;
- temperature;
- temperature difference (between 2 m and 10 m);
- atmospheric pressure;
- net solar radiation; and
- precipitation

Where single 10-minute records of wind speed, wind direction and temperature were missing, these were substituted with the average of the records before and after the missing data. Where more than one consecutive 10-minute record was missing, the whole hour(s) in which the record fell was entered as missing data. The average data recovery for each parameter following this treatment was 99% over the year.

The Upper Air Estimator tool within AERMET was used to estimate upper air data. This is a non-US EPA AERMET option, which allows the pre-processing of meteorological data in

AERMET without the use of actual upper air data. The Upper Air Estimator tool was developed by Lakes Environmental and is designed to allow the US EPA AERMET program to run for sites without upper air data. This option estimates upper air data from the hourly surface data. Mixing height is not considered to be a significant factor for low level fugitive emission sources, such as the tipping hall doors, and the use of the Upper Air Estimator tool was considered appropriate for this application. The non-default BETA option to adjust surface friction velocity for low wind speed stable conditions was selected within AERMET, following discussions with the DER. Samples of the AERMET input files are presented in Appendix B. The albedo and Bowen ratio values were based on AERMET guidance for the land-use type corresponding to the surrounds of the meteorological monitoring station.

The annual wind rose derived from wind speed and direction measurements at the Alcoa mudlakes site for the 2011 calendar year was compared to the annual wind roses derived from the meteorological data collected by the DER at the Hope Valley monitoring site during the 1996 calendar year. Moderate easterlies and stronger south-westerlies dominate the winds at the Alcoa mudlakes sites, which is consistent with the wind rose for the Hope Valley site (Figure 7). However, the Hope Valley data does exhibit stronger south-westerly and lower easterly components than the Alcoa mudlake data, which may be attributable to the different monitoring locations or differences in the general meteorology associated with the monitoring years.

5.3 Model Parameterisation

5.3.1 DISPMOD

Both versions of DISPMOD (i.e. DISPMOD97 and DISPMOD05) were used in the assessment of the impacts of SO_2 emissions from the proposed WtE facility to retain consistency with the 2009 Kwinana EPP SO_2 redetermination. DISPMOD05 was used for the assessment of the other modelled compounds, as the more conservative of the two model versions (as demonstrated in Section 6.1).

The air dispersion modelling for SO_2 was completed using the three model domains summarised in Table 8, in line with the 2009 redetermination.

Table 8: Summary of Model Domains Applied for SO_2 Assessment

Domain Name	Full	Eastern	Northern
Bottom Left Coordinate (mE AMG)	375000	385700	386350
Bottom Left Coordinate (mN AMG)	6424000	6433050	6442600
Number of x coordinates	21	18	18
Number of x coordinates	26	18	18
Grid Interval (m)	1000	100	100

The full model domain is the same as that used in the 1992 redetermination and covers the area shown on Figure 1 and used a grid interval of 1,000 m. The northern and eastern model domains were used in the 2009 redetermination to better define the potential impacts in areas where elevated concentrations (1-hour average for northern and 24-hour average for

eastern) were predicted to occur on the full grid. The northern and eastern model domains used a grid interval of 100 m. All model domains are presented as Figure 1.

The air dispersion modelling for compounds other than SO_2 was completed using a single model domain covering an area of 8 km by 8 km and centered on the proposed Phoenix WtE facility. This grid was modelled with a spacing of 400 m, the bounds of which are presented in Figure 16.

DISPMOD was run in "tracer" mode (for all compounds with the exception of SO_2) using a unit emission rate of 1 g/s for the stack source. As particulates are expected to be less than 0.1 microns it was deemed appropriate to model as a tracer gas. The results generated from DISPMOD were then processed through a series of post-processing methods to take into account the effect of actual pollutant emission rates from each source for each hour of the model run and grid point.

5.3.2 AERMOD

AERMOD (version 12345) was used for the air dispersion modelling assessment of odorous emissions from the proposed WtE facility. The model was set up to predict concentrations at ground level within a model domain of 8 km by 8 km centered on the proposed Phoenix WtE facility and with grid intervals of 200 m.

Terrain elevation data for the model domain was obtained from the US National Aeronautics and Space Administration"s (NASA) Shuttle Radar Topography Mission (SRTM3/SRTM1). Terrain elevation data were incorporated into AERMOD using the AERMAP terrain processor. AERMOD was run using the rural dispersion coefficient and the adjusted friction velocity option (Adjust Horizontal Meander) was selected, in line with the treatment of meteorological data within AERMET.

5.4 Emission Estimates and Stack Parameters

Phoenix Energy provided ENVIRON with a list of emissions rates for various compounds expected from the plant under „normal operating conditions" and for odour, under a hypothetical scenario, which ignores the beneficial implications of maintaining negative air pressure in the tipping hall. The emission rates were derived from a combination of stack testing from similar operating facilities internationally and European Directive 2000/76/EC compliance emission limits (EU, 2000). ENVIRON initially undertook a hypothetical screening exercise by using the extremely conservative assumption that the Air Pollution Control (APC) system is designed to achieve the WID limits and that all pollutants were simultaneously at their WID limit values (i.e. essentially ignoring the fact that both Martin grate lines will operate independently and in parallel). Where the results of the screening assessment indicated a potentially significant contribution to the GLC for a particular pollutant, the modelling reverted to using an emission rate derived from actual stack test results obtained from existing Martin GmbH reference facilities. The results of the screening assessment can be found in Appendix C.

Where emission rates are derived from WID limit values, Phoenix Energy considers that those emissions rates are highly conservative and represent hypothetical worst case emission rates from the facility. Phoenix Energy expects that the actual operating emission rates will either be (a) below the rates modelled, where those rates are derived from WID

limit value concentrations; or (b) similar to the rates modelled, where actual stack test emission concentrations were used for the air dispersion modelling.

Phoenix Energy have indicated that when the proposed WtE facility is starting up or shutting down, either because of a planned maintenance period or in response to an unplanned emergency event, the release rate of all pollutants will decrease, as the waste input to the furnace will either be ramping up to full capacity (in the case of a plant start-up) or will cease (in the case of a plant shutdown). The maximum emissions rates for the facility operating under „normal conditions", as described above, have therefore been applied in this assessment as the „worst-case" emissions scenario.

A summary of the stack parameters and emissions rates are provided in Table 9. The air dispersion modelling assessment has considered odour emissions as a volume source of fugitives from the tipping hall and waste bunker (as discussed with the DER), while all other modelled compounds are associated with emissions from the multi-flue stack. The multi-flue stack has been modelled as a single stack source using exhaust parameters provided by Phoenix Energy and an effective stack diameter was calculated based on the exit velocity and combined volumetric flow rate for each flue. However, as the combination of multi-flue emissions can be dependent on wind direction, an additional model run has been completed assuming no buoyancy enhancement between the two plumes. The results of this assessment are presented in Appendix D.

The maximum predicted $PM_{2.5}$ GLCs have been assessed as representative of TSP and PM_{10}. However, Phoenix Energy expects particulate matter from the multi-flue stack will be comprised primarily of particles less than 0.1 micron in diameter.

Table 9: Summary of Emission Estimates and Stack Parameters

Parameter	Unit	Multi-flue Stack	Tipping Hall and Waste Bunker
Easting	m	384,946	384,819
Northing	m	6,435,610	6,435,605
Building dimensions (L x W x H)	m		56.1 x 56.1 x 7.5
Multi-Flue Stack Release Height	m	87.5	
Effective Stack Diameter[1]	m	3.0	-
Exit Velocity	m/s	18.3	-
Exit Temperature	K	405	-
Initial Lateral Dimension	m	-	14.26
Initial Vertical Dimension	m	-	3.63
Modelled Compounds			
SO_2[2]	g/s	19	-
NO_x[3]	g/s	8.4	-
Particulate Matter[2]	g/s	2.9	-

Table 9: Summary of Emission Estimates and Stack Parameters

Parameter	Unit	Multi-flue Stack	Tipping Hall and Waste Bunker
CO[2]	g/s	9.7	-
HF[2]	g/s	0.4	-
HCl[2]	g/s	5.8	-
Dioxins and Furans[2]	g/s	9.7E-09	-
Antimony[3]	g/s	6.8E-05	-
Arsenic[3]	g/s	6.7E-05	-
Cadmium[3]	g/s	4.4E-05	-
Chromium VI[3]	g/s	4.8E-05	-
Copper[3]	g/s	1.2E-04	-
Lead[3]	g/s	2.6E-04	-
Manganese[3]	g/s	1.7E-04	-
Mercury[3]	g/s	1.6E-03	-
Nickel[3]	g/s	1.9E-04	-
Odour[4]	OU/s	-	545

Notes
1. Effective stack diameter calculated based on the exit velocity and combined volumetric flow rate for each flue.
2. Emission estimate based on WID Emission Limits.
3. Emission estimate based on stack testing data provided by Phoenix Energy.
4. Based on odour estimates provided by Phoenix Energy.

The European Directive 2000/76/EC also includes emission concentrations for Total Organic Carbon (TOC). As there is no air quality objective or environmental assessment level for TOC or VOCs collectively, it is necessary to use a reference species for modelling purposes. However, the stack testing results from similar operating facilities, as provided by Phoenix Energy, do not provide speciation of the measurements for VOCs and Total Hydrocarbons. While benzene can conservatively be used to represent VOCs, the available stack test data does not provide any evidence of the presence of benzene or commentary on the use of benzene to represent VOCs or TOC for this type of facility. In the absence of representative speciation data, TOCs have not been considered in this assessment.

5.5 Treatment of Oxides of Nitrogen Concentrations

In the absence of information on the ratio of NO_2 to total oxides of nitrogen (NO_x) present in stack emissions, the Ambient Ratio Method (ARM) and the equation developed by Dames and Moore (1993) was used for this assessment of NO_2 impacts.

The ARM typically relies on at least a year"s worth of ambient monitoring data and assumes the final NO_2 to NO_x ratio will be equal to the existing ambient NO_2 to NO_x ratio. An equation

developed by Dames and Moore (1993) based on monitoring data from Kwinana determined a NO_2 to NO_x ratio of 0.59 to 0.43 as follows:

$$NO_2 = 0.59 \times NO_x - 0.00038 \times NO_x^2 \qquad \text{Equation 2}$$

Where:

NO_2 = ambient concentration of nitrogen dioxide ($\mu g/m^3$)

NO_x = ambient concentration of oxides of nitrogen ($\mu g/m^3$)

The ARM accounts for the NO_2 present in emissions from the proposed WtE facility, and also accounts for the conversion of NO to NO_2.

This method is considered to be conservative (i.e. tending to over-predict GLCs) as:

- the fraction of NO_2 present in emissions is expected to be low given the nature of NO_x emission sources from the proposed WtE facility; and
- the background ozone levels in the Kwinana region are relatively low, limiting photochemical conversion of NO to NO_2.

6 Modelling Results

6.1 Normal Operations – Sulphur Dioxide

The results of the DISPMOD modelling for SO_2 are summarised for the approved industry emissions and the cumulative impacts with the proposed WtE facility, as follows:

- Existing Kwinana Industry emissions, using the Maximum Permissible Quantities (Tables 10 to 12);
- Existing Kwinana Industry emissions with the proposed WtE facility (Tables 13 to 15); and
- Difference between the predicted concentration statistics with and without the proposed WtE facility (Tables 16 to 18).

The tabulated results are presented for the three modelling domains (Full, Eastern and Northern) respectively.

Contours of the predicted GLCs of SO_2 for the Existing Kwinana Industry emissions and for the Existing Kwinana Industry emissions with the proposed WtE facility are presented in Figures 8 to 11, as follows:

- Maximum predicted 1-hr average GLC of SO_2 (Figure 8);
- 9^{th} highest predicted 1-hr average GLC of SO_2 (Figure 9);
- Maximum predicted 24-hr average GLC of SO_2 (Figure 10); and
- Predicted annual average GLC of SO_2 (Figure 11).

It should be noted that the predicted GLC contours are presented for the Full modelling domain using DISPMOD 2005 for the 1996 calendar year only, as this combination tends to be the most conservative (i.e. highest predicted GLCs).

Table 10: DISPMOD SO_2 Air Dispersion Modelling Results – Full Modelling Domain – Existing Industry																
Model Domain	**Area**	**DISPMOD 1997**			**DISPMOD 2005**			**EPP Guidelines**		**% Guidelines DM 1997**			**% Guidelines DM 2005**		
		1980	**1995**	**1996**	**1980**	**1995**	**1996**	**Standard**	**Limit**	**1980**	**1995**	**1996**	**1980**	**1995**	**1996**
1hr max. (ug/m^3)	A	682	717	700	965	1016	1084	na	1400	49%	51%	50%	69%	73%	77%
	B	422	412	416	454	481	450	na	1000	42%	41%	42%	45%	48%	45%
	C	305	316	323	375	357	339	na	700	44%	45%	46%	54%	51%	48%
1hr 99.9th percentile (ug/m^3)	A	515	605	591	730	872	869	700	na	74%	86%	84%	104%	125%	124%
	B	319	298	338	335	322	362	500	na	64%	60%	68%	67%	64%	72%
	C	233	223	257	235	233	258	350	na	67%	64%	73%	67%	67%	74%
No. hours 1hr max. >350 ug/m^3	A	33	80	63	132	166	127								
	B	3.3	2.5	6.9	4.9	3.9	12								
	C	0.4	0.7	0.4	1.0	1.4	0.9								
No. hours 1hr max. >500 ug/m^3	A	10	27	23	34	96	72								
	B	0.2	0.2	0.2	0.2	0.8	0.2								
	C	0.0	0.0	0.0	0.0	0.1	0.0								
No. hours 1hr max. >700 ug/m^3	A	0.7	1.6	1.0	11	39	32								
	B	0.0	0.0	0.0	0.0	0.0	0.0								
	C	0.0	0.0	0.0	0.0	0.0	0.0								
24hr max. (ug/m^3)	A	106	117	121	143	186	208	200	365	29%	32%	33%	39%	51%	57%
	B	84	94	91	98	93	126	150	200	42%	47%	45%	49%	47%	63%
	C	72	97	67	70	87	68	125	200	36%	49%	34%	35%	44%	34%
No. days 24hr max. >125 ug/m^3	A	0	0	0	3	6	5								
	B	0	0	0	0	0	1								
	C	0	0	0	0	0	0								
Annual average (ug/m^3)	A	24	22	23	31	26	29	60	80	31%	27%	29%	39%	32%	36%
	B	14	12	15	14	13	16	50	60	23%	21%	25%	24%	21%	27%
	C	11	11	12	10	10	11	50	60	19%	18%	21%	17%	17%	19%

Table 11: DISPMOD SO_2 Air Dispersion Modelling Results – Eastern Modelling Domain – Existing Industry															
Model Domain	**Area**	**DISPMOD 1997**			**DISPMOD 2005**			**EPP Guidelines**		**% Guidelines DM 1997**			**% Guidelines DM 2005**		
		1980	**1995**	**1996**	**1980**	**1995**	**1996**	**Standard**	**Limit**	**1980**	**1995**	**1996**	**1980**	**1995**	**1996**
1hr max. (ug/m^3)	A	305	311	342	331	353	354	na	1400	22%	22%	24%	24%	25%	25%
	B	431	391	405	470	431	433	na	1000	43%	39%	41%	47%	43%	43%
	C	356	358	329	397	405	379	na	700	51%	51%	47%	57%	58%	54%
1hr 99.9th percentile (ug/m^3)	A	202	228	210	220	241	228	700	na	29%	33%	30%	31%	34%	33%
	B	261	292	261	281	311	281	500	na	52%	58%	52%	56%	62%	56%
	C	200	251	208	218	266	227	350	na	57%	72%	59%	62%	76%	65%
No. hours 1hr max. >350 ug/m^3	A	0	1	1	1	1	1								
	B	3	3	4	4	6	4								
	C	1	2	0	1	3	1								
No. hours 1hr max. >500 ug/m^3	A	0	0	0	0	0	0								
	B	0	0	0	1	1	0								
	C	0	0	0	1	0	0								
No. hours 1hr max. >700 ug/m^3	A	0	0	0	0	0	0								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
24hr max. (ug/m^3)	A	62	52	70	63	53	70	200	365	17%	14%	19%	17%	14%	19%
	B	88	72	64	89	74	67	150	200	44%	36%	32%	45%	37%	34%
	C	54	68	50	56	70	51	125	200	27%	34%	25%	28%	35%	26%
No. days 24hr max. >125 ug/m^3	A	0	0	0	0	0	0								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
Annual average (ug/m^3)	A	5.5	5.3	5.3	5.5	5.3	5.3	60	80	7%	7%	7%	7%	7%	7%
	B	8.4	7.2	7.9	8.3	7.2	8.0	50	60	14%	12%	13%	14%	12%	13%
	C	4.7	4.7	4.4	4.8	4.7	4.4	50	60	8%	8%	7%	8%	8%	7%

Table 12: DISPMOD SO_2 Air Dispersion Modelling Results – Northern Modelling Domain – Existing Industry															
Model Domain	**Area**	**DISPMOD 1997**			**DISPMOD 2005**			**EPP Guidelines**		**% Guidelines DM 1997**			**% Guidelines DM 2005**		
		1980	**1995**	**1996**	**1980**	**1995**	**1996**	**Standard**	**Limit**	**1980**	**1995**	**1996**	**1980**	**1995**	**1996**
1hr max. (ug/m^3)	A	381	320	381	480	434	506	na	1400	27%	23%	27%	34%	31%	36%
	B	329	308	356	371	367	409	na	1000	33%	31%	36%	37%	37%	41%
	C	350	305	363	396	359	416	na	700	50%	44%	52%	57%	51%	59%
1hr 99.9th percentile (ug/m^3)	A	292	250	300	350	313	369	700	na	42%	36%	43%	50%	45%	53%
	B	269	248	287	292	272	317	500	na	54%	50%	57%	58%	54%	63%
	C	277	246	288	298	263	315	350	na	79%	70%	82%	85%	75%	90%
No. hours 1hr max. >350 ug/m^3	A	2	1	2	9	5	12								
	B	1	0	1	2	1	4								
	C	1	0	1	3	1	4								
No. hours 1hr max. >500 ug/m^3	A	0	0	0	1	0	1								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
No. hours 1hr max. >700 ug/m^3	A	0	0	0	0	0	0								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
24hr max. (ug/m^3)	A	80	103	66	90	94	80	200	365	22%	28%	18%	25%	26%	22%
	B	75	105	69	82	95	72	150	200	38%	52%	34%	41%	47%	36%
	C	74	105	65	78	95	68	125	200	37%	53%	33%	39%	47%	34%
No. days 24hr max. >125 ug/m^3	A	0	0	0	0	0	0								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
Annual average (ug/m^3)	A	14	12	14	15	13	16	60	80	17%	15%	18%	19%	16%	20%
	B	13	12	14	15	13	15	50	60	22%	21%	24%	24%	22%	25%
	C	13	12	13	12	12	13	50	60	21%	20%	22%	21%	20%	22%

Table 13: DISPMOD SO_2 Air Dispersion Modelling Results – Full Modelling Domain – Existing Industry with Kwinana WtE Facility																
Model Domain	**Area**	**DISPMOD 1997**			**DISPMOD 2005**			**EPP Guidelines**		**% Guidelines DM 1997**			**% Guidelines DM 2005**		
		1980	**1995**	**1996**	**1980**	**1995**	**1996**	**Standard**	**Limit**	**1980**	**1995**	**1996**	**1980**	**1995**	**1996**
1hr max. (ug/m^3)	A	683	718	703	965	1016	1087	na	1400	49%	51%	50%	69%	73%	78%
	B	422	435	416	454	482	451	na	1000	42%	44%	42%	45%	48%	45%
	C	309	317	326	375	365	352	na	700	44%	45%	47%	54%	52%	50%
1hr 99.9th percentile (ug/m^3)	A	515	605	597	731	875	871	700	na	74%	86%	85%	104%	125%	124%
	B	320	301	342	335	324	364	500	na	64%	60%	68%	67%	65%	73%
	C	236	224	258	237	234	260	350	na	67%	64%	74%	68%	67%	74%
No. hours 1hr max. >350 ug/m^3	A	34	81	64	132	168	128								
	B	3.5	3.5	7.4	5.1	3.9	12.6								
	C	0.5	0.7	0.4	1.0	1.4	1.0								
No. hours 1hr max. >500 ug/m^3	A	10	28	23	34	97	73								
	B	0.2	0.2	0.2	0.2	0.8	0.2								
	C	0.0	0.0	0.0	0.0	0.1	0.0								
No. hours 1hr max. >700 ug/m^3	A	0.7	1.6	1.0	10.9	39.6	32.5								
	B	0.0	0.0	0.0	0.0	0.0	0.0								
	C	0.0	0.0	0.0	0.0	0.0	0.0								
24hr max. (ug/m^3)	A	106	117	122	143	187	208	200	365	29%	32%	33%	39%	51%	57%
	B	84	94	91	99	94	126	150	200	42%	47%	46%	49%	47%	63%
	C	73	98	68	71	88	69	125	200	36%	49%	34%	36%	44%	34%
No. days 24hr max. >125 ug/m^3	A	0	0	0	3	7	5								
	B	0	0	0	0	0	1								
	C	0	0	0	0	0	0								
Annual average (ug/m^3)	A	25	22	23	31	26	29	60	80	31%	28%	29%	39%	33%	36%
	B	14	12	15	15	13	16	50	60	24%	21%	26%	24%	21%	27%
	C	12	11	13	10	10	11	50	60	19%	18%	21%	17%	17%	19%

Table 14: DISPMOD SO_2 Air Dispersion Modelling Results – Eastern Modelling Domain – Existing Industry with Kwinana WtE Facility															
Model Domain	**Area**	**DISPMOD 1997**			**DISPMOD 2005**			**EPP Guidelines**		**% Guidelines DM 1997**			**% Guidelines DM 2005**		
		1980	**1995**	**1996**	**1980**	**1995**	**1996**	**Standard**	**Limit**	**1980**	**1995**	**1996**	**1980**	**1995**	**1996**
1hr max. (ug/m^3)	A	305	311	342	331	353	354	na	1400	22%	22%	24%	24%	25%	25%
	B	431	391	405	470	431	433	na	1000	43%	39%	41%	47%	43%	43%
	C	356	358	329	397	405	379	na	700	51%	51%	47%	57%	58%	54%
1hr 99.9th percentile (ug/m^3)	A	202	228	210	223	241	229	700	na	29%	33%	30%	32%	34%	33%
	B	261	292	261	281	311	281	500	na	52%	58%	52%	56%	62%	56%
	C	200	253	209	218	268	227	350	na	57%	72%	60%	62%	77%	65%
No. hours 1hr max. >350 ug/m^3	A	0	1	1	1	1	1								
	B	3	3	4	4	6	4								
	C	1	2	0	1	3	1								
No. hours 1hr max. >500 ug/m^3	A	0	0	0	0	0	0								
	B	0	0	0	1	1	0								
	C	0	0	0	1	0	0								
No. hours 1hr max. >700 ug/m^3	A	0	0	0	0	0	0								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
24hr max. (ug/m^3)	A	62	52	70	63	53	70	200	365	17%	14%	19%	17%	14%	19%
	B	88	72	64	89	74	67	150	200	44%	36%	32%	45%	37%	34%
	C	54	69	50	56	70	51	125	200	27%	34%	25%	28%	35%	26%
No. days 24hr max. >125 ug/m^3	A	0	0	0	0	0	0								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
Annual average (ug/m^3)	A	5.6	5.3	5.3	5.6	5.3	5.4	60	80	7%	7%	7%	7%	7%	7%
	B	8.5	7.2	8.1	8.4	7.3	8.1	50	60	14%	12%	13%	14%	12%	14%
	C	4.8	4.7	4.4	4.8	4.8	4.5	50	60	8%	8%	7%	8%	8%	7%

Table 15: DISPMOD SO_2 Air Dispersion Modelling Results – Northern Modelling Domain – Existing Industry with Kwinana WtE Facility																
Model Domain	**Area**	**DISPMOD 1997**			**DISPMOD 2005**			**EPP Guidelines**		**% Guidelines DM 1997**			**% Guidelines DM 2005**		
		1980	**1995**	**1996**	**1980**	**1995**	**1996**	**Standard**	**Limit**	**1980**	**1995**	**1996**	**1980**	**1995**	**1996**
1hr max. (ug/m^3)	A	382	320	382	481	435	506	na	1400	27%	23%	27%	34%	31%	36%
	B	331	310	358	372	367	412	na	1000	33%	31%	36%	37%	37%	41%
	C	354	307	365	397	362	419	na	700	51%	44%	52%	57%	52%	60%
1hr 99.9th percentile (ug/m^3)	A	293	252	302	352	314	370	700	na	42%	36%	43%	50%	45%	53%
	B	270	249	289	294	274	320	500	na	54%	50%	58%	59%	55%	64%
	C	280	247	290	300	264	318	350	na	80%	71%	83%	86%	75%	91%
No. hours 1hr max. >350 ug/m^3	A	2	1	2	9	5	12								
	B	1	0	1	3	2	4								
	C	1	0	2	3	1	4								
No. hours 1hr max. >500 ug/m^3	A	0	0	0	1	0	1								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
No. hours 1hr max. >700 ug/m^3	A	0	0	0	0	0	0								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
24hr max. (ug/m^3)	A	80	104	67	90	95	80	200	365	22%	29%	18%	25%	26%	22%
	B	76	106	69	83	95	72	150	200	38%	53%	35%	41%	48%	36%
	C	75	106	66	79	96	68	125	200	37%	53%	33%	39%	48%	34%
No. days 24hr max. >125 ug/m^3	A	0	0	0	0	0	0								
	B	0	0	0	0	0	0								
	C	0	0	0	0	0	0								
Annual average (ug/m^3)	A	14	12	15	15	13	16	60	80	17%	15%	18%	19%	16%	20%
	B	14	13	14	15	13	15	50	60	23%	21%	24%	25%	22%	25%
	C	13	12	14	13	12	13	50	60	21%	20%	23%	21%	20%	22%

Table 16: Difference Between Predicted Concentrations for Existing Kwinana Sources With and Without Kwinana WtE Facility – Full Domain

Model Domain	Area	DISPMOD 1997			DISPMOD 2005		
		1980	1995	1996	1980	1995	1996
1hr max. (µg/m^3)	A			3			3
	B		23				
	C	4		3		8	13
1hr 99.9th percentile (µg/m^3)	A			6		3	2
	B		3	4		2	2
	C	3			2		2
No. hours 1hr max. >350 µg/m^3	A	1	1	1		2	
	B		1				
	C						
No. hours 1hr max. >500 µg/m^3	A						
	B						
	C						
No. hours 1hr max. >700 µg/m^3	A						
	B						
	C						
24hr max. (µg/m^3)	A						
	B						
	C						
No. days 24hr max. >125 µg/m^3	A						
	B						
	C						
Annual average (µg/m^3)	A						
	B						
	C						

Notes

1. Where the predicted difference between the runs was less than 1.0 µg/m^3 the value has been deleted for ease of reading.
2. The value is a subtraction of new less old and is reflective of an increase in concentration (or number of exceedances) over and above any current predictions.

Table 17: Difference Between Predicted Concentrations for Existing Kwinana Sources With and Without Kwinana WtE Facility – Eastern Domain

Model Domain	Area	DISPMOD 1997			DISPMOD 2005		
		1980	1995	1996	1980	1995	1996
1hr max. (µg/m^3)	A						
	B						
	C						
1hr 99.9th percentile (µg/m^3)	A				3		
	B						
	C		2			2	
No. hours 1hr max. >350 µg/m^3	A						
	B						
	C						
No. hours 1hr max. >500 µg/m^3	A						
	B						
	C						
No. hours 1hr max. >700 µg/m^3	A						
	B						
	C						
24hr max. (µg/m^3)	A						
	B						
	C						
No. days 24hr max. >125 µg/m^3	A						
	B						
	C						
Annual average (µg/m^3)	A						
	B						
	C						

Notes

1. Where the predicted difference between the runs was less than 1.0 µg/m^3 the value has been deleted for ease of reading.
2. The value is a subtraction of new less old and is reflective of an increase in concentration (or number of exceedances) over and above any current predictions.

Table 18: Difference Between Predicted Concentrations for Existing Kwinana Sources With and Without Kwinana WtE Facility – Northern Domain

Model Domain	Area	DISPMOD 1997			DISPMOD 2005		
		1980	1995	1996	1980	1995	1996
1hr max. (µg/m^3)	A						
	B	2	2	2			3
	C	4	2	2		3	3
1hr 99.9th percentile (µg/m^3)	A		2	2	2		
	B			2	2	2	3
	C	3		2	2		3
No. hours 1hr max. >350 µg/m^3	A						
	B						
	C						
No. hours 1hr max. >500 µg/m^3	A						
	B						
	C						
No. hours 1hr max. >700 µg/m^3	A						
	B						
	C						
24hr max. (µg/m^3)	A						
	B						
	C						
No. days 24hr max. >125 µg/m^3	A						
	B						
	C						
Annual average (µg/m^3)	A						
	B						
	C						

Notes

1. Where the predicted difference between the runs was less than 1.0 µg/m^3 the value has been deleted for ease of reading.
2. The value is a subtraction of new less old and is reflective of an increase in concentration (or number of exceedances) over and above any current predictions.

The DISPMOD modelling results indicate that the emissions from the proposed WtE facility will not result in a significant increase to the maximum predicted GLCs of SO_2 associated with emissions from the existing industry located in Kwinana. This finding is based on a comparison of the modelling results for Existing Kwinana Industry emissions, with and without the proposed WtE facility emissions, which indicates the following:

- Very little change to the existing maximum predicted GLCs of SO_2 within Area A;
- No significant change to the existing maximum predicted GLCs of SO_2 within Area B and Area C;

- Up to a 23 µg/m^3 increase in the maximum predicted 1-hr average GLC of SO_2 is predicted to occur (within Area B), which represents an increase from 41% (Existing Industry) to 44% (Existing Industry with Kwinana WtE Facility) of the Area B Limit;
- Up to a 6 µg/m^3 increase in the 9th highest predicted 1-hr average GLC of SO_2 is predicted to occur (within Area A), which represents an increase from 84% (Existing Industry) to 85% (Existing Industry with Kwinana WtE Facility) of the Area A Standard;
- The largest increases in the GLCs are predicted to occur within Area B (Full modelling domain), located immediately east of the proposed location for the proposed Kwinana WtE facility.

The DISPMOD modelling results also indicate broad compliance with the Kwinana EPP Limits and Standards, except for a number of exceedances that are predicted to also occur for Existing Kwinana Industry emissions, without the proposed Kwinana WtE facility. The predicted exceedances occur within Area A, in the immediate vicinity of the BP Refinery and Alcoa Alumina Refinery, and were identified as part of the redetermination (DER, 2009) to represent an over-prediction. The proposed Kwinana WtE facility does not affect or add to these predicted exceedances.

It can therefore be concluded that the emissions from the proposed Kwinana WtE facility are not expected to significantly increase the maximum predicted GLCs of SO_2 within the Kwinana area, and will not result in any change to compliance with the Standards and Limits of the Kwinana EPP.

6.1.2 Kwinana WtE Facility in Isolation

The results of DISPMOD modelling of SO_2 emissions from the proposed Kwinana WtE facility in isolation are presented in Table 19. The results have been presented for the Full modelling domain using DISPMOD 2005 for the 1996 calendar year only, as this combination tends to be the most conservative (i.e. highest predicted GLCs).

Table 19: Predicted SO_2 Concentrations for Kwinana WtE Facility in Isolation – Full Domain

Model Domain	Area	EPP Guidelines		DISPMOD 2005	% Guideline
		Standard	Limit	1996	
1hr max. (µg/m^3)	A	na	1400	36	2.6%
	B	na	1000	35	3.5%
	C	na	700	17	2.4%
1hr 99.9th percentile (µg/m^3)	A	700	na	21	3.0%
	B	500	na	21	4.2%
	C	350	na	10	2.9%
24hr max. (µg/m^3)	A	200	365	7.0	3.5%
	B	150	200	6.4	4.3%
	C	125	200	1.9	1.5%
Annual average (µg/m^3)	A	60	80	0.4	0.7%
	B	50	60	0.8	1.6%
	C	50	60	0.2	0.3%

The data presented in Table 19 indicates that the predicted SO_2 GLCs for the proposed Kwinana WtE facility operating in isolation are expected to remain well below the Kwinana EPP Limits and Standards. The maximum 1-hour average SO_2 GLCs predicted for Areas A, B and C represent no more than 3.5% of the applicable Limit value. The 99.9th percentile 1-hour average SO_2 GLCs predicted within each of the Policy areas are no greater than 4.2% of the applicable Standard value. The maximum predicted 24-hour average SO_2 GLCs are similarly no more than 4.3% of the corresponding Standard, while the annual average predicted SO_2 GLCs remain less than 1.6% of the applicable Standard.

Contours of the maximum 1-hour average and 99.9th percentile 1-hour average SO_2 GLCs indicate that peak concentrations are expected to occur approximately 1 km south west of the proposed WtE facility (Figures 12 and 13). The peak 24-hour average SO_2 GLCs are predicted to occur to the west of the proposed WtE facility (Figure 14), while peak annual average SO_2 GLCs are predicted to occur to the north east of the site (Figure 15).

6.2 Normal Operations – Other Pollutants

A summary of the maximum GLCs predicted for each of the modelled compounds using DISPMOD and the maximum emissions rates for the proposed WtE facility operating under „normal conditions" is presented in Table 20. The relevant ambient air quality criteria are provided for comparison.

The maximum predicted $PM_{2.5}$ GLCs have been assessed as representative of TSP and PM_{10}. However, as noted in Section 5.4, Phoenix Energy expects particulate matter from the flues will be comprised primarily of particles less than 0.1 micron in diameter.

Table 20: Summary of Predicted GLCs for Normal Operations (Maximum Emission Rates)

Compound	Averaging Period	DISPMOD 2005			Guideline (µg/m^3)[1]	% Guideline Value[2]
		1980	1995	1996		
NO_2	1-hour	13	11	12	246	5.3%
	Annual	0.2	0.2	0.2	62	0.3%
CO	8-hour	8.2	7.7	9.3	11,254	0.08%
$PM_{2.5}$	24-hour	1.0	1.0	1.0	25	4.0%
	Annual	0.1	0.1	0.1	8	1.3%
PM_{10}[3]	24-hour	1.0	1.0	1.0	50	2.0%
TSP[3]	1-hour	7.7	6.2	7.1	758[4]	1.0%
	24-hour	1.0	1.0	1.0	90[5]	1.1%
HF	1-hour	1.0	0.8	1.0	262	0.4%
	24-hour	0.1	0.1	0.1	1.5[6]/2.9[7]	6.7%[6]/3.4%[7]
	7-days	0.06	0.07	0.06	0.8[6]/1.7[7]	8.9%[6]/4.1%[7]
	30-days	0.04	0.04	0.04	0.4[6]/0.84[7]	11%[6]/4.8%[7]
	90-days	0.03	0.03	0.04	0.25[6]/0.5[7]	14%[6]/8.0%[7]
HCl	1-hour	16	12	14	153	10%
	Annual	0.3	0.2	0.3	10	3.0%
Lead	Annual	0.00001	0.00001	0.00001	0.5	0.002%
Cadmium	1-hour	0.0001	0.0001	0.0001	0.0196	0.5%
	24-hour	0.00002	0.00002	0.00002	0.022	0.1%
	Annual	0.000002	0.000002	0.000002	0.011	0.02%
Mercury	1-hour	0.004	0.003	0.004	0.65	0.6%
	Annual	0.00007	0.00006	0.00007	0.22	0.03%
Antimony	1-hour	0.0002	0.0001	0.0002	0.98	0.02%
	Annual	0.000003	0.000003	0.000003	0.033	0.009%
Arsenic	1-hour	0.0002	0.0001	0.0002	0.098	0.2%
	24-hour	0.00002	0.00002	0.00002	0.033	0.06%
	Annual	0.000003	0.000003	0.000003	0.0033	0.09%
Copper	1-hour	0.0003	0.0002	0.0003	20	0.002%
	24-hour	0.00004	0.00004	0.00004	1.1	0.004%
Chromium VI	1-hour	0.0001	0.0001	0.0001	0.098	0.1%

Table 20: Summary of Predicted GLCs for Normal Operations (Maximum Emission Rates)

Compound	Averaging Period	DISPMOD 2005			Guideline (µg/m^3)[1]	% Guideline Value[2]
		1980	1995	1996		
Chromium VI	24-hour	0.00002	0.00002	0.00002	0.33	0.006%
	Annual	0.000002	0.000002	0.000002	0.00022	1.0%
Manganese	1-hour	0.0005	0.0004	0.0004	20	0.003%
	24-hour	0.00006	0.00006	0.00006	0.16	0.04%
Nickel	1-hour	0.0005	0.0004	0.0005	0.19	0.3%
	24-hour	0.00007	0.00007	0.00007	0.15	0.05%
	Annual	0.000009	0.000007	0.000009	0.0033	0.3%
Dioxins and Furans	1-hour	3.0E-08	2.1E-08	2.4E-08	0.0000022	1.4%

Notes
1. Referenced to 0ºC, and 1013.25 hPa.
2. Comparison of maximum predicted GLC for the three modelled years against the relevant guideline value.
3. The maximum predicted $PM_{2.5}$ GLCs have been assessed as representative of TSP and PM_{10}.
4. Based on the Kwinana EPP 15-minute Area C Standard for TSP.
5. Kwinana EPP Area C Standard.
6. Specialised land use criteria, including all areas sensitive to fluoride.
7. General land use criteria, including residential.

The data presented in Table 20 indicates that the predicted GLCs are expected to comply with the applicable short-term and long-term ambient air quality guidelines for all of the modelled pollutants when considered in isolation.

The maximum 90-day average HF GLC predicted for the 1996 modelled year most closely approaches the relevant guideline, representing 14% of the ANZECC guideline applicable for specialised land use (Table 20), though once again it is noted that the assessment is using the very conservative assumption that both Martin grate lines are operating simultaneously at the WID limit. However, the specialised land use criteria are not intended for application within industrial areas or buffer zones associated with fluoride emitting industries (ANZECC, 1990). The general land use criteria, which are applicable within residential areas and are designed to protect most of the sensitive species in the natural environment, are considered more appropriate for application within the KIA. As such, the maximum predicted 90-day average HF GLC, which is predicted to occur within the boundaries of the KIA, represents 8.0% of the general land use guideline.

The maximum 30-day average HF GLC predicted for each of the modelled years is equal to 4.8% of the general land use criteria, while the maximum 7-day average predicted for the 1995 modelled year is equal to 4.1% of the general land use criteria (Table 20). The maximum predicted 24-hour average HF GLC also remains well below the general land use criteria, representing 3.4% of the guideline value. The maximum predicted 1-hour average HF GLC represents no more than 0.4% of the corresponding OEHHA guideline value (Table 20). Contours of the predicted 24-hour, 7-day, 30-day and 90-day average HF GLCs are presented in Figures 16 through 19 and indicate that peak concentrations are expected to occur approximately 1 km north east of the proposed WtE facility.

The maximum 1-hour average HCl GLC predicted for the 1980 modelled year represents 10% of the NSW OEH guideline (Table 20), though once again it is noted that the assessment is using the very conservative assumption that both Martin grate lines are operating simultaneously at the WID limit. Contours of the 1-hour HCl GLCs indicate that peak concentrations are expected to occur approximately 500 m to the west of the proposed Kwinana WtE site (Figure 20). The predicted annual average HCl GLCs remain well below the corresponding criteria, representing no more than 3.0% of the annual OEHHA guideline. Contours of the annual average HCl GLCs indicate that peak concentrations are expected to occur approximately 1 km north east of the proposed WtE facility (Figure 21).

The maximum 1-hour average NO_2 GLC predicted for the 1980 modelled year is 13 $\mu g/m^3$ (Table 20). This concentration represents 5.3% of the applicable NEPM Standard and is expected to occur to the west of the proposed WtE facility (Figure 22). The predicted annual average NO_2 GLCs remain well below the corresponding criteria, representing no more than 0.3% of the annual NEPM Standard. Contours of the annual average NO_2 GLCs indicate that peak concentrations are expected to occur approximately 1 km to the north east of the proposed WtE facility (Figure 23).

The maximum 24-hour average $PM_{2.5}$ GLC predicted for each of the modelled years represents 4.0% of the 24-hour NEPM Advisory Reporting Standard (Table 20). Contours of the 24-hour $PM_{2.5}$ GLCs indicate the maximum concentrations are expected to occur to the north east of the proposed WtE facility (Figure 24). The predicted annual average $PM_{2.5}$ GLCs remain well below the relevant guideline, representing no more than 1.3% of the annual NEPM Advisory Reporting Standard. Contours of the annual average $PM_{2.5}$ GLCs

indicate peak concentrations are also expected to occur to the north east of the proposed WtE facility (Figure 25). Compliance with the less stringent PM_{10} and TSP criteria is also demonstrated by these results.

The maximum 1-hour average dioxins and furans GLC predicted for any of the modelled years is 3.0E-08 µg-TEQ/m^3 and represents 1.4% of the applicable NSW OEH guideline (Table 20). Contours of the maximum 1-hour average dioxins and furans GLCs indicate peak concentrations are expected to occur to the west of the proposed Kwinana WtE site (Figure 26).

The predicted GLCs of CO and the remaining metals (i.e. lead, cadmium, mercury, antimony, arsenic, copper, chromium VI, manganese and nickel) associated with normal operations at maximum emission rates comfortably comply with the applicable air quality guidelines, being less than 1.0% of the corresponding short-term and long-term criteria[1].

6.3 Cumulative Impact Assessment

A summary of the cumulative impacts of the maximum emissions scenario for NO_2, PM_{10} and $PM_{2.5}$, under „normal operations" for the proposed WtE facility on ambient air quality at the available monitoring locations is presented in Table 21. The maximum ambient NO_2, PM_{10}, $PM_{2.5,}$ and heavy metals (i.e. lead, cadmium, mercury, antimony, arsenic, copper, chromium VI, manganese and nickel) concentrations measured throughout the Kwinana region (as presented in Section 4) have been used in this assessment.

The cumulative impact of the proposed WtE facility has been determined by adding the maximum GLCs predicted for NO_2, PM_{10} and $PM_{2.5}$ at the nominated receptors, to the maximum ambient concentrations measured at each site. The percentage change between the measured and cumulative GLCs predicted for the modelled scenario has also been presented.

It should be noted that this assessment is extremely conservative for the short term (i.e. 1-hour and 24-hour) averaging times as it is assumed that the maximum predicted GLCs for the proposed WtE facility operations occur at the same time as the maximum ambient concentrations measured at the monitoring sites, which is not expected to occur in reality.

[1] Note while contours have only been presented for compounds where the maximum predicted GLC is >1% of the corresponding short-term air quality guideline, the 1-hour and annual average dispersion patterns for the remaining modelled compounds can be inferred from Figures 20 and 21 and the predicted GLCs scaled accordingly (based on the emission rates presented in Table 9).

Table 21: Summary of Maximum Predicted Cumulative Impacts for Normal Operations (Maximum Emission Rates)

Compound	Averaging Period	Standard (µg/m^3)[8]	Parameter	Units[8]	Monitoring Station Sites				
					Hope Valley	Calista Primary School	Hillman Child Care Centre	Abercrombie Road	Kwinana Shopping Centre
NO_2	1-hour	246	Measured[1]	µg/m^3	173	101	88	n.a.	n.a.
			Measured + Maximum Predicted GLC[2]	µg/m^3	179	105	91		
				% Change	3.5%	3.4%	3.8%		
			Measured + Predicted 99.9th Percentile GLC[3]	µg/m^3	178	103	90		
				% Change	2.8%	1.9%	2.2%		
	Annual	62	Measured[1]	µg/m^3	10	10	12		
			Measured + Maximum Predicted GLC[4]	µg/m^3	10	10	12		
				% Change	0.9%	0.1%	0.08%		
PM_{10}	24-hour	50	Measured[1]	µg/m^3	n.a.	n.a.	n.a.	63[6]	n.a.
			Measured + Maximum Predicted GLC[2]	µg/m^3				63	
				% Change				0.6%	
			Measured + Predicted 99.5th Percentile GLC[5]	µg/m^3				63	
				% Change				0.5%	
$PM_{2.5}$	24-hour	25	Measured[1]	µg/m^3	n.a.	57[6]	61[6]	n.a.	32[6]
			Measured + Maximum Predicted GLC[2]	µg/m^3		57	61		32
				% Change		0.5%	0.3%		0.9%
			Measured + Predicted 99.5th Percentile GLC[5]	µg/m^3	n.a.	57	57	n.a.	32
				% Change		0.4%	0.2%		0.6%
	Annual	8	Measured[1]	µg/m^3		8.7	9.0		7.5
			Measured + Maximum Predicted GLC[4]	µg/m^3		8.7	9.0		7.5
				% Change		0.1%	0.1%		0.1%

Notes

1. Maximum ambient GLC as measured by DER.
2. The maximum cumulative GLCs have been calculated by adding the maximum GLC predicted for the three modelled years at the nominated receptor (using maximum emission rates), to the maximum measured GLCs at each site.
3. The „Measured + Predicted 99.9th Percentile GLCs" have been calculated by adding the highest of the 99.9th percentile 1-hour average GLCs predicted at the nominated receptor for each of the three modelled years (using maximum emission rates), to the maximum measured GLCs at each site.
4. The cumulative annual GLCs have been calculated by adding the maximum annual average GLC predicted at the nominated receptor for the three modelled years, to the highest annual average GLC measured at each site.
5. The „Measured + Predicted 99.5th Percentile GLCs" have been calculated by adding the highest 99.5th percentile 24-hour average GLC predicted at the nominated receptor for each of the three modelled years (using maximum emission rates), to the maximum measured GLCs at each site.
6. Smoke haze identified as contributing factor to measured concentration.
7. „N.A." indicates compound is not monitored at receptor.
8. Referenced to 0ºC, and 1013.25 hPa.

The maximum cumulative 1-hour average NO_2 GLC concentration predicted at the Hope Valley monitoring site is 179 µg/m^3 and represents a 3.5% increase in the maximum measured 1-hour average NO_2 GLC (Table 21). However, it should be noted the predicted cumulative NO_2 GLC is considered to be highly conservative as it assumes that the maximum predicted concentration of NO_2 occurs at the same time as the maximum recorded concentration, which is not expected to occur in reality. The cumulative 1-hour average NO_2 concentrations calculated at Hope Valley using the predicted 99.9th highest 1-hour average NO_2 GLCs is 178 µg/m^3 and represents an increase of 2.8% in the maximum 1-hour average NO_2 GLCs measured at the site (Table 21).

The maximum cumulative 1-hour average NO_2 GLCs predicted at the Calista Primary School and Hillman Child Care Centre monitoring sites are 105 µg/m^3 and 91 µg/m^3 respectively (Table 21). These concentrations represent respective increases of 3.4% and 3.8% in the maximum measured 1-hour average NO_2 GLC at each site. The cumulative 1-hour average NO_2 concentrations calculated using the predicted 99.9th highest 1-hour average NO_2 GLCs are 103 µg/m^3 at the Calista Primary School and 90 µg/m^3 at the Hillman Child Care Centre. These concentrations represent respective increases of 1.9% and 2.2% in the maximum 1-hour average NO_2 GLCs measured at each site.

The maximum increase in the cumulative PM_{10} concentration predicted at the Abercrombie Road monitoring site is expected to be minimal, equal to 0.6% of the measured 24-hour concentration (Table 21). The maximum increase in the cumulative $PM_{2.5}$ concentrations is also small, equal to 0.9% at the Kwinana Shopping Centre site, 0.3% at the Hillman Child Care Centre and 0.5% at the Calista Primary School (Table 21). It is noted the predicted cumulative PM_{10} and $PM_{2.5}$ GLCs are considered to be highly conservative as they assume that the maximum predicted concentration of PM_{10} and $PM_{2.5}$ occur at the same time as the maximum recorded concentrations.

The maximum increases in the cumulative PM_{10} and $PM_{2.5}$ concentrations predicted at each receptor using the 99.5th percentile[2] 24-hour averages (the second highest 24-hour average GLC predicted by the model) are expected to be minimal, equal to no more than 0.6% of the measured concentrations at any site.

The increase in the annual average NO_2 and $PM_{2.5}$ GLCs predicted at the nominated receptors is also expected to be minimal, equal to no more than 0.9% of the measured concentrations at any site.

As noted in Section 4.4, the ambient concentrations of arsenic, antimony, cadmium, chromium, copper, lead, manganese, mercury and nickel as measured by the DER at the Hope Valley, Calista and Hillman monitoring sites remain well below the applicable guidelines (<10%). The maximum GLCs of these compounds predicted over the modelled domain is similarly small, representing no more than 1% of the relevant criteria (Table 20). The GLCs predicted at the Hope Valley, Calista and Hillman monitoring sites represent an even smaller fraction of the relevant criteria. As such, the cumulative impacts of emissions of

[2] The 99.5th percentile 24-hour GLC represents the maximum second highest 24-hour average GLC predicted for any of the three modelled years (i.e. the predicted 24-hour average concentrations are equal to or less than this value for 364 days of each modelled year).

these compounds from the proposed WtE facility at the nominated monitoring sites are considered negligible.

Ambient monitoring data and/or suitable regional emissions inventories are not available to undertake a quantitative cumulative assessment for HF, HCl and dioxins and furans. The maximum predicted GLCs for these compounds (each very conservatively estimated to be at their respective WID limits), however, are either at or below 10% of the relevant guidelines (Table 20). As such, the contribution of these emissions from the proposed WtE facility is not expected to be significant in terms of cumulative air quality impacts within the region.

6.4 Incremental Carcinogenic Risk Assessment

A summary of the maximum annual average GLCs predicted using maximum emission limits for each of the modelled compounds for which there are applicable Unit Risk Factors is presented in Table 22.

Table 22: Comparison of Predicted Annual Average GLCs to ICR Guidelines

Compound	Maximum Annual Average Predicted GLC for Modelled Year (µg/m^3)			ICR Guideline[1]	Maximum Predicted Annual GLC as a % of ICR Guideline
	1980	1995	1996	µg/m^3	
Cadmium	0.000002	0.000002	0.000002	0.3	0.0007%
Lead	0.00001	0.00001	0.00001	0.083	0.01%
Arsenic	0.000003	0.000003	0.000003	0.00067	0.4%
Nickel	0.000009	0.000007	0.000009	0.0026	0.3%
Chromium VI	0.000002	0.000002	0.000002	0.000025	8.0%
Dioxins	4.5E-10	3.6E-10	4.5E-10	2.60E-08	1.7%
Furans	4.5E-10	3.6E-10	4.5E-10	2.60E-07	0.2%

Notes
1. Annual average concentration associated with an excess lifetime risk of one in a million.

Comparison of the predicted annual averages against the annual average concentrations associated with an excess lifetime risk for each of the modelled pollutants indicates that the predicted incremental carcinogenic risks associated with the emissions from the proposed WtE facility are expected to be well below the USEPA recommended *de minimus* risk value of one-in-one-million.

The maximum predicted annual average GLC for chromium VI corresponds to 8.0% of the excess lifetime risk concentration for this compound (this assessment conservatively assumes all chromium is present as chromium VI). The predicted annual average GLC for dioxins represents 1.7% of the relevant ICR guideline. The annual average concentrations predicted for arsenic, cadmium, nickel, lead and furans represent no more than 0.4% of the corresponding excess lifetime risk criteria.

6.5 Odour Assessment

The 99.5th percentile 1-hour average odour concentration (presented as odour units) predicted from the fugitive emissions releases associated with the opening and closing of the tipping hall doors, without the expected beneficial implication of maintaining the Tipping Hall under negative air pressure, is presented in Table 23. The predicted results are considered conservative as the modelling ignores the effects of maintaining the Tipping Hall under negative air pressure and assumes a continuous emission release, while the opening and closing of the tipping hall doors is likely to occur intermittently and for short periods at a time.

Table 23: Summary of Maximum Predicted Odour Concentrations Across the Model Domain

Averaging Period	OU	Guideline (OU)	% Guideline Value
Maximum 1-hour	0.31	-	-
99.5th percentile 1-hour	0.18	2.5[1]	7.2%

Notes
1. Applicable guideline for ground-level sources and down-washed plumes from short stacks.

The results in Table 23 indicate the predicted odour concentrations comfortably comply with the applicable 1-hour average odour guideline of 2.5 OU. The highest 99.5th 1-hour average odour unit predicted for the 2011 modelled year represents 7.2% of the odour guideline. Contours of the predicted 99.5th 1-hour average odour unit indicate that peak concentrations are expected to occur within close proximity of the proposed WtE facility (Figure 27).

In addition to the AERMOD model run, a screening level assessment of odour emissions from the proposed WtE facility was completed using Ausplume, a Gaussian dispersion model developed by the Victorian Environmental Protection Authority. The screening assessment utilised an artificial meteorological data file supplied with Ausplume that contains a set of wind speeds, mixing heights and stability classes which could span all those that could be reasonably expected to occur.

The maximum 1-hour average odour concentration conservatively predicted using the screening level meteorological data set is 1.2 OU, while the 99.5th percentile 1-hour average is 0.19 OU and complies comfortably with the corresponding odour guideline of 2.5 OU. These results indicate that under worst case meteorological conditions and conservatively assuming a continuous emission release without the expected beneficial implication of maintaining the Tipping Hall under negative air pressure, the maximum predicted odour concentrations are expected to remain below the applicable guideline.

6.6 Contribution to Photochemical Smog Pollution

Photochemical smog is an air pollution problem common in large cities. It is characterised by high ozone concentrations at ground level, and can be generated through the interaction of NO_x and reactive organic compounds (ROC) in the environment. Potential sources of NO_x and ROC include industrial processes, vehicle exhausts and bushfires.

Current ambient air quality monitoring of ozone concentrations reported by the DER (2011) for the Perth airshed indicate that the NEPM 1-hour and 4-hour ozone standards (0.10 ppm and 0.08 ppm respectively) were exceeded at the inland Caversham and Rolling Green

monitoring sites (located more than 40 km north east of Kwinana) during 2009. Only the 4-hour ozone concentrations recorded at Rolling Green did not meet the NEPM goal of no more than 1-day in excess of the standard. The DER (2011) indicated that these events were smoke induced and were the first exceedances of the NEPM 1-hour and 4-hour ozone standards recorded since 2004.

The Perth Photochemical Smog Study (Western Power and Department of Environmental Protection, 1996) found that the control of photochemical smog is a complex issue in the Perth airshed. The study also reported that motor vehicles were the dominant cause of photochemical smog in the Perth airshed being the largest emission sources of NO_x and ROC.

The proposed Kwinana WtE facility is expected to be a relatively small emitter of NO_x in the Kwinana airshed. Based on the emission rates provided in Table 9 and assuming continuous release throughout the year, it is estimated that the proposed WtE facility will emit approximately 132 tonnes of NO_x annually. By comparison, data from the National Pollutant Inventory (NPI) indicates a total of 6,600 tonnes of NO_x were emitted to the Kwinana airshed for the 2011/2012 reporting year. The NPI reports total NO_x emissions for the Perth airshed for 2011/2012 are estimated to be 26,378 tonnes. In considering these figures, the 2011/2012 NPI data indicate that within the Perth airshed approximately 25,560 tonnes (out of the total of 26,378 tonnes) of NO_x emissions are from diffuse (i.e. non industrial) sources including motor vehicles (21,683 tonnes) and biogenic sources (2,606 tonnes) and that these diffuse emission estimates are based on data from 1999.

The proposed Kwinana WtE Facility is conservatively estimated to add approximately 132 tonnes per year of NO_x to the Perth airshed (i.e. a further 0.5% to the total airshed NO_x emissions). Due to the complexity of photochemistry in the Perth airshed, it is difficult to reliably quantify the impact of such a small increase in the overall NO_x emissions as the change in the total airshed"s emission is very small and would be no more than “noise” in any numerical modelling assessment.

The Perth Photochemical Smog Study found that the emissions from the KIA “resulted in a significant quenching of ozone across those portions of the metropolitan area impacted by the Kwinana NO_x plume” (Western Power and Department of Environmental Protection, 1996). This quenching was due to the presence of NO and a low ROC:NO_x ratio within the KIA emissions. Therefore, as the proposal will result in a small increase in the airshed"s NO_x emissions, it may result in further slight quenching of ozone in the airshed. The proposal will result in a small reduction in the ROC-NO_x ratio which may also contribute to a small reduction in the ozone formation potential.

6.7 Qualitative Assessment of Dioxin and Furan Deposition

Polychlorinated dioxins and furans are formed primarily as a by-product of combustion or chemical manufacturing processes. Emissions may be generated through the incineration of solid waste, sewerage sludge and hospital wastes; smelting operations; scrap metal recovery furnaces; wood petroleum products; and the manufacturing of chlorine and chlorinated organic compounds. Dioxins are known to bio-accumulate and may build up in the food chain, resulting in measurable concentrations in animals. Human exposure to dioxins may occur through breathing, ingestion or absorption through the skin (ingestion being the most common exposure-pathway).

Industrial sources of polychlorinated dioxins and furans within the Kwinana region include electricity generation, alumina and petroleum refining and chemical manufacturing. A summary of the polychlorinated dioxins and furans emissions reported to the NPI within the Kwinana airshed between 2007 and 2012 is presented in Figure 28, indicating that the primary sources of polychlorinated dioxins and furans emissions reported to the NPI for the Kwinana airshed are non-ferrous metal manufacturing (i.e. alumina refining) and electricity generation.

Other significant regional sources of polychlorinated dioxins and furans emissions not captured within the NPI database include bushfires, motor vehicles and domestic fuel burning (e.g. wood fired heaters). An inventory of dioxin emissions within the Australian environment for the 2002 calendar year was compiled as part of the Federal Government"s National Dioxins Program (PAE, 2004). The national inventory identifies uncontrolled combustion sources as the greatest source of dioxin emissions within Australia, contributing nearly 70% of total emissions to air and approximately 75% of all emissions in Australia (PAE, 2004). This includes biomass burning (i.e. bushfires), waste burning (outside of controlled devices) and accidental fires.

Phoenix Energy have indicated the concentration of polychlorinated dioxins and furans emissions from the proposed WtE facility will meet world"s best practice under the Australian National Action Plan for Dioxins, namely 0.1 ng/m^3. However, this estimate is considered conservative on the basis that Phoenix Energy expects that the actual operating emission rates for dioxins and furans will be below the WID emission limits modelled as part of this assessment. Stack testing data collected from similar facilities operating internationally indicates dioxin and furan emissions could be up to four orders of magnitude lower than the WID emission limits.

On this basis, the estimated annual mass emission of dioxins and furans from the proposed WtE facility is approximately 3.0E-05 g, conservatively assuming constant release over the course of a year. The contribution of emissions from the proposed WtE facility to the total dioxin and furan emissions released within the Kwinana airshed is therefore expected to be negligible. The predicted deposition rate associated with such emissions would also be expected to be negligible, particularly in comparison to other significant regional sources including bushfires, motor vehicles and domestic fuel burning.

7 Conclusions

Air dispersion modelling has been completed to assess the potential air quality impacts associated with emissions from the proposed Kwinana WtE plant. The air dispersion model DISPMOD has been used to assess atmospheric emissions from the mulit-flued stack, while the air dispersion model AERMOD has been used to assess fugitive odour emissions associated with the opening and closing of the tipping hall doors, while ignoring the expected beneficial effects of maintaining a negative air pressure within the Tipping Hall.

The DISPMOD modelling of SO_2 emissions has been completed in accordance with the methodology documented for the Kwinana EPP redetermination (DER, 2009), and accounts for the cumulative impacts of the proposed WtE facility together with existing Kwinana Industrial emissions of SO_2 as defined by the last redetermination.

Where ambient monitoring data is available for the compounds of interest, this has been used to determine the cumulative impacts of the proposed WtE facility at the monitoring locations.

The key findings of the air dispersion modelling are as follows:

- Emissions from the proposed Kwinana WtE facility are not expected to significantly increase the maximum predicted GLCs of SO_2 within the Kwinana area, and will not result in any change to compliance with the Standards and Limits of the Kwinana EPP:
  - The proposed Kwinana WtE facility does not affect or add to the exceedances of the Kwinana EPP Standards and Limits predicted to occur within Area A for existing Kwinana industry, which were identified as part of the most recent redetermination to represent an over-prediction;
  - The largest increase in the 1-hour average GLCs of SO_2 is 23 $\mu g/m^3$ and is predicted to occur within Area B (Full model domain). This represents an increase from 41% (Existing Industry) to 44% (Existing Industry with Kwinana WtE Facility) of the Area B Limit;
  - The largest increase in the 9^{th} highest predicted 1-hour average GLCs of SO_2 is 6 $\mu g/m^3$ and is predicted to occur within Area A (Full model domain). This represents an increase from 84% (Existing Industry) to 85% (Existing Industry with Kwinana WtE Facility) of the Area A Standard;
- The predicted concentrations for all other compounds undertaken using DISPMOD indicates that the predicted GLCs are expected to comply with the applicable short-term and long-term ambient air quality guidelines for all of the modelled pollutants:
  - The maximum predicted 1-hour average HCl GLC predicted for the 1980 modelled year most closely approaches the relevant guideline, representing 10% of the NSW OEH guideline based on the highly conservative assumption that the emission rate for the full plant is at its WID limit value;
  - The maximum 90-day average HF GLC predicted for the 1996 modelled year represents 8% of the ANZECC guideline general land use, as applicable within the KIA. The 24-hour, 7-day and 30-day averages remain below 5% of the general land use criteria, while the maximum 1-hour average HF GLC is equal to less than 1% of the OEHHA guideline value;

  - The maximum 1-hour average NO_2 GLC predicted for the 1980 modelled year represents 5.3% of the applicable NEPM Standard and the annual average NO_2 GLCs represent no more than 0.3% of the annual NEPM Standard;
  - The maximum 24-hour average $PM_{2.5}$ GLC predicted for the 2008 modelled year represents 4.0% of the 24-hour NEPM Advisory Reporting Standard, while the predicted annual average $PM_{2.5}$ GLCs represent no more than 1.3% of the annual NEPM Advisory Reporting Standard;
  - The maximum 1-hour average dioxins and furans GLC predicted for the 2008 modelled year is 3.0E-08 µg-TEQ/m^3 and represents 1.4% of the applicable NSW OEH guideline;
  - The predicted GLCs of CO and the remaining metals (i.e. lead, cadmium, mercury, antimony, arsenic, copper, chromium VI, manganese and nickel) associated with normal operations at maximum emission rates comfortably comply with the applicable air quality guidelines, being less than 1.0% of the corresponding short-term and long-term criteria.

- Assessment of the cumulative impacts of the proposed WtE facility indicates that a maximum increase in the 1-hour average NO_2 GLCs of 3.8% is predicted at the Hillman Child Care Centre, with maximum increases of 3.5% and 3.4% predicted at the Hope Valley and Calista Primary School monitoring sites respectively. However, these estimates are considered highly conservative as it assumes that the maximum predicted concentration of NO_2 occurs at the same time as the maximum recorded concentration at each site. Emissions of PM_{10} and $PM_{2.5}$ from the proposed WtE facility are not expected to result in increases of any more than 0.9% of the maximum PM_{10} and $PM_{2.5}$ concentrations measured within the Kwinana region.
- Comparison of the predicted annual averages against the annual average concentrations associated with an excess lifetime risk concentration (the concentration at which one in a million people may be expected to develop cancer from lifetime exposure to the atmospheric concentrations of the carcinogenic compound) for each of the modelled carcinogenic pollutants indicates that the incremental carcinogenic risks associated with emissions from the proposed WtE facility are expected to be well below the USEPA recommended *de minimus* risk value of one-in-one-million.
- Comparison of the predicted odour concentrations against the nominated guidelines indicates that no exceedances of the odour guidelines are predicted to occur.
- Analysis of emissions of NO_x from the proposed WtE Plant indicates that it is unlikely to make a noticeable contribution to ozone formation within the Perth airshed.
- Emissions from the proposed WtE facility are not expected to result in a significant increase in the concentration of dioxins and furans within the surrounding environment.
- Predicted GLCs for independent plumes from Multi-Flue Stack indicates that the maximum GLCs predicted assuming there is no mixing of the two plumes, and therefore no enhancement of plume buoyancy, do not significantly differ from the GLCs predicted assuming enhanced plume buoyancy. The results presented in Appendix D, Table D2 indicate that limited mixing of emissions from the multi-flue stack, with no enhancement of momentum buoyancy, is not expected to result in unacceptable air quality impacts.

As with any modelling evaluation, there are areas of uncertainty in this assessment. To ensure that the potential air quality impacts associated with the proposed WtE facility are not under-estimated, conservative assumptions have been used to characterise emissions and the ground level impacts where possible. This includes use of emission rates derived from WID limit values for a number of modelled compounds including SO_2, PM, CO, HCl and dioxins and furans. The use of WID emission limits are considered by Phoenix Energy to be highly conservative and represent worst case emission rates from the facility under „normal operating conditions".

In assessing the cumulative impacts of NO_2, PM_{10} and $PM_{2.5}$ emissions from the proposed WtE facility, the maximum GLCs predicted at the nominated receptors have been added to the maximum ambient concentrations measured at each site – this assessment is extremely conservative for the short term (i.e. 1-hour and 24-hour) averaging times as it is assumed that the maximum predicted GLCs for the proposed WtE facility operations occur at the same time as the maximum ambient concentrations measured at the monitoring sites, which is not expected to occur in reality.

In assessing the cumulative impacts of those heavy metals considered relevant to this assessment (i.e. arsenic, antimony, cadmium, chromium, copper, lead, manganese, mercury and nickel), the maximum GLCs of those compounds represent no more than 1% of the relevant criteria (Table 20). Furthermore, the GLCs predicted at the Hope Valley, Calista and Hillman monitoring sites represent an even smaller fraction of the relevant criteria. As such, the cumulative impacts of emissions of these compounds from the proposed WtE facility at the nominated monitoring sites are considered negligible.

8 References

Australian and New Zealand Environment Conservation Council (ANZECC). 1990. "National Goals for Fluoride in Ambient Air and Forage."

Dames and Moore. 1993. "Proposed Integrated Steel Mill and Utilities Complex. East Rockingham Industrial Park near Kwinana. Environmental Review and Management Plan." Report prepared for Compact Steel, December 1993.

Department of Environment Regulation (DER) (former DEC). 2003. "Review of Existing Swan Valley Brickworks." May 2003.

Department of Environment Regulation (DER) (former DEC). 2010. "2009 Western Australia Air Monitoring Report." July 2010.

Department of Environment Regulation (DER) (former DEC). 2011a. "Background Air Quality Monitoring in Kwinana 2005-10." December 2011.

Department of Environment Regulation (DER) (former DEC). 2011b. "2010 Western Australia Air Monitoring Report." July 2011.

Department of Environment Regulation (DER) (former DEC). 2011c. "Background Air Quality Monitoring in Kwinana 2005-2010." December 2011.

Department of Environment Regulation (DER) (former DEC). 2012. "2011 Western Australia Air Monitoring Report." July 2012.

Department of Environment Regulation (DER) (former DEC). 2009a. "2008 Western Australia Air Monitoring Report." Technical Report AQM 4, December 2009.

Department of Environment Regulation (DER) (former DEC). 2009b. "Redetermination of maximum permissible quantities of sulphur dioxide under the Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999." DEC, July 2009.

ENVIRON. 2011. "Kwinana Ammonium Nitrate Expansion – Air Dispersion Modelling Report." Report prepared for CSBP Limited, March 2011.

Environmental Protection Authority (EPA). 2009. "Options for the review of the *Environmental protection (Kwinana) (Atmospheric Wastes) Policy 1999.*" EPA, June 2009.

European Union (EU). 2000. "Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste." Official Journal of the European Union, 28 December 2010.

European Union (EU). 2010. "Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and Control." Official Journal of the European Union, 17 December 2010.

Government of Western Australia. 2009. "State Environmental (Ambient Air) Policy 2009." Environmental Protection Authority, June 2009.

Hanna SR, Briggs GA, Deardroff J, et al. 1977. "Summary of recommendations made by the AMS workshop on stability classification schemes and sigma curves." Bulletin of American Meteorological Society 58: 1305–9.

Muller J, Muller R, Goudkamp K, Shaw M, Mortimer M, Haynes D, Burniston D, Symons R & Moore M. 2004. "Dioxins in Soils in Australia." National Dioxins Program Technical Report No. 5, Australian Government Department of the Environment and Heritage, Canberra.

National Environmental Protection Council (NEPC). 2003. "National Environmental Protection (Ambient Air Quality Measure)." National Environmental Protection Council, July 2003.

New South Wales Department of Environment and Conservation (NSW DEC). 2005. "Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales." Department of Environment and Conservation, August 2005.

Office of Environmental Health Hazard Assessment (OEHHA) (2013). Acute, 8-hour and Chronic Reference Exposure Level (REL) Summary. October, 2013.

PAE (Pacific Air & Environment). 2004. "National Dioxins Program Technical Report No. 3: Inventory of Dioxin Emissions in Australia, 2004". Report prepared for Department of the Environment and Heritage, May 2004.

Queensland Environmental Protection Agency (QLD EPA). 2004. "Odour Impact Assessment from Developments." July 2004.

Rayner, K. and Blockley, A. 2000. "Improvements in the coastal dispersion model DISPMOD." Proceedings of the 15th Conference of the Clean Air Society of Australia and New Zealand, Sydney. November, 2000.

Victorian Environmental Protection Authority (Vic EPA). 2001. "State Environmental Protection Policy (Air Quality Management)." Victorian Government Gazette No. S240, 21 December 2001.

Western Power and Department of Environmental Protection. 1996. "The Perth Photochemical Smog Study." May, 1996.

World Health Organisation (WHO) (2000). WHO Air Quality Guidelines for Europe. Second Edition. WHO, Regional Office for Europe, Copenhagen.

9 Limitations

ENVIRON Australia prepared this report in accordance with the scope of work as outlined in our proposal to Phoenix Energy Australia dated 11 October 2013 and in accordance with our understanding and interpretation of current regulatory standards.

The conclusions presented in this report represent ENVIRON"s professional judgment based on information made available during the course of this assignment and are true and correct to the best of ENVIRON"s knowledge as at the date of the assessment.

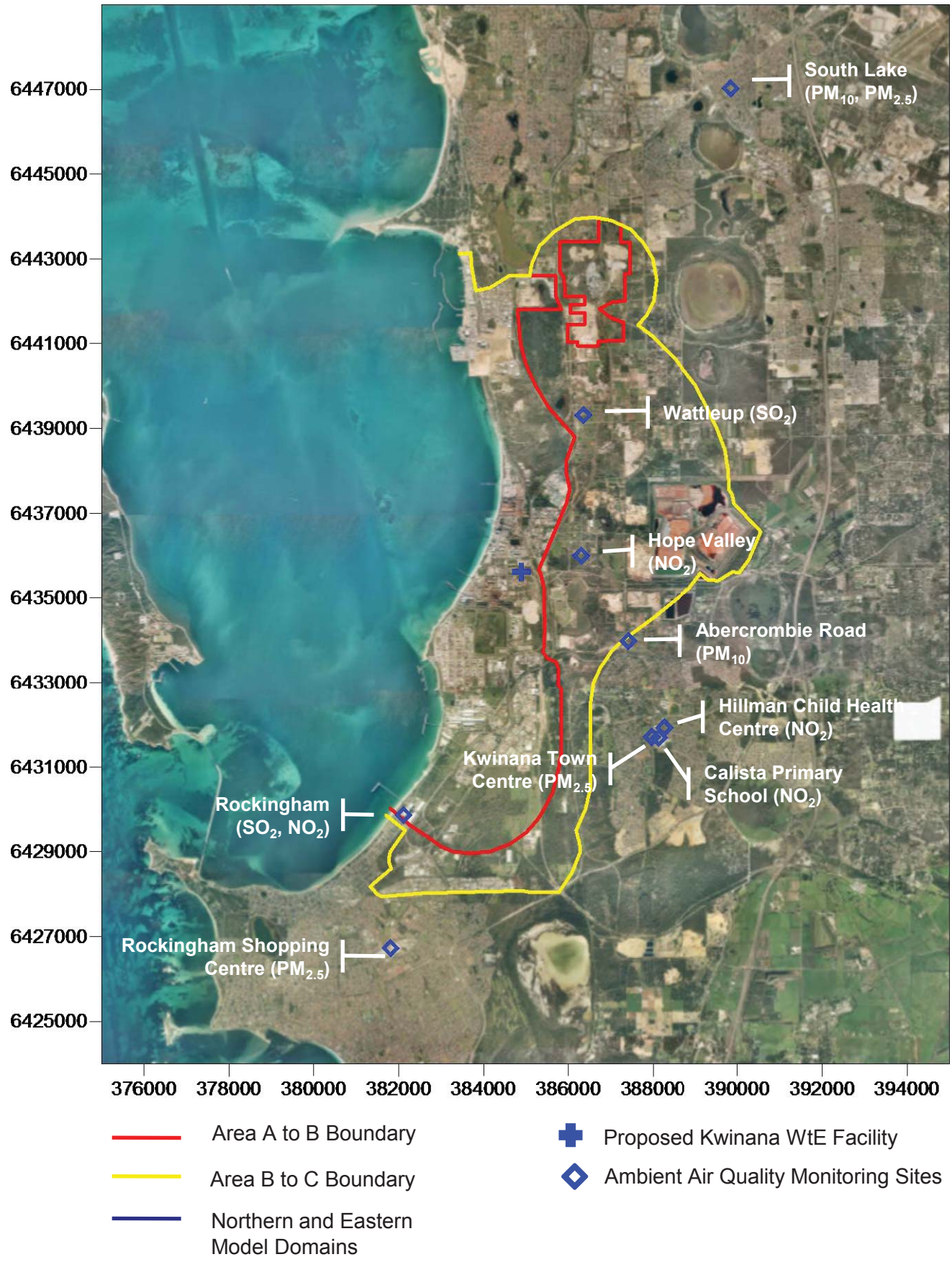
ENVIRON did not independently verify all of the written or oral information provided to ENVIRON during the course of this investigation. While ENVIRON has no reason to doubt the accuracy of the information provided to it, the report is complete and accurate only to the extent that the information provided to ENVIRON was itself complete and accurate.

This report does not purport to give legal advice. This advice can only be given by qualified legal advisors.

9.1 User Reliance

This report has been prepared exclusively for Phoenix Energy Australia and may not be relied upon by any other person or entity without ENVIRON"s express written permission.

Figures



Phoenix Energy

Kwinana WTE Project - Air Dispersion Modelling Assessment

Kwinana Environment Protection Policy Area Boundaries and Sulphur Dioxide Modelling Domains

ENVIRON | JOB NO: AS110691 | DATE: May 2014 | FIGURE 1

Phoenix Energy
Kwinana WTE Project - Air Dispersion Modelling Assessment

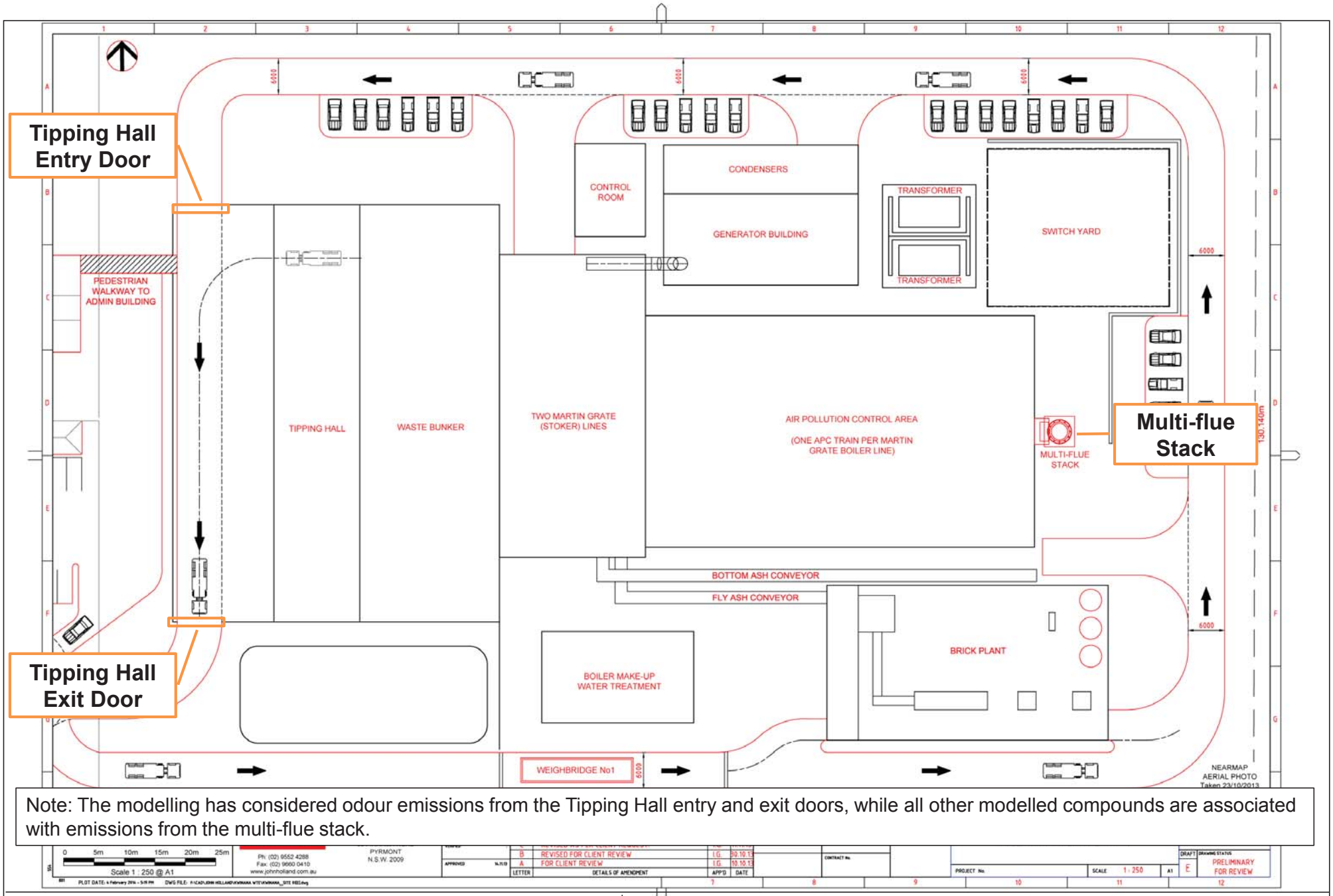
Location of the Proposed WtE Facility
Image Source: Google Earth

ENVIRON

JOB NO: AS110691

DATE: May 2014

FIGURE 2



Note: The modelling has considered odour emissions from the Tipping Hall entry and exit doors, while all other modelled compounds are associated with emissions from the multi-flue stack.

Phoenix Energy
Kwinana WTE Project - Air Dispersion Modelling Assessment

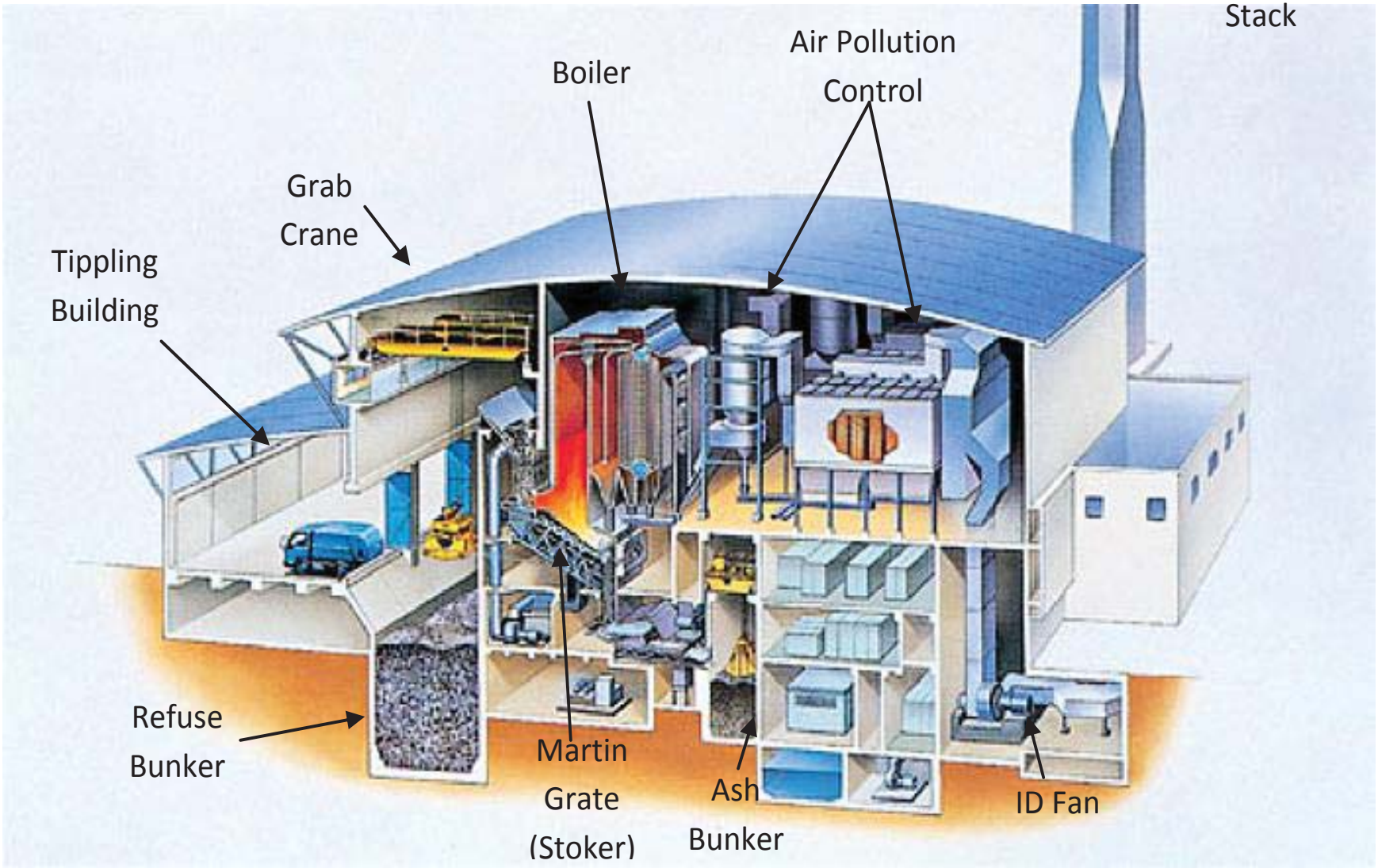
Layout of the Proposed WtE Facility
Source: Phoenix Energy

ENVIRON

JOB NO: AS110691

DATE: May 2014

FIGURE 3



Phoenix Energy
Kwinana WTE Project - Air Dispersion Modelling Assessment

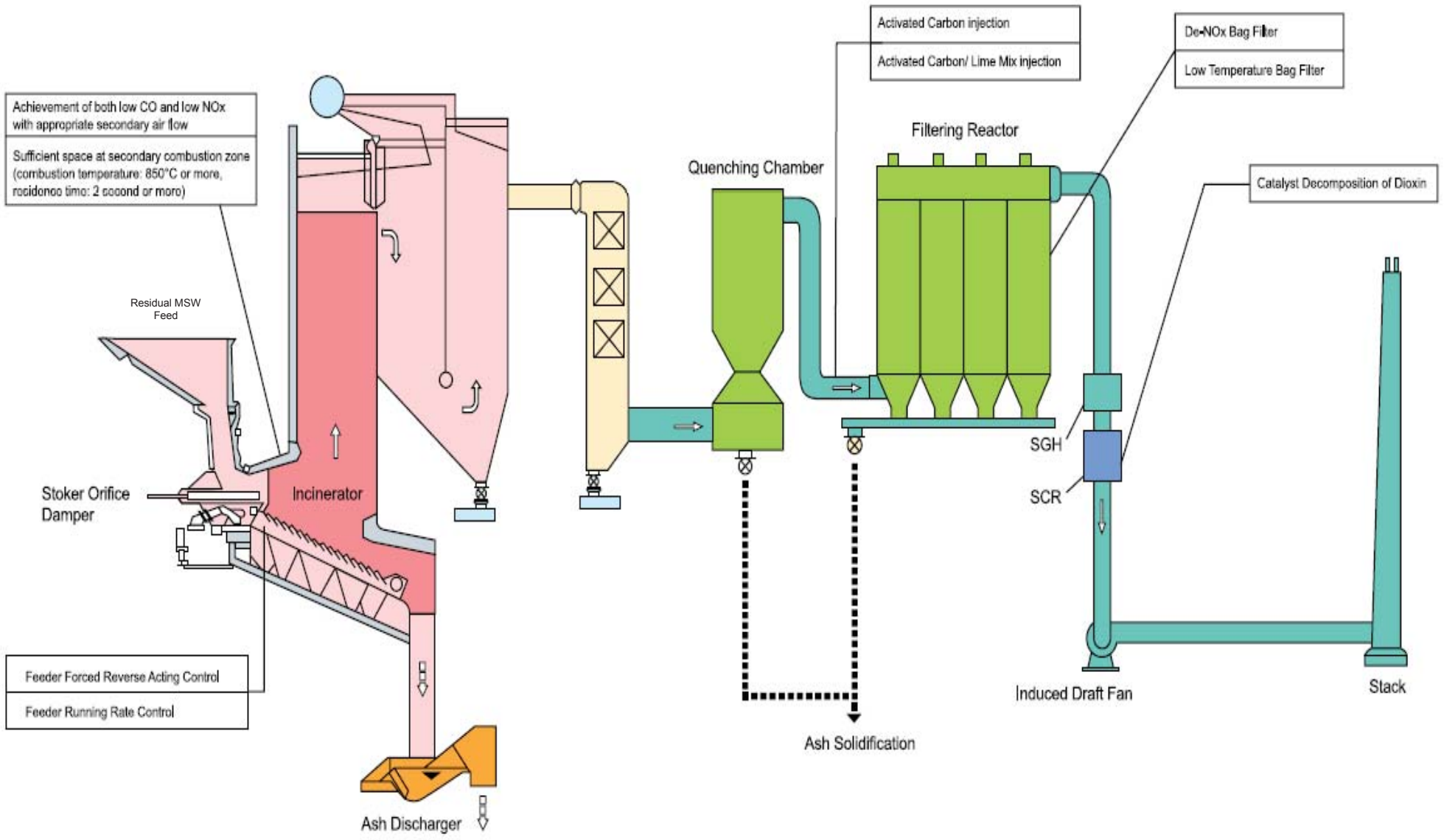
Typical WtE Facility Employing Martin-grate Technology
Image Source: Phoenix Energy

ENVIRON

JOB NO: AS110691

DATE: May 2014

FIGURE 4



Phoenix Energy
Kwinana WTE Project - Air Dispersion Modelling Assessment

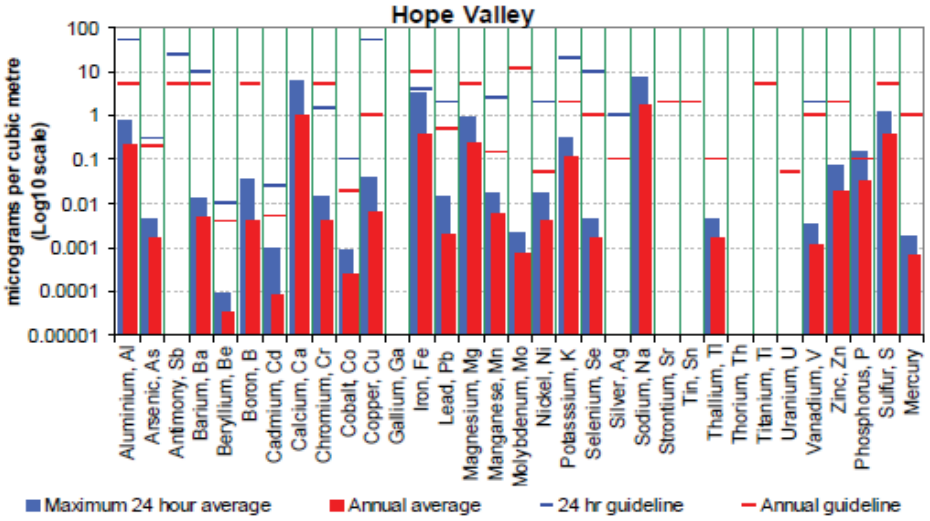
Typical WtE Facility Material Flows and Emission Controls
Image Source: Phoenix Energy

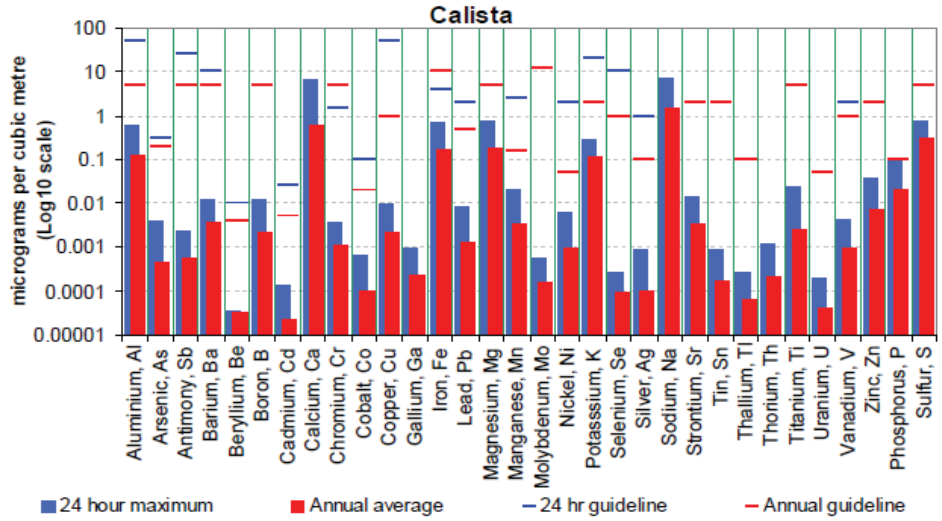
ENVIRON

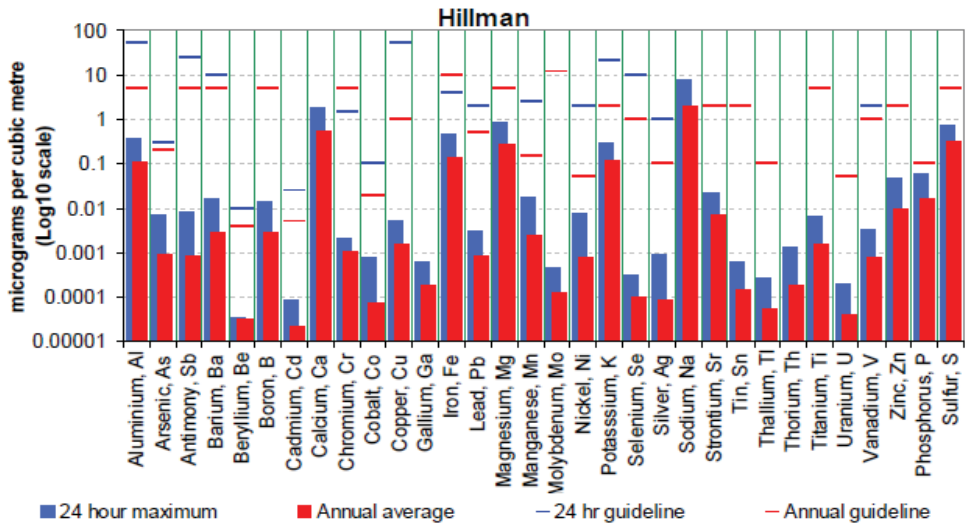
JOB NO: AS110691

DATE: May 2014

FIGURE 5

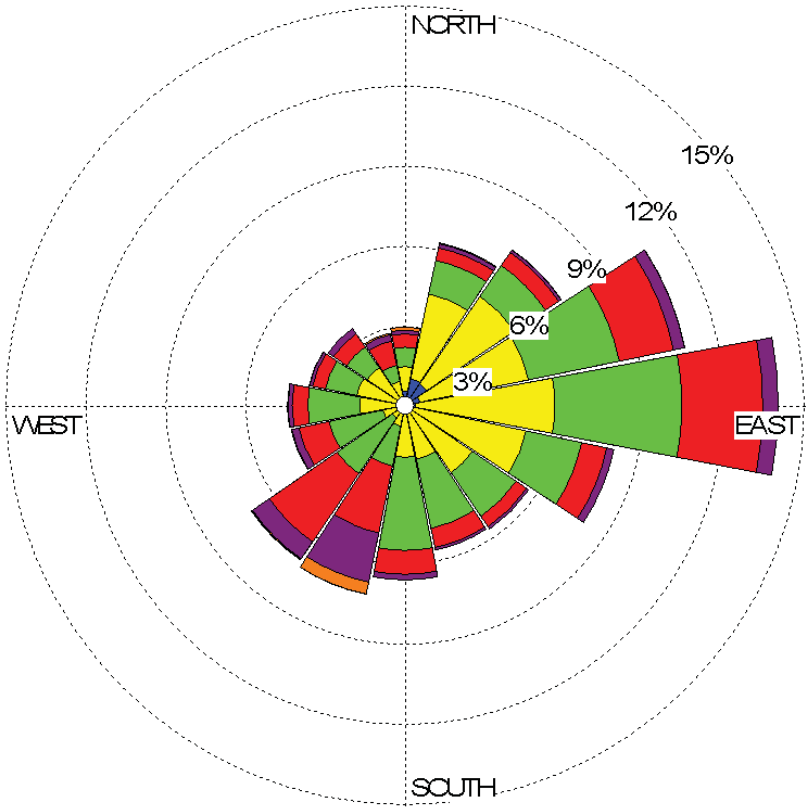




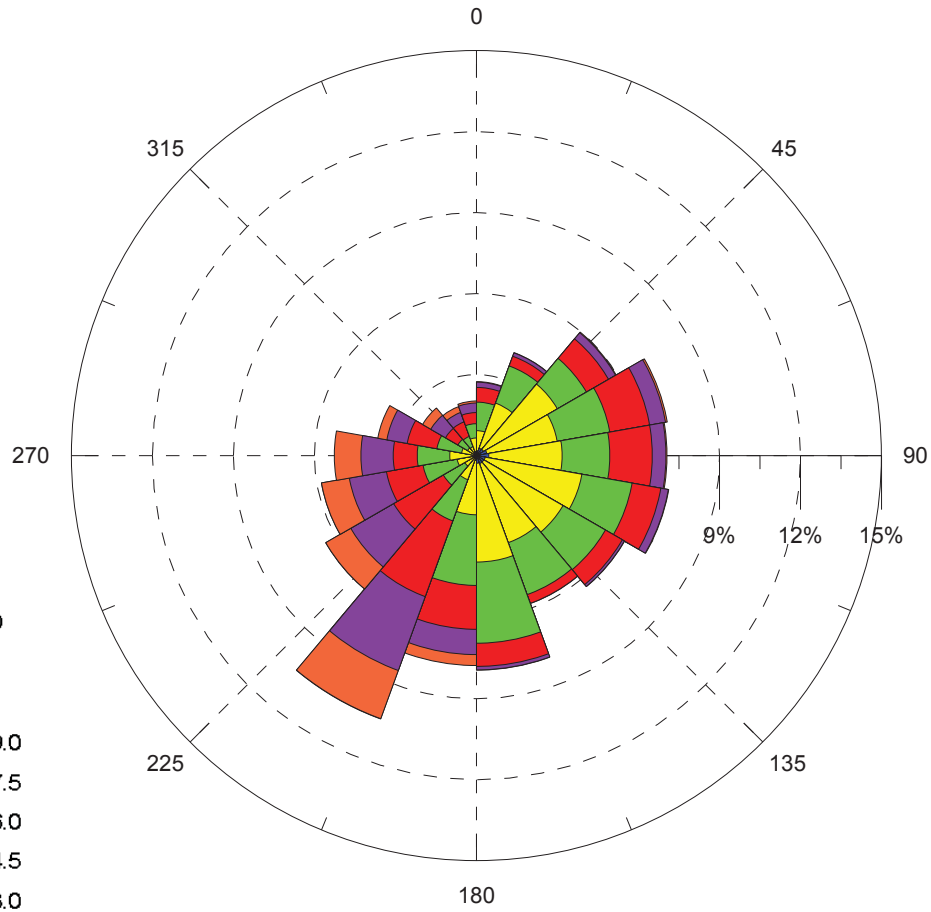


Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Summary of Results of Ambient Heavy Metal Monitoring – Kwinana 2005 to 2010 Source: DER, 2011a

Alcoa Mudlakes 2011



Hope Valley 1996



Phoenix Energy
Kwinana WTE Project - Air Dispersion Modelling Assessment

Annual Wind Roses – Alcoa Mudlakes 2011 and Hope Valley 1996

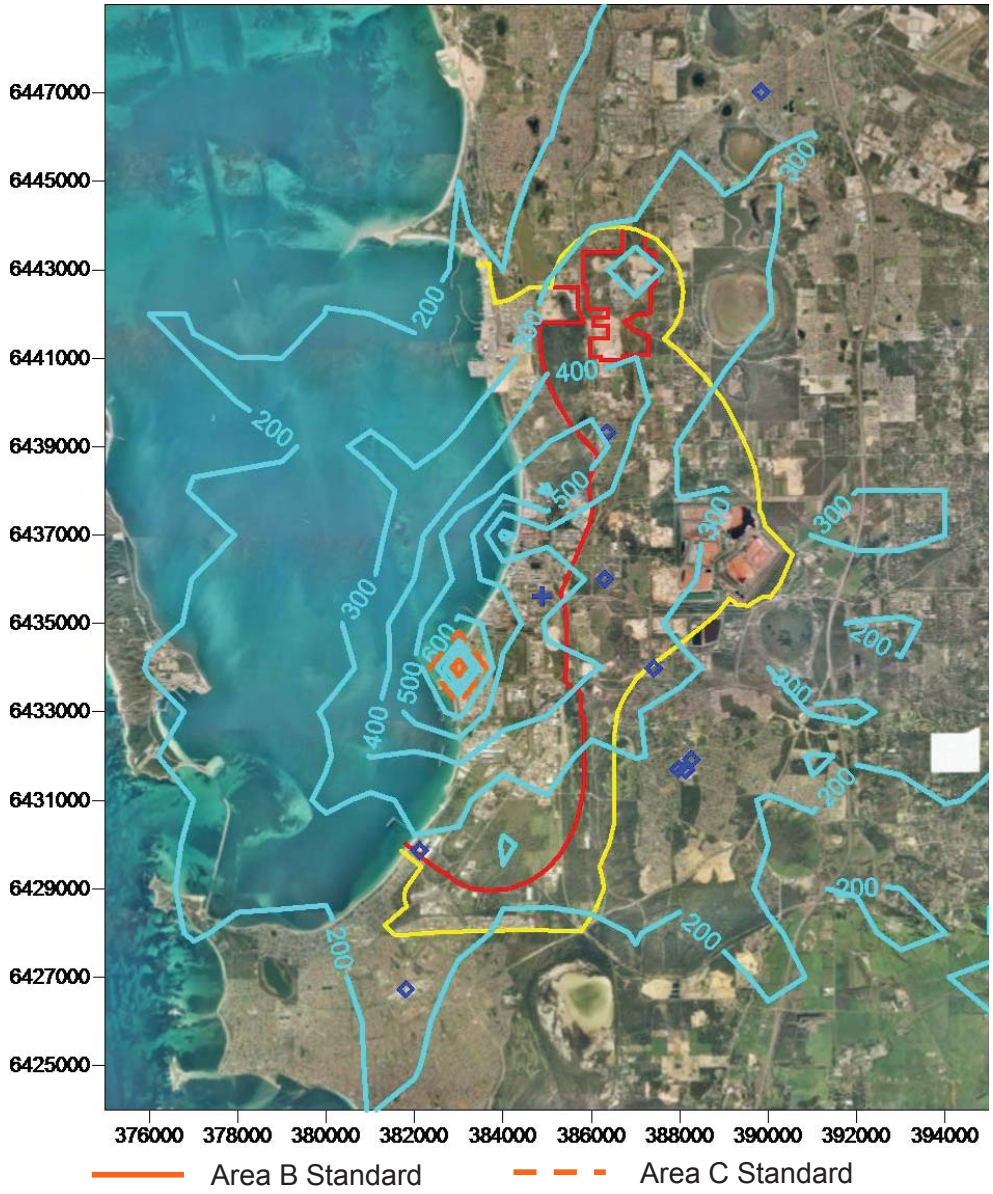
ENVIRON

JOB NO: AS110691

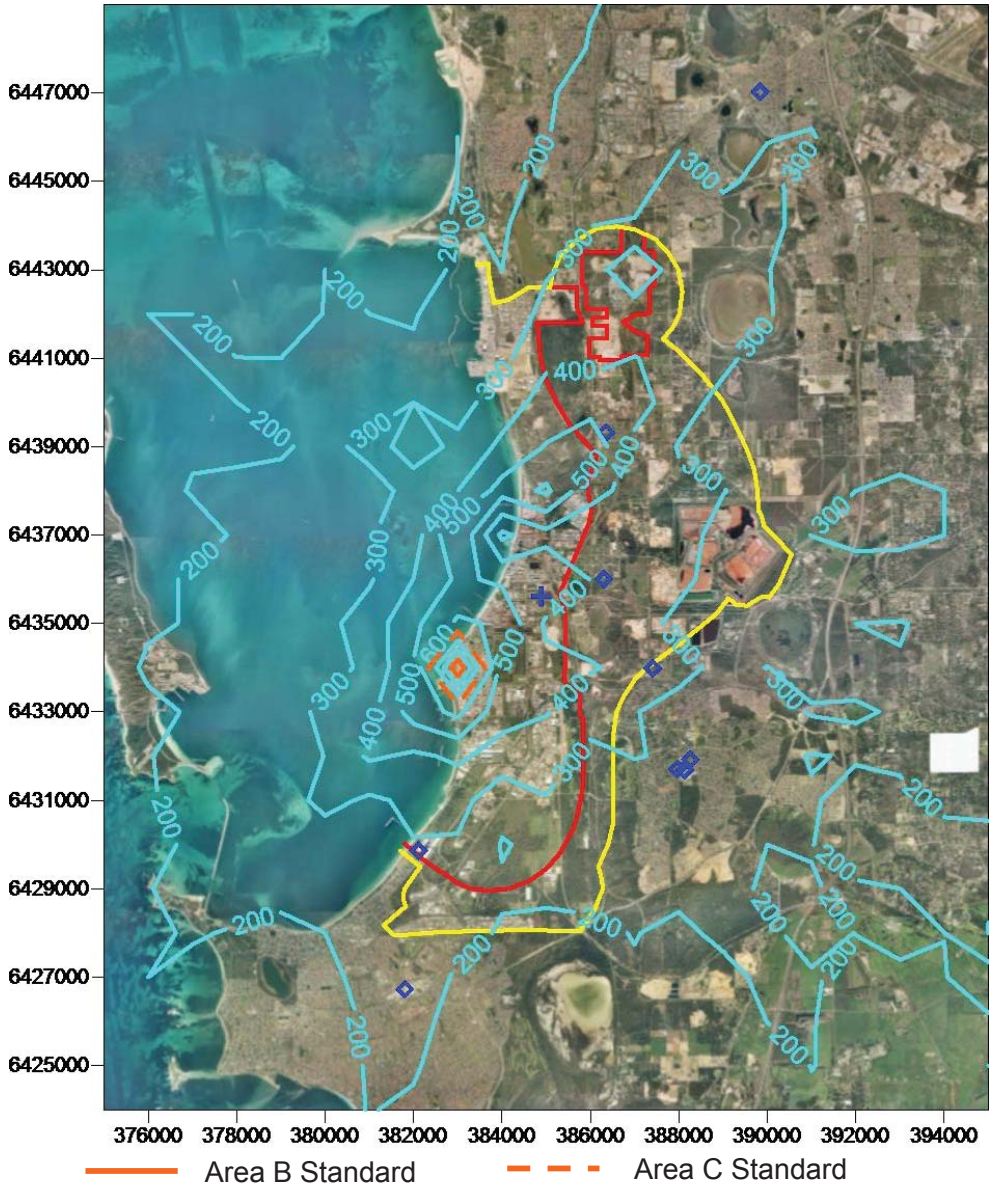
DATE: May 2014

FIGURE 7

Existing Industry



Existing Industry with Kwinana WtE Facility



Phoenix Energy
Kwinana WTE Project - Air Dispersion Modelling Assessment

Maximum Predicted 1-hr Average SO_2 GLC (µg/m^3)
Full Modelling Domain; DISPMOD 2005; 1996

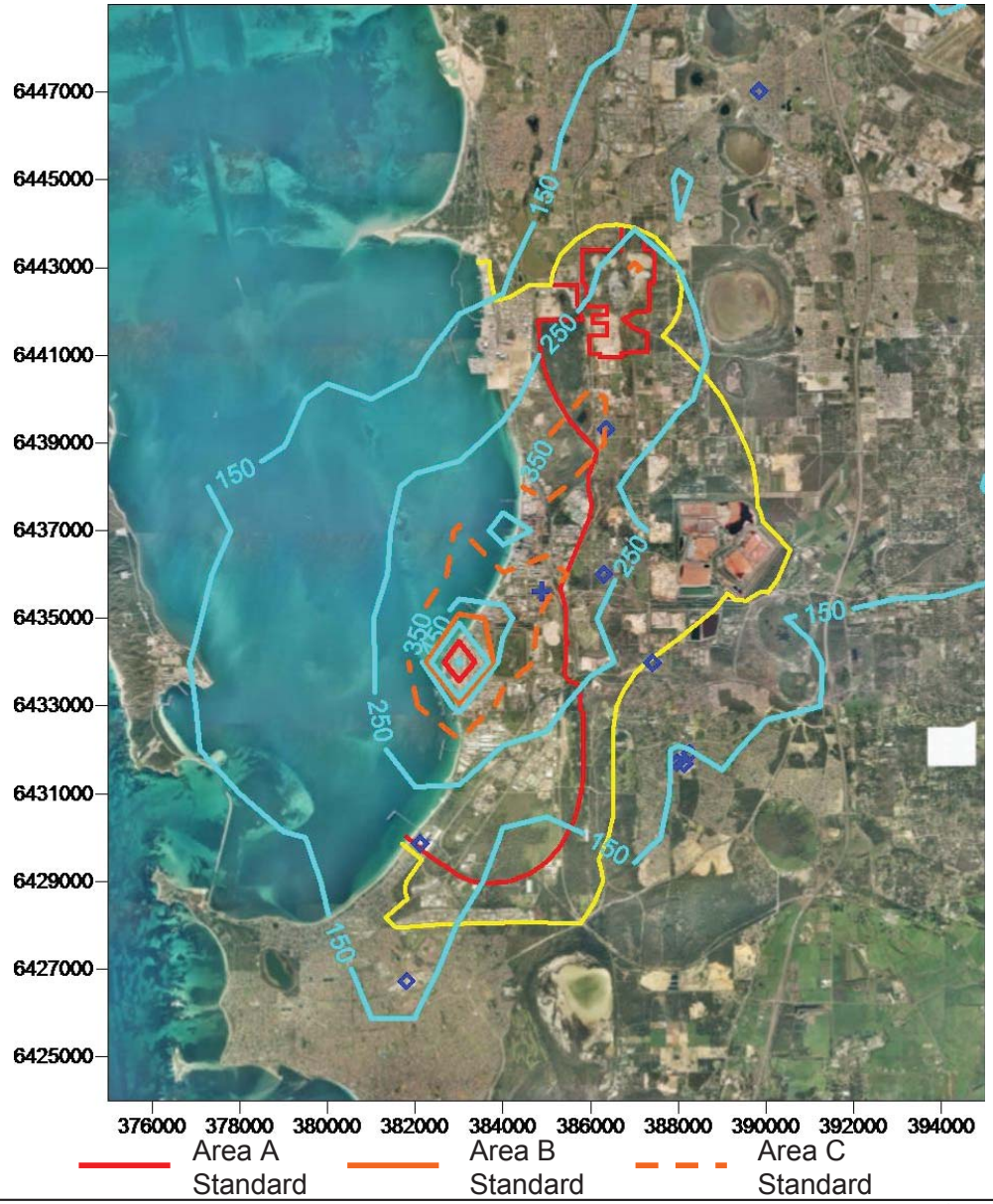
ENVIRON

JOB NO: AS110691

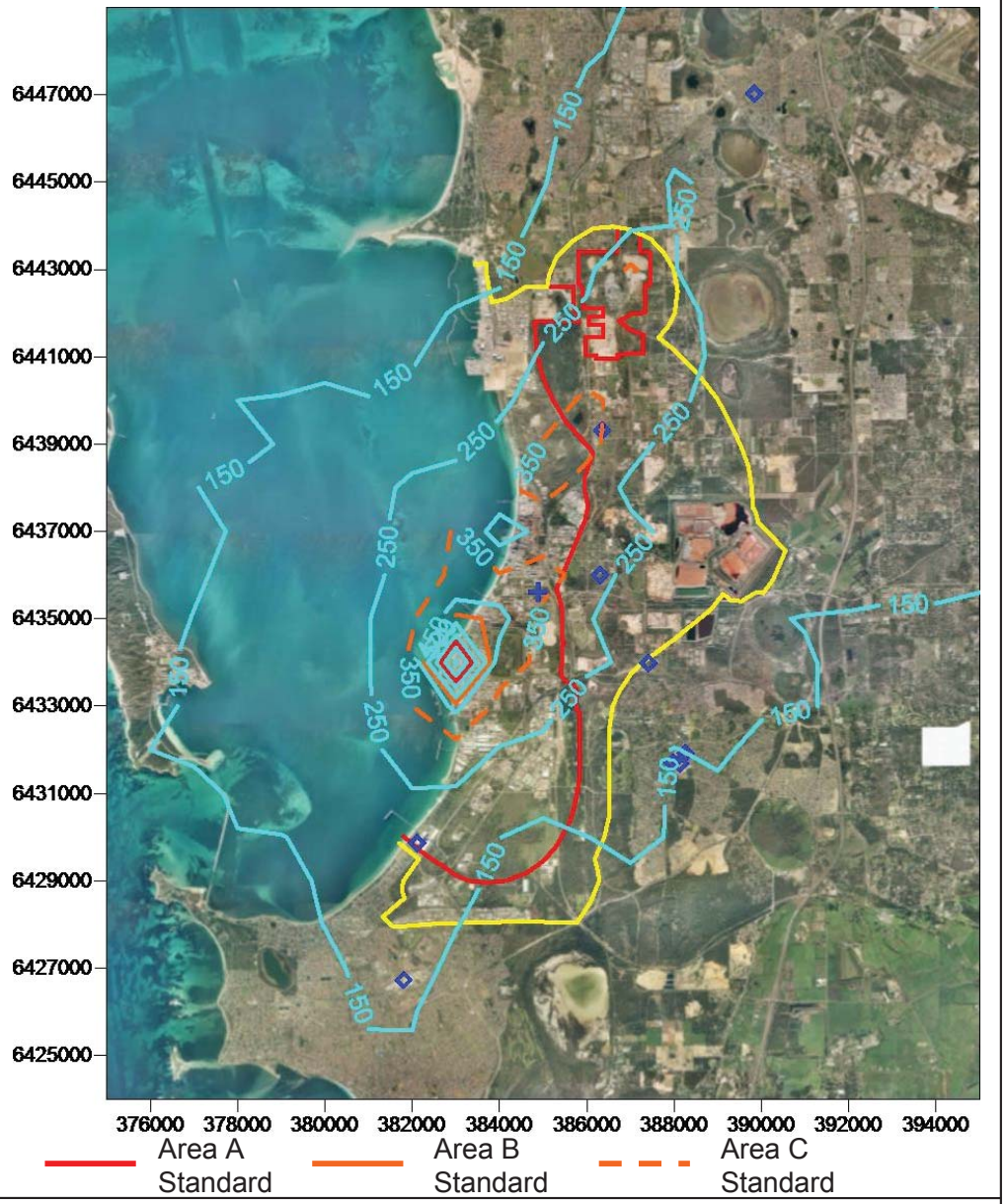
DATE: May 2014

FIGURE 8

Existing Industry



Existing Industry with Kwinana WtE Facility



Phoenix Energy
Kwinana WTE Project - Air Dispersion Modelling Assessment

9th Highest Predicted 1-hr Average SO_2 GLC (µg/m³)
Full Modelling Domain; DISPMOD 2005; 1996

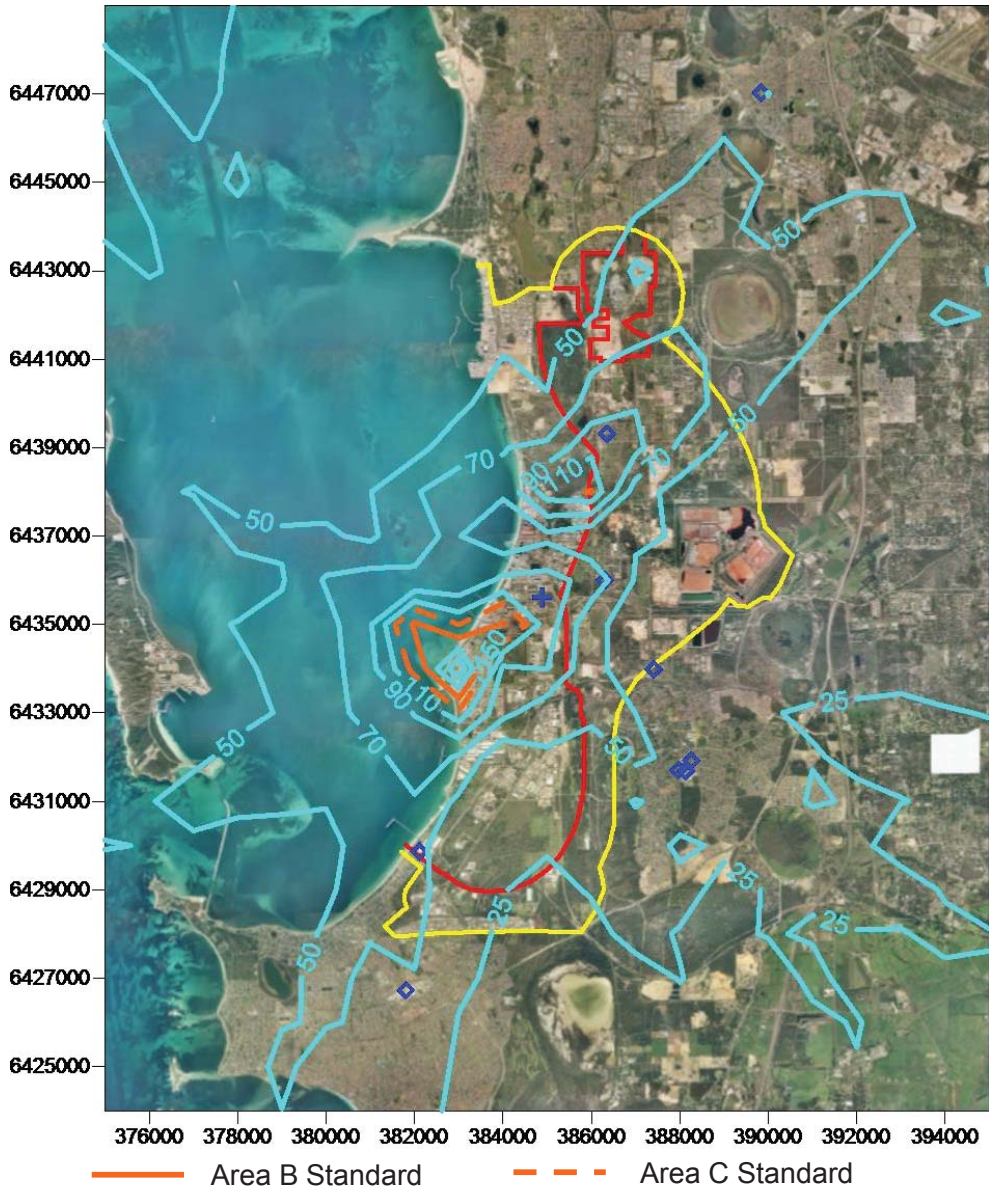
ENVIRON

JOB NO: AS110691

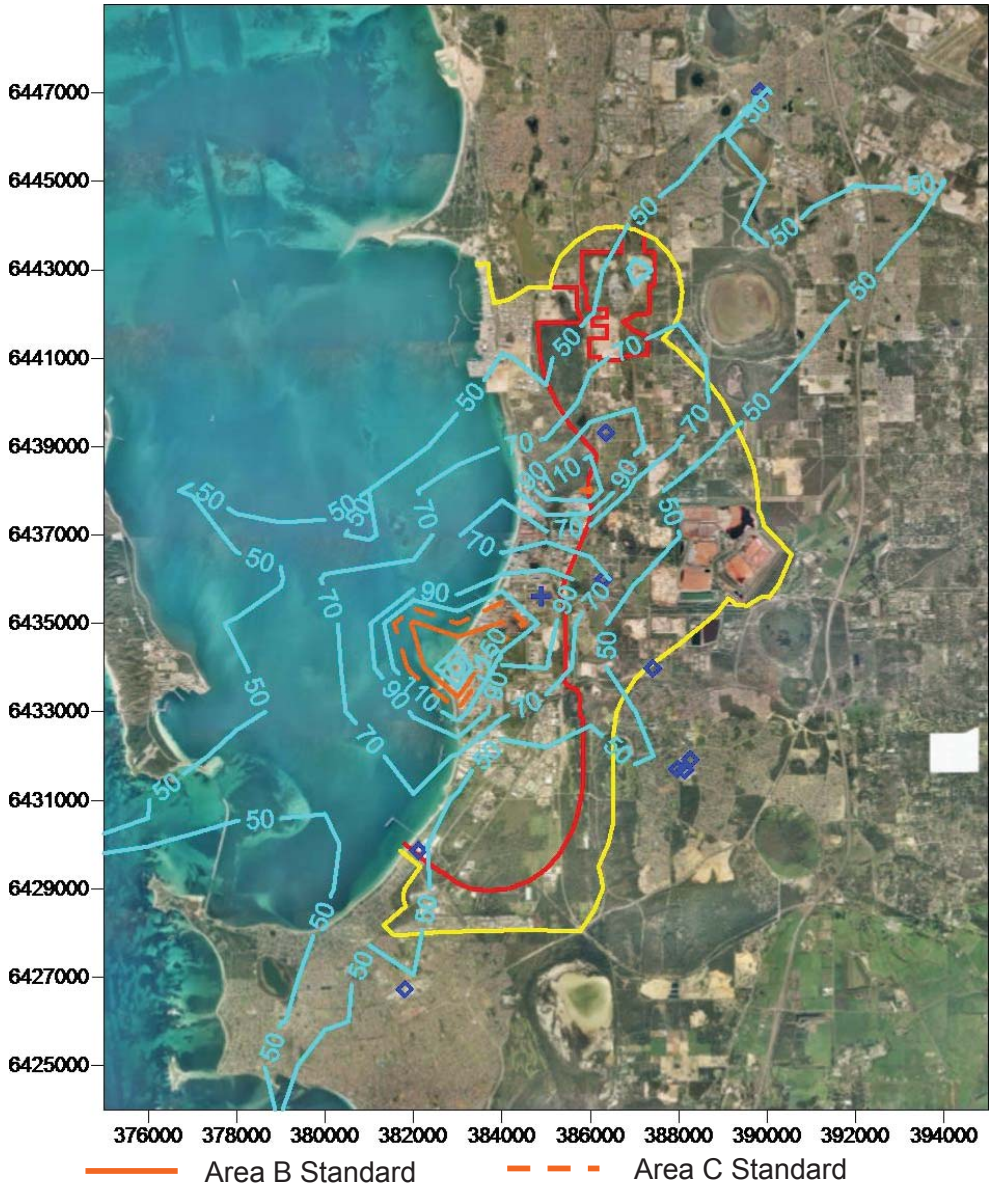
DATE: May 2014

FIGURE 9

Existing Industry



Existing Industry with Kwinana WtE Facility



Phoenix Energy
Kwinana WTE Project - Air Dispersion Modelling Assessment

Maximum Predicted 24-hr Average SO_2 GLC (µg/m^3)
Full Modelling Domain; DISPMOD 2005; 1996

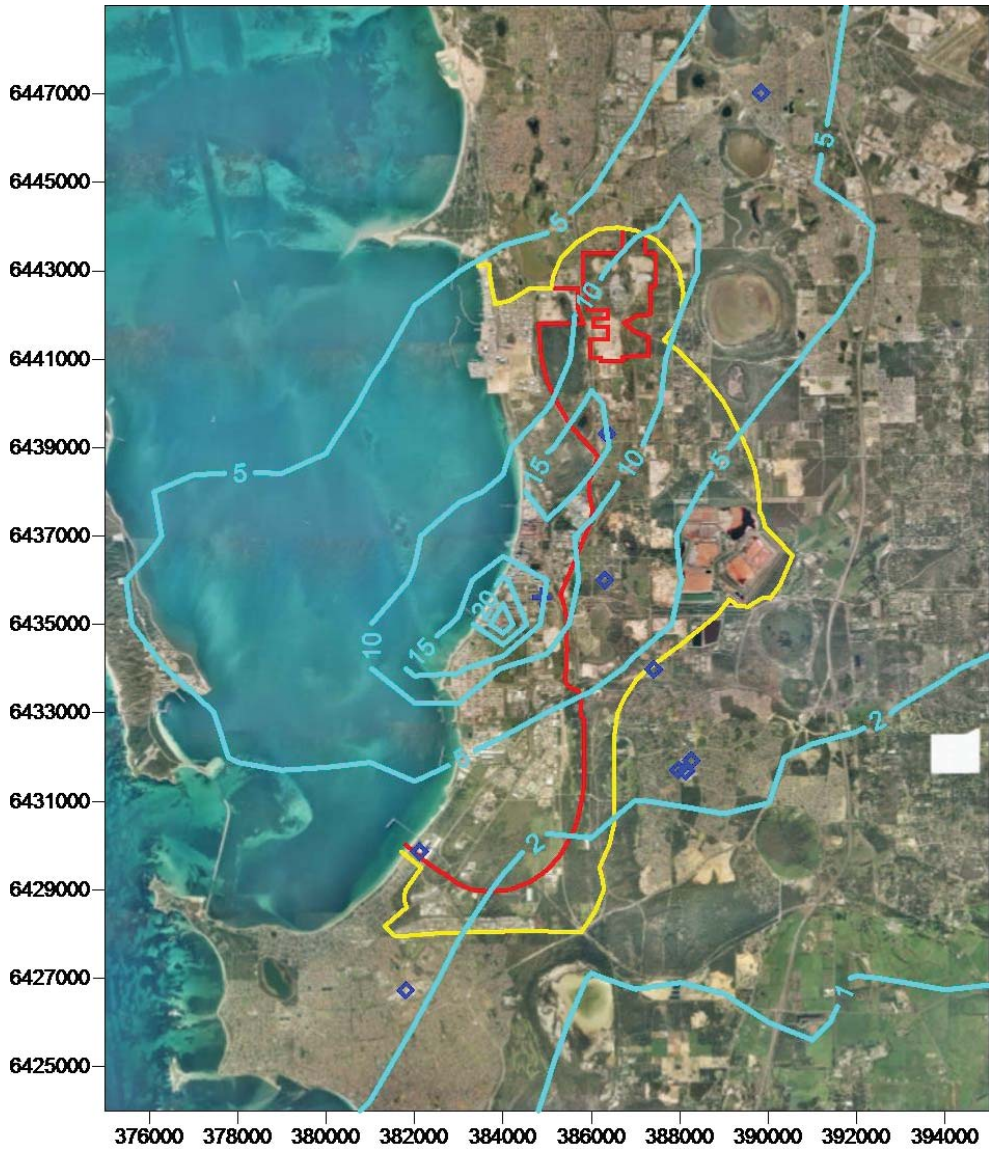
ENVIRON

JOB NO: AS110691

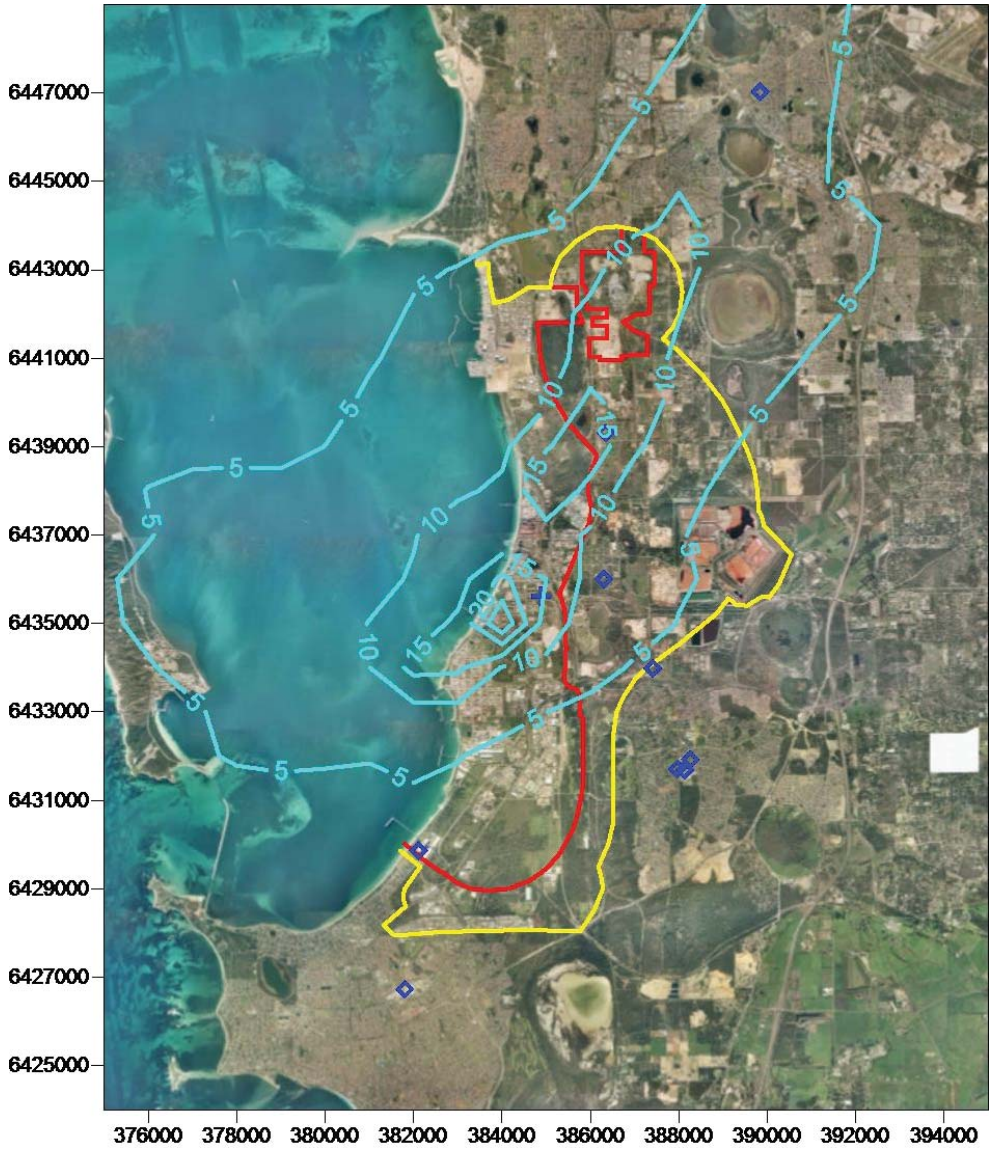
DATE: May 2014

FIGURE 10

Existing Industry



Existing Industry with Kwinana WtE Facility



Phoenix Energy
Kwinana WTE Project - Air Dispersion Modelling Assessment

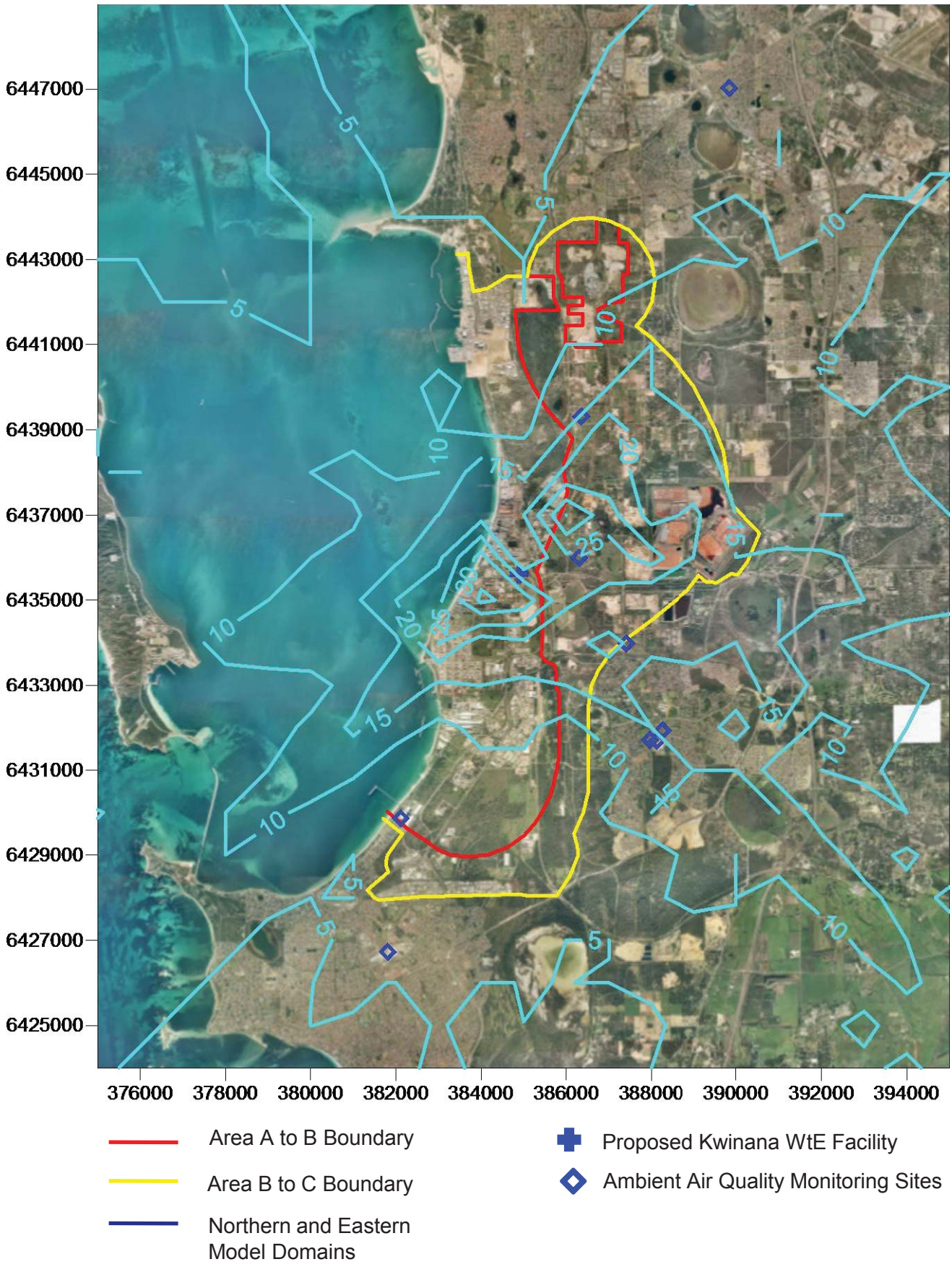
Predicted Annual Average SO_2 GLC (µg/m^3)
Full Modelling Domain; DISPMOD 2005; 1996

ENVIRON

JOB NO: AS110691

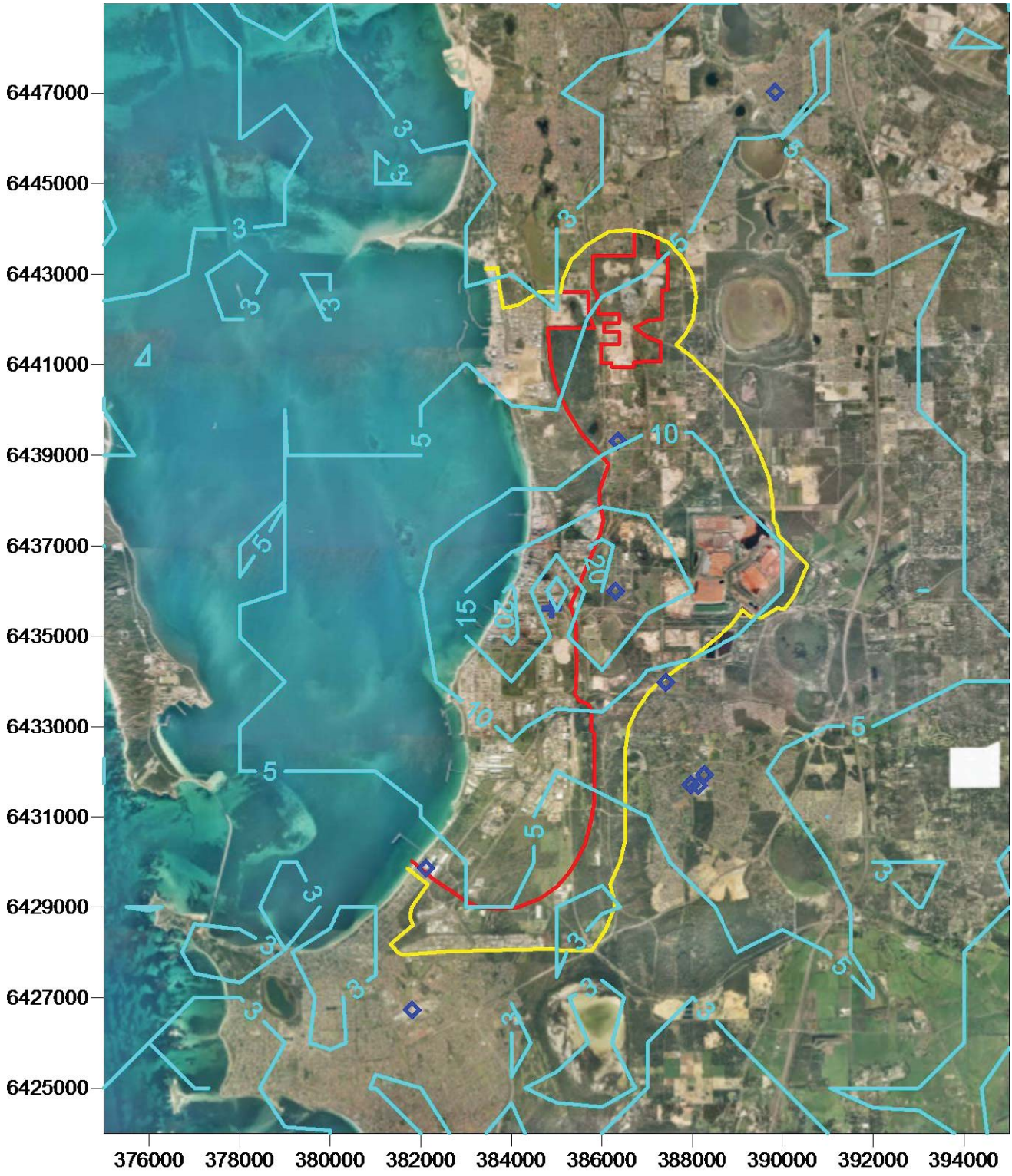
DATE: May 2014

FIGURE 11



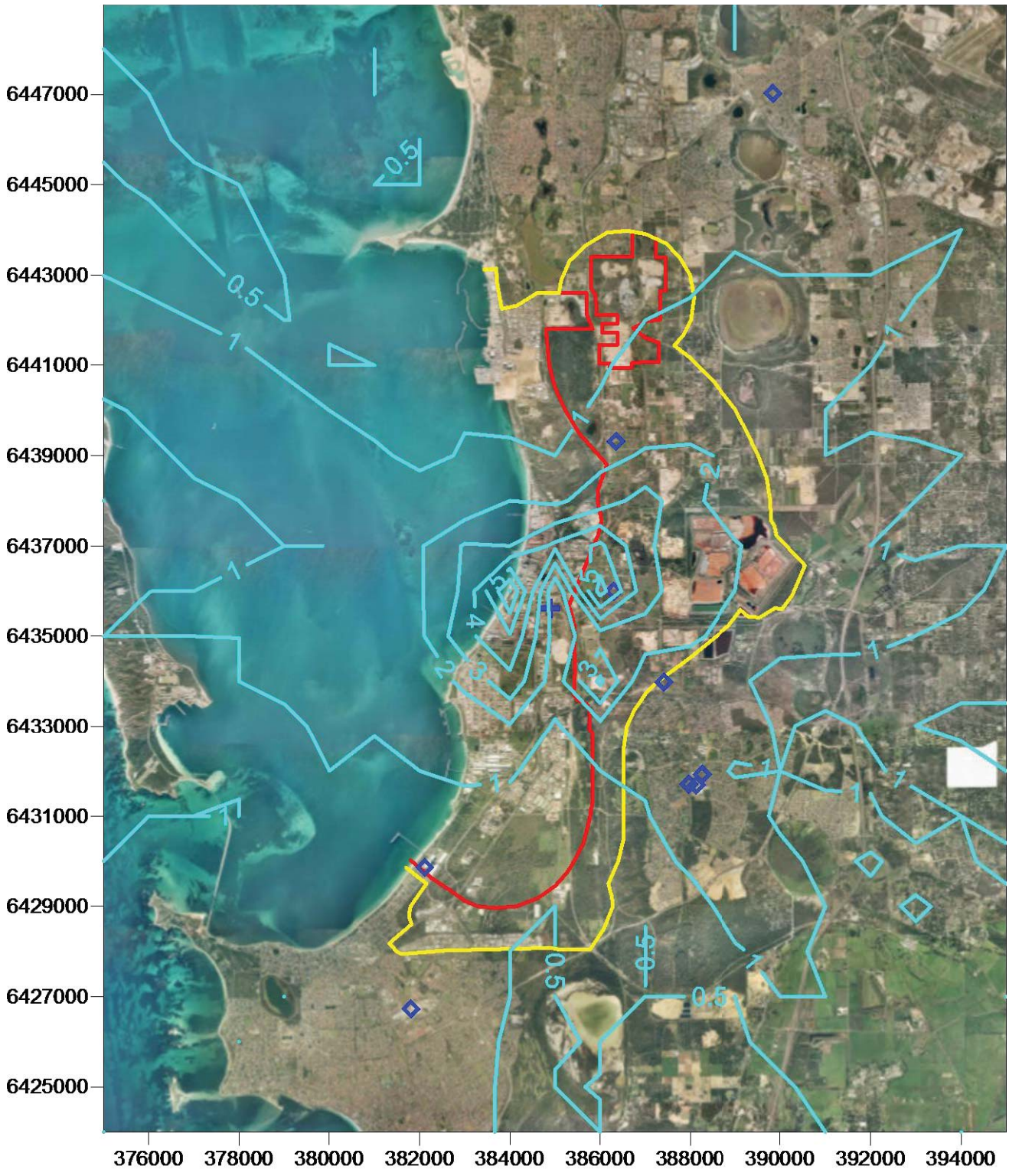
Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Maximum Predicted 1-hour Average SO_2 GLCs (µg/m^3) – Kwinana WtE Facility in Isolation (Maximum Emission Limits) Full Modelling Domain; DISPMOD 2005; 1996

ENVIRON JOB NO: AS110691 DATE: May 2014 FIGURE 12



Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	9th Highest Predicted 1-hour Average SO_2 GLCs (µg/m^3) – Kwinana WtE Facility in Isolation (Maximum Emission Limits) Full Modelling Domain; DISPMOD 2005; 1996

ENVIRON JOB NO: AS110691 DATE: May 2014 FIGURE 13



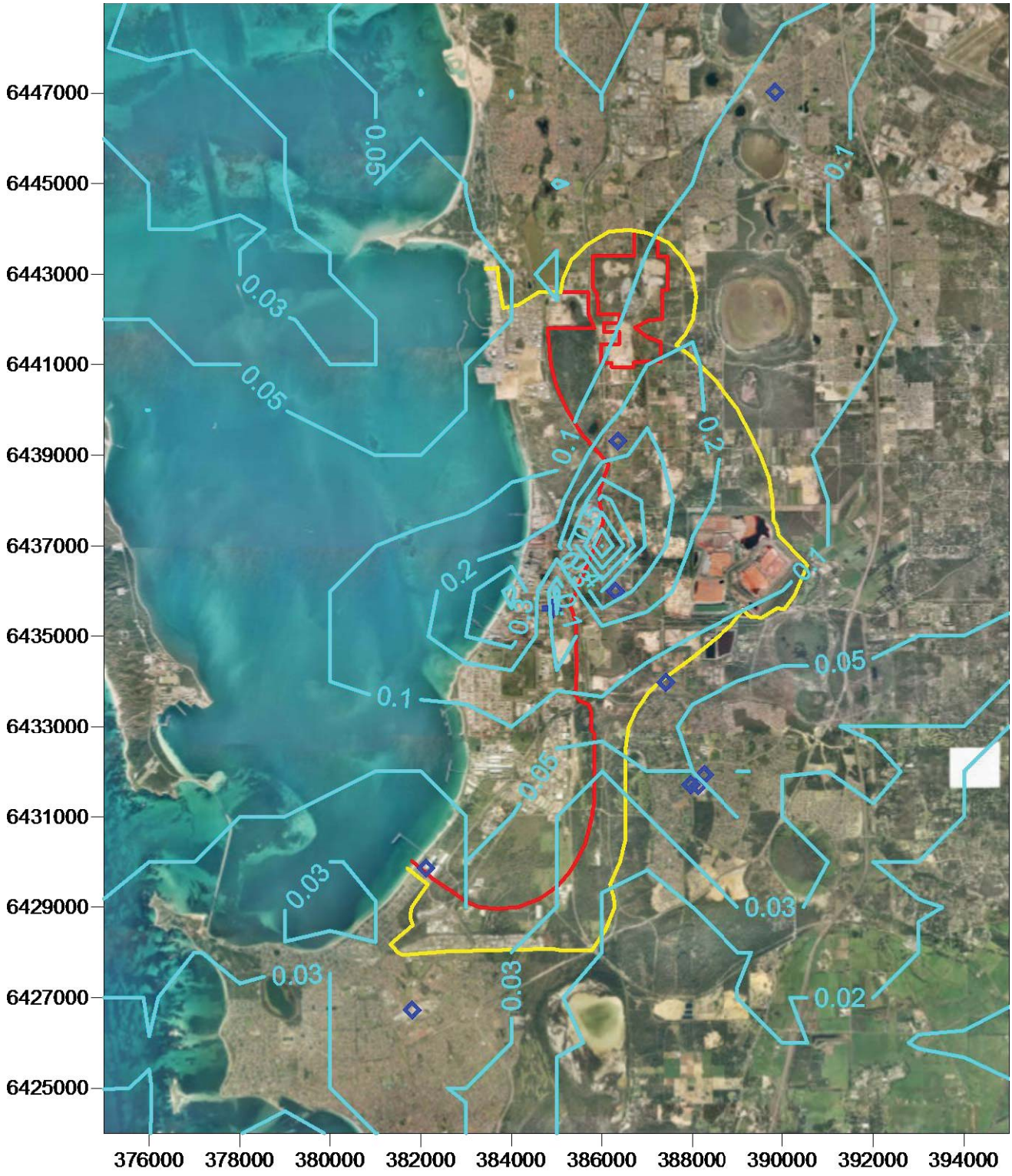
Phoenix Energy

Kwinana WTE Project - Air Dispersion Modelling Assessment

Maximum Predicted 24-hour Average SO_2 GLCs (µg/m^3) – Kwinana WtE Facility in Isolation (Maximum Emission Limits)

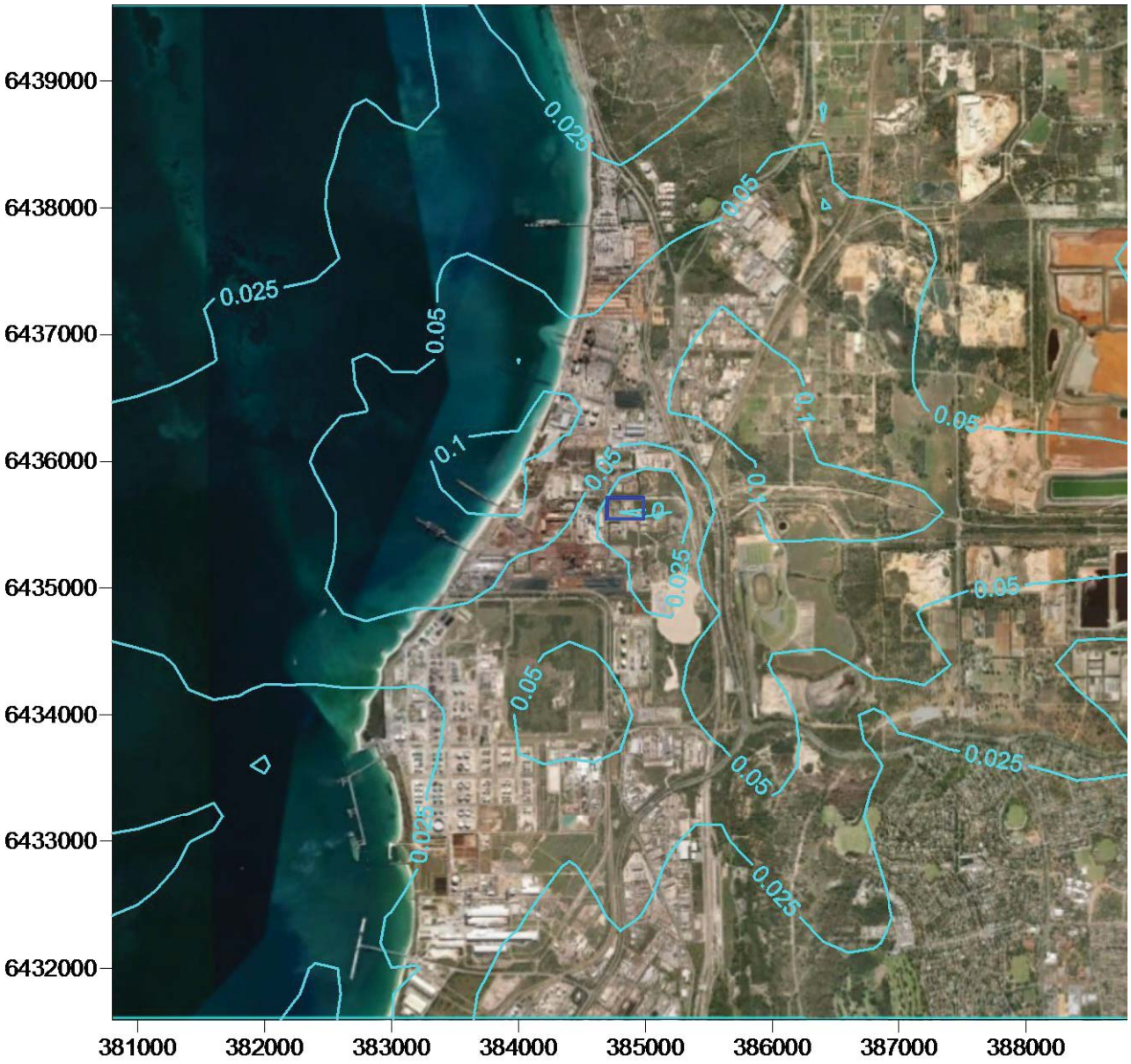
Full Modelling Domain; DISPMOD 2005; 1996

ENVIRON | JOB NO: AS110691 | DATE: May 2014 | FIGURE 14

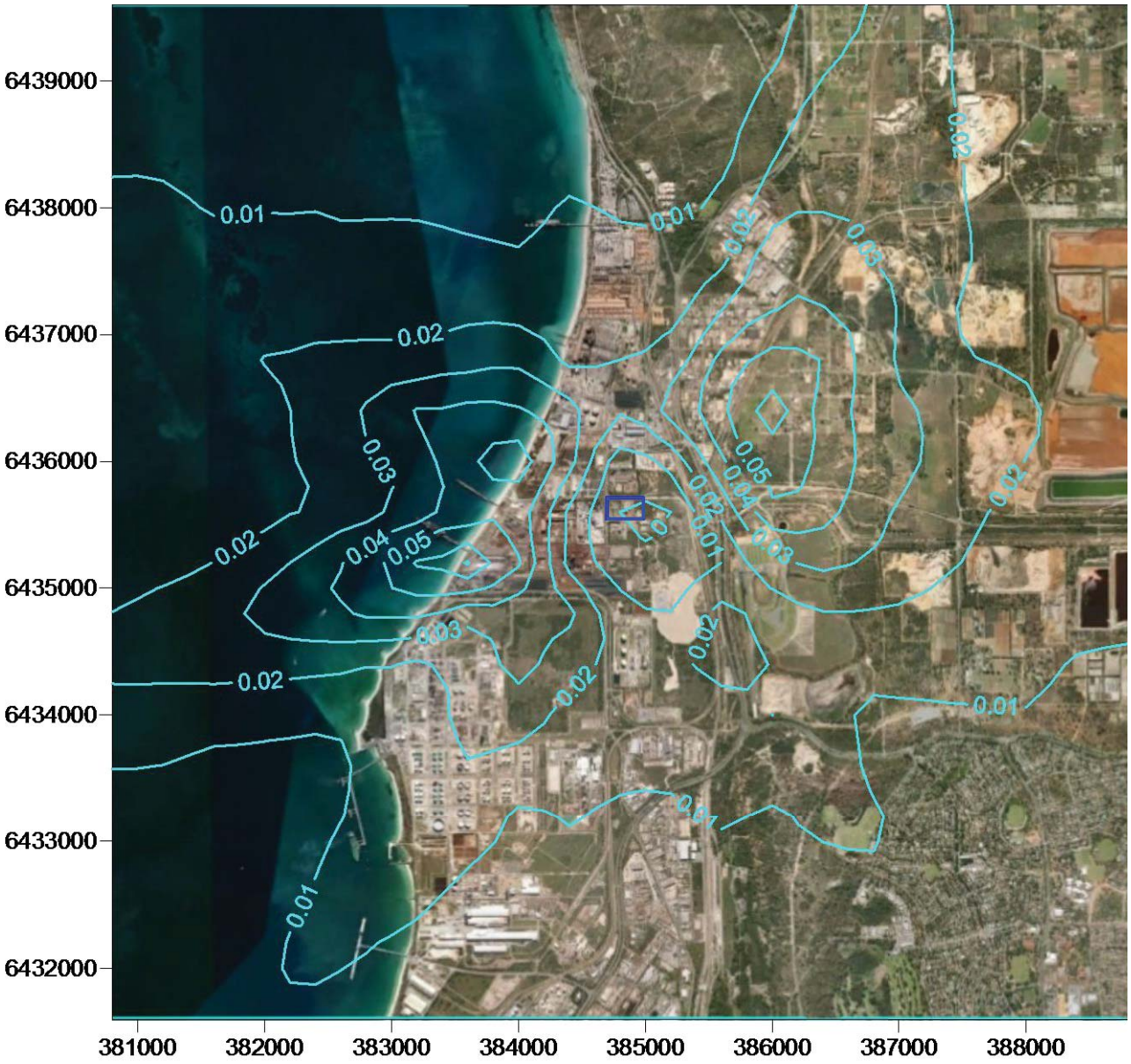


Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Predicted Annual Average SO_2 GLCs (µg/m^3) – Kwinana WtE Facility in Isolation (Maximum Emission Limits) Full Modelling Domain; DISPMOD 2005; 1996

ENVIRON JOB NO: AS110691 DATE: May 2014 FIGURE 15

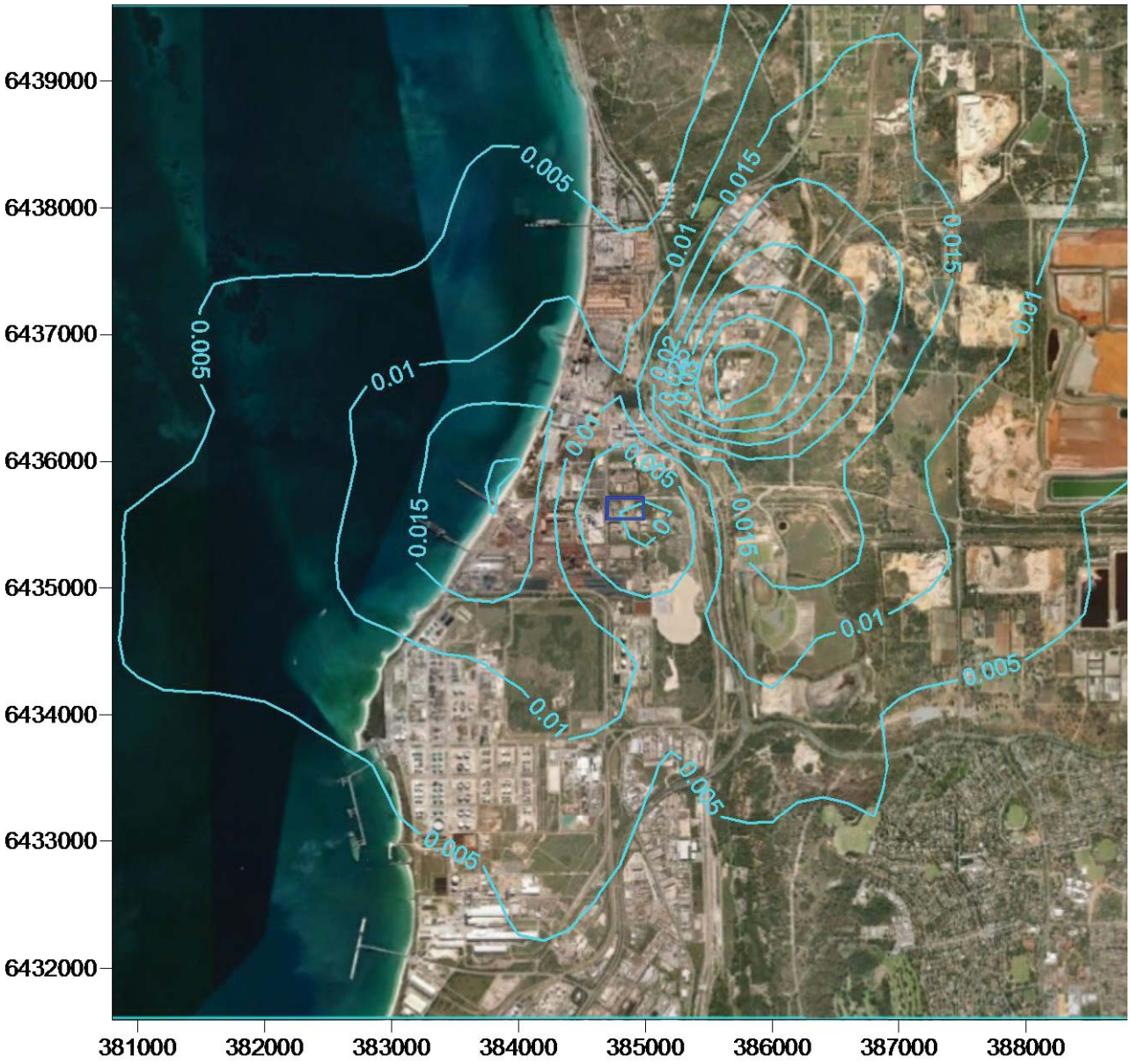


Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Maximum Predicted 24-hour Average HF GLCs (µg/m^3) – Normal Operations (Maximum Emission Limits) DISPMOD 2005; 1980



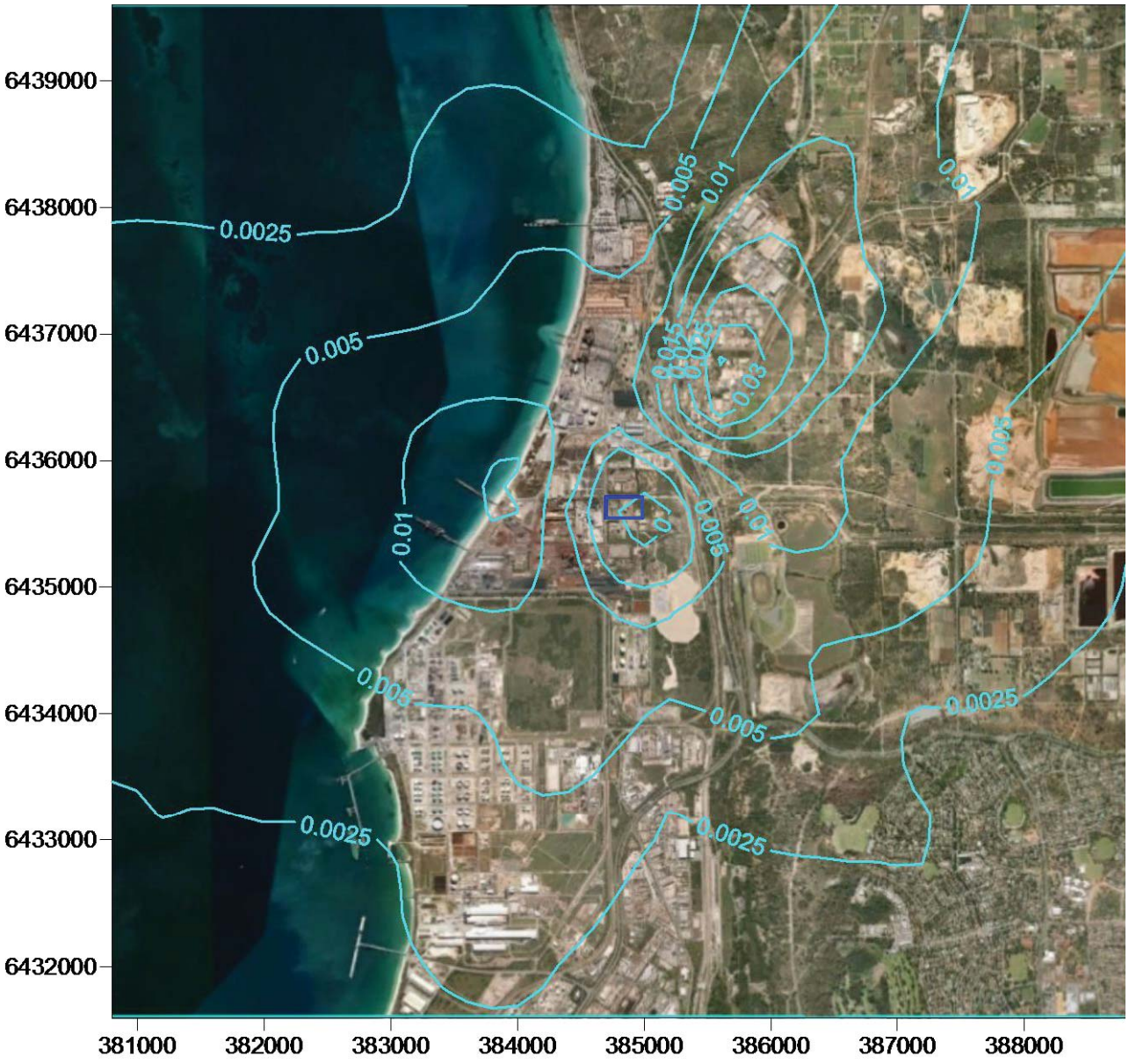
Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Maximum Predicted 7-day Average HF GLCs (µg/m^3) – Normal Operations (Maximum Emission Limits) DISPMOD 2005; 1995

ENVIRON | JOB NO: AS110691 | DATE: May 2014 | FIGURE 17



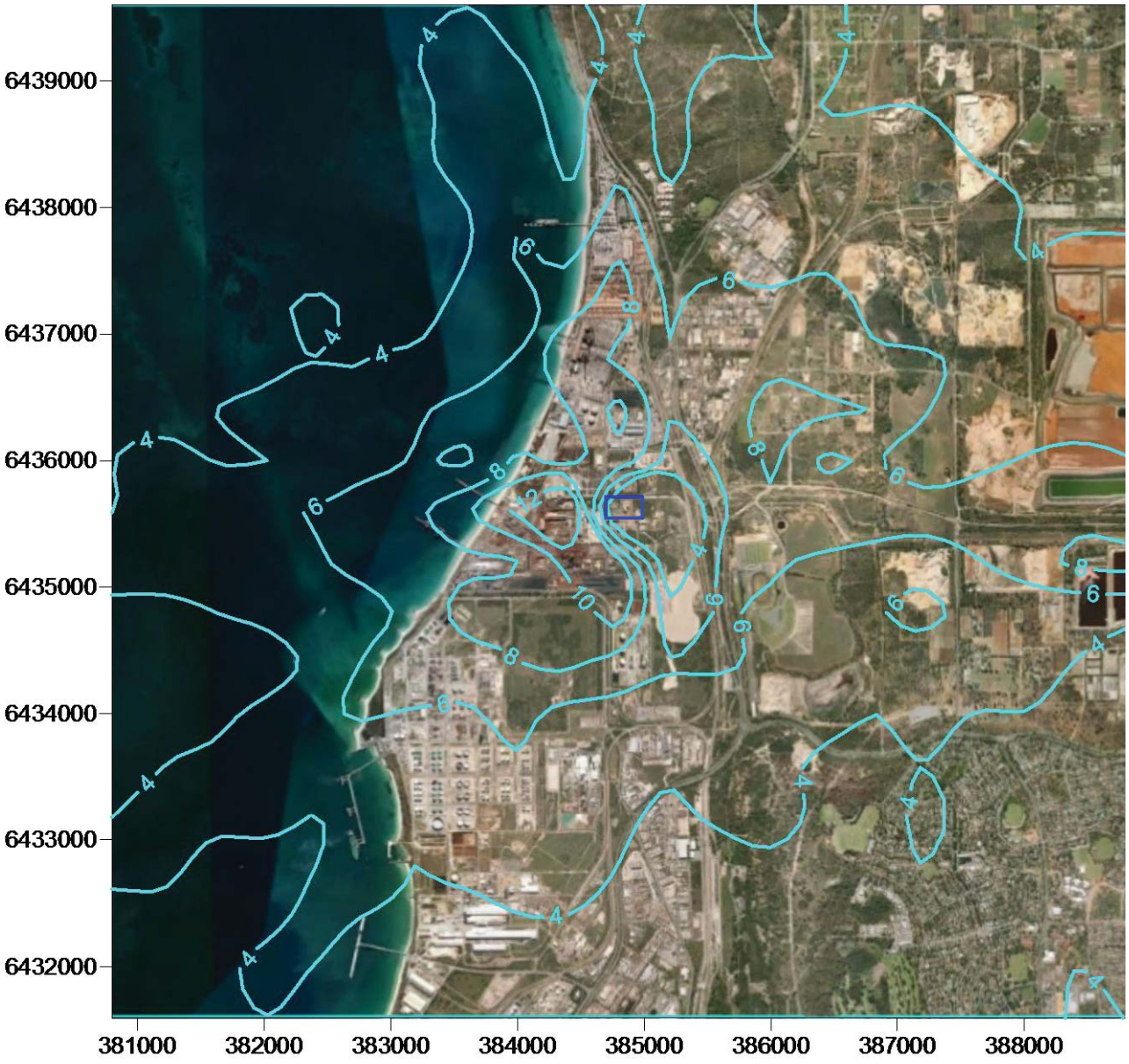
Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Maximum Predicted 30-day Average HF GLCs (µg/m^3) – Normal Operations (Maximum Emission Limits) DISPMOD 2005; 1996

ENVIRON | JOB NO: AS110691 | DATE: May 2014 | FIGURE 18

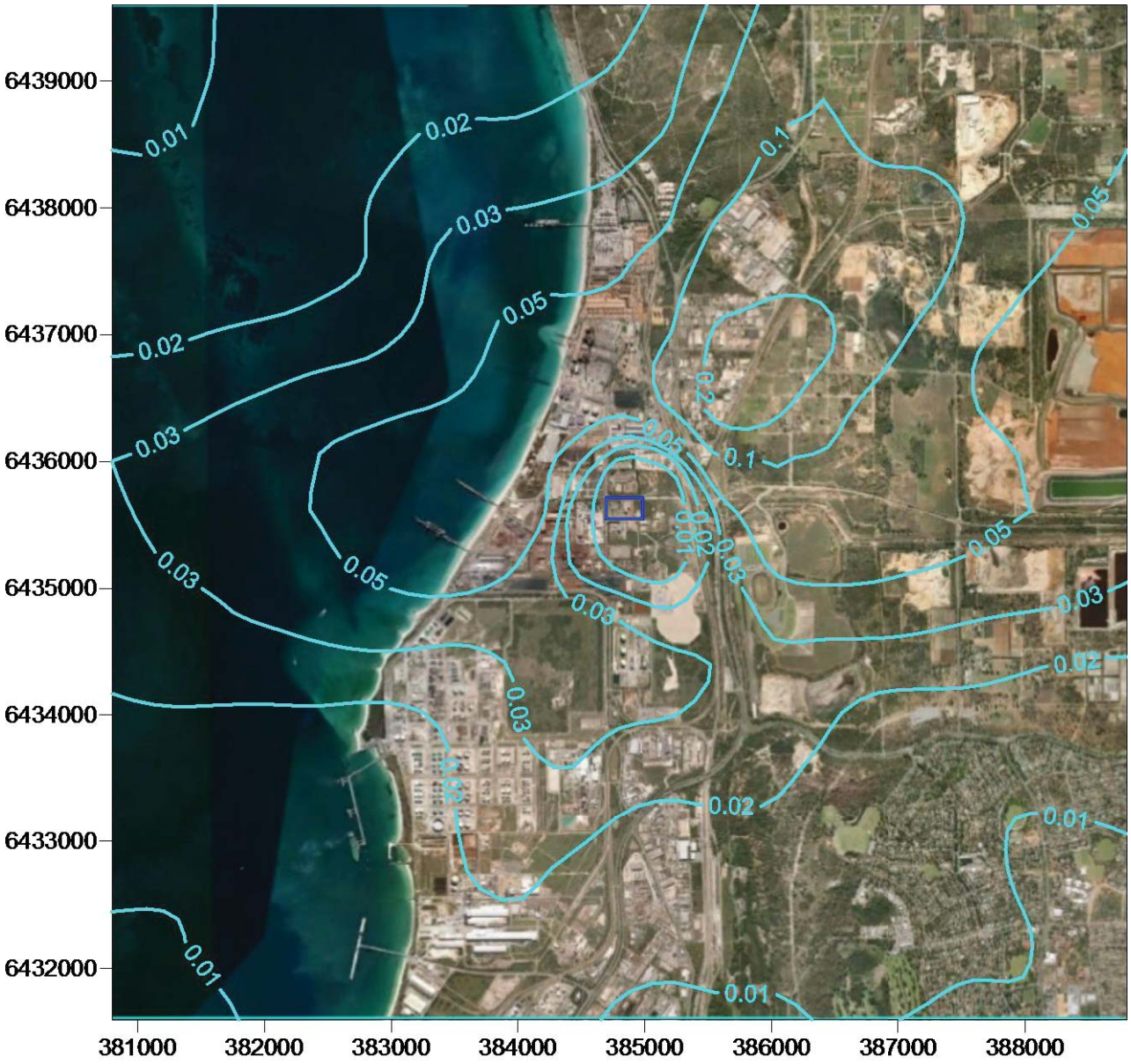


Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Maximum Predicted 90-day Average HF GLCs (µg/m^3) – Normal Operations (Maximum Emission Limits) DISPMOD 2005; 1996

ENVIRON JOB NO: AS110691 DATE: May 2014 FIGURE 19

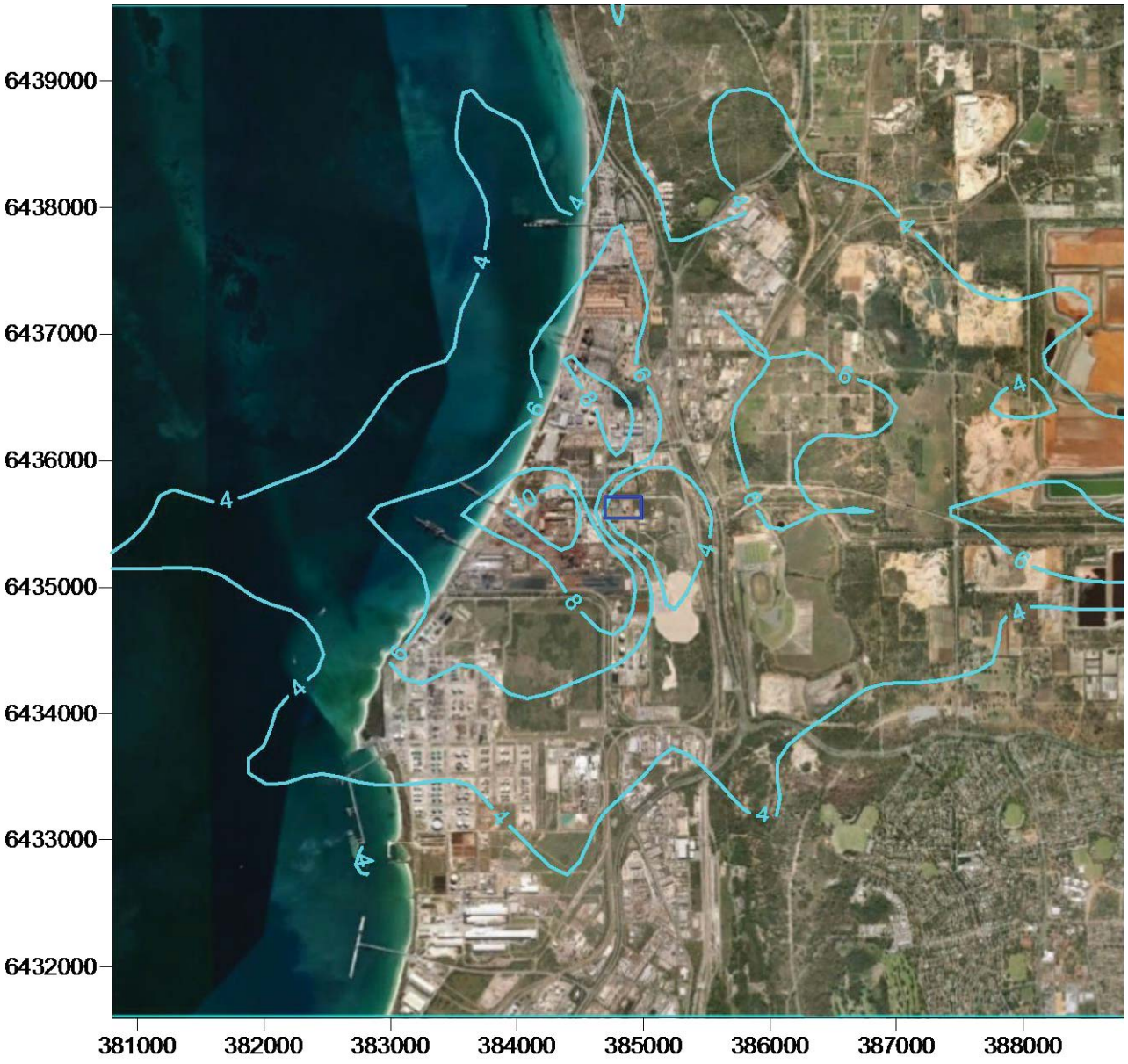


Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Maximum Predicted 1-hour Average HCl GLCs (µg/m^3) – Normal Operations (Maximum Emission Limits) DISPMOD 2005; 1980



Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Predicted Annual Average HCl GLCs (µg/m^3) – Normal Operations (Maximum Emission Limits) DISPMOD 2005; 1980

ENVIRON JOB NO: AS110691 DATE: May 2014 FIGURE 21



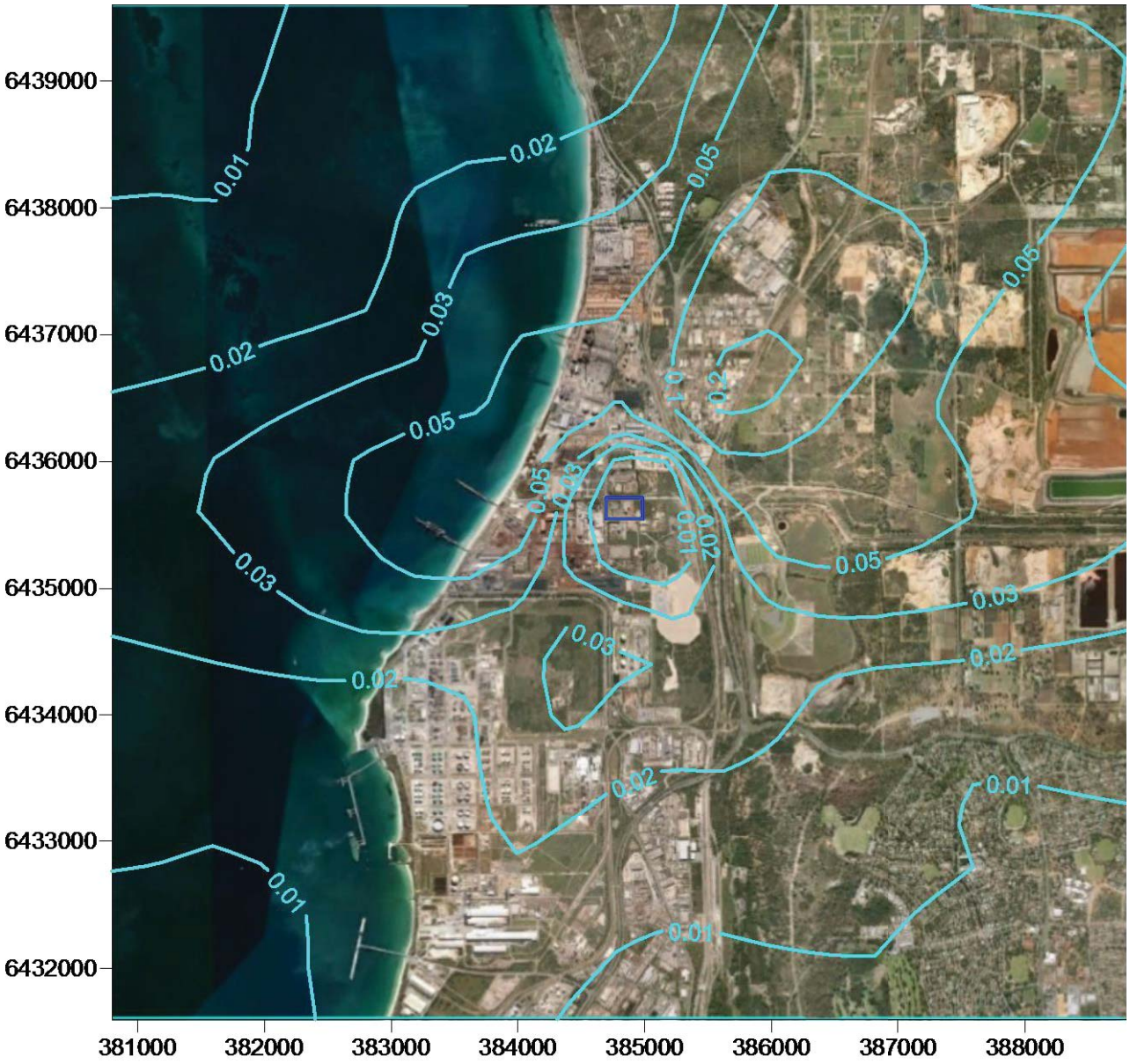
Phoenix Energy

Kwinana WTE Project - Air Dispersion Modelling Assessment

Maximum Predicted 1-hour Average NO_2 GLCs (µg/m^3) – Normal Operations (Maximum Emission Limits)

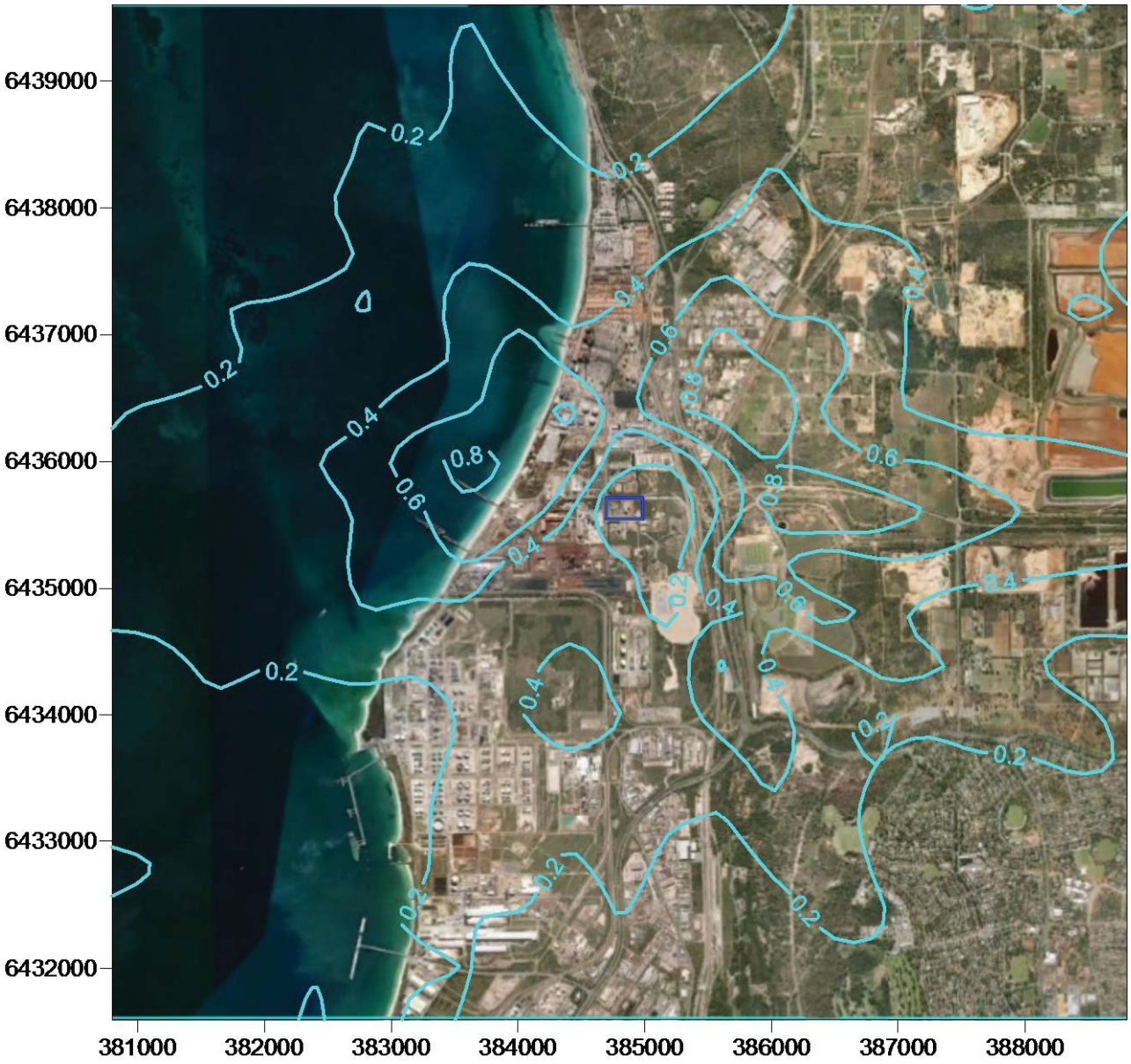
DISPMOD 2005; 1980

ENVIRON | JOB NO: AS110691 | DATE: May 2014 | FIGURE 22



Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Predicted Annual Average NO_2 GLCs (µg/m^3) – Normal Operations (Maximum Emission Limits) DISPMOD 2005; 1980

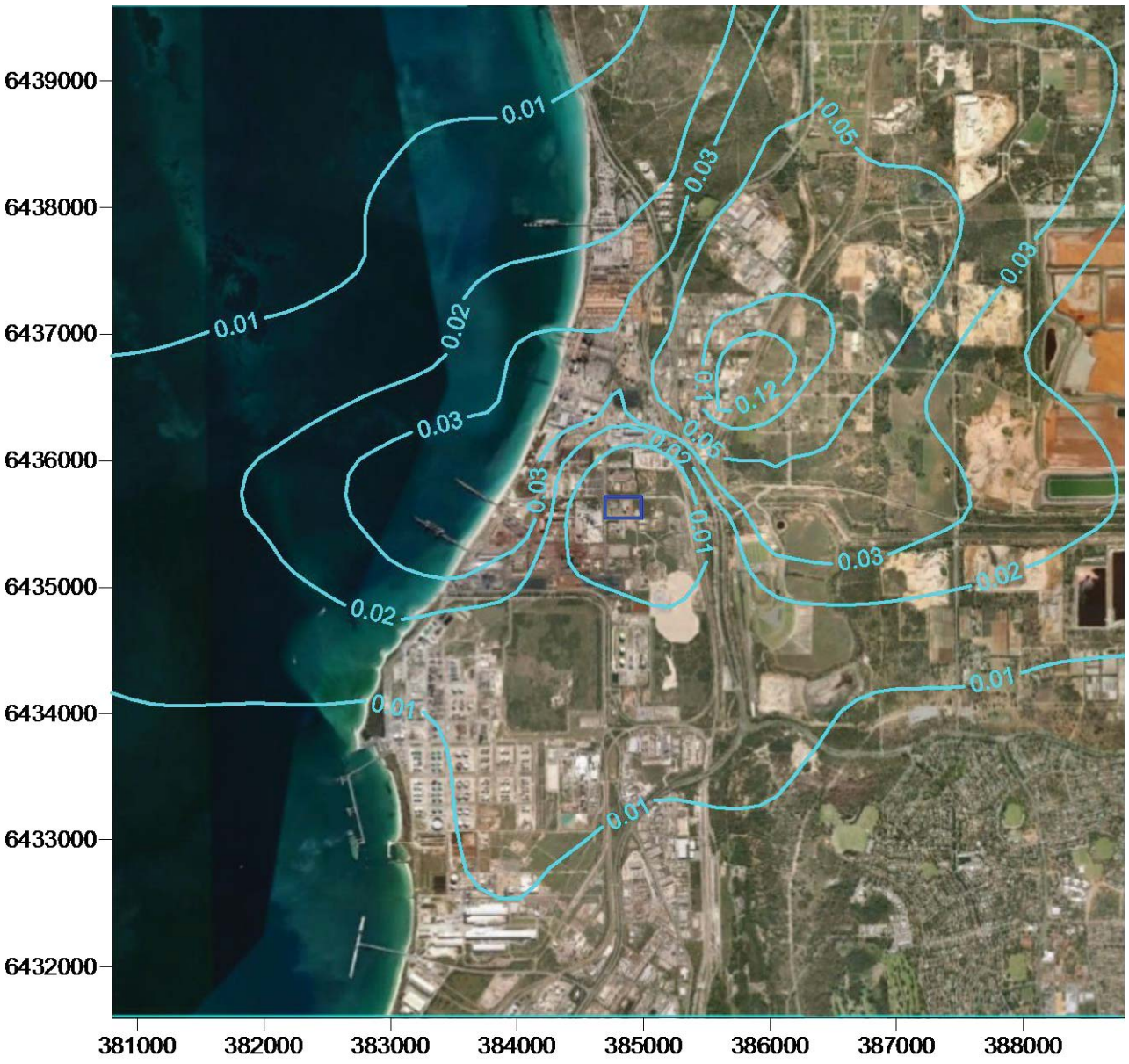
ENVIRON | JOB NO: AS110691 | DATE: May 2014 | FIGURE 23



Proposed Kwinana WtE Facility

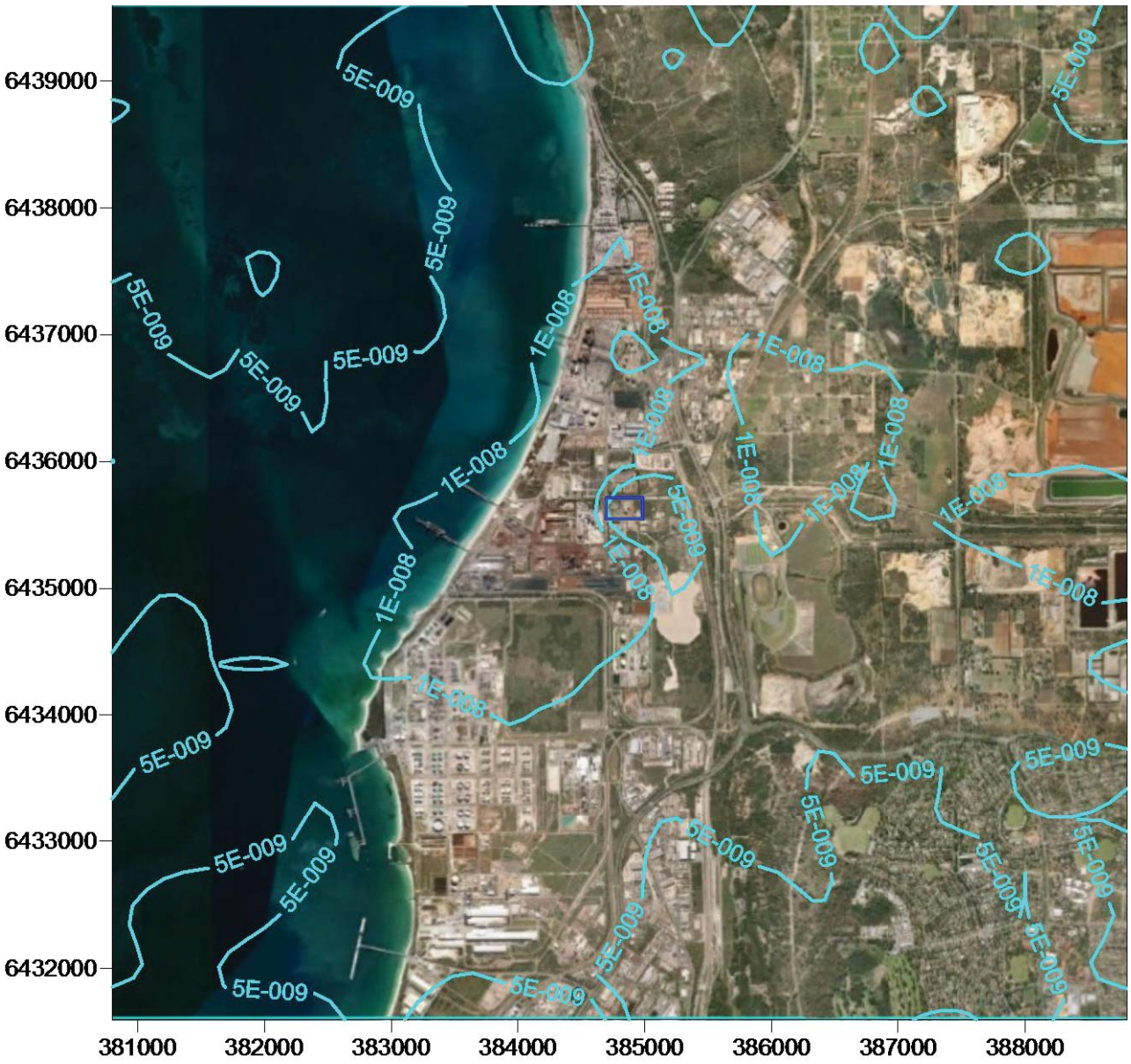
Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Maximum Predicted 24-hour Average $PM_{2.5}$ GLCs (µg/m^3) – Normal Operations (Maximum Emission Limits) DISPMOD 2005; 1980

ENVIRON JOB NO: AS110691 DATE: May 2014 FIGURE 24



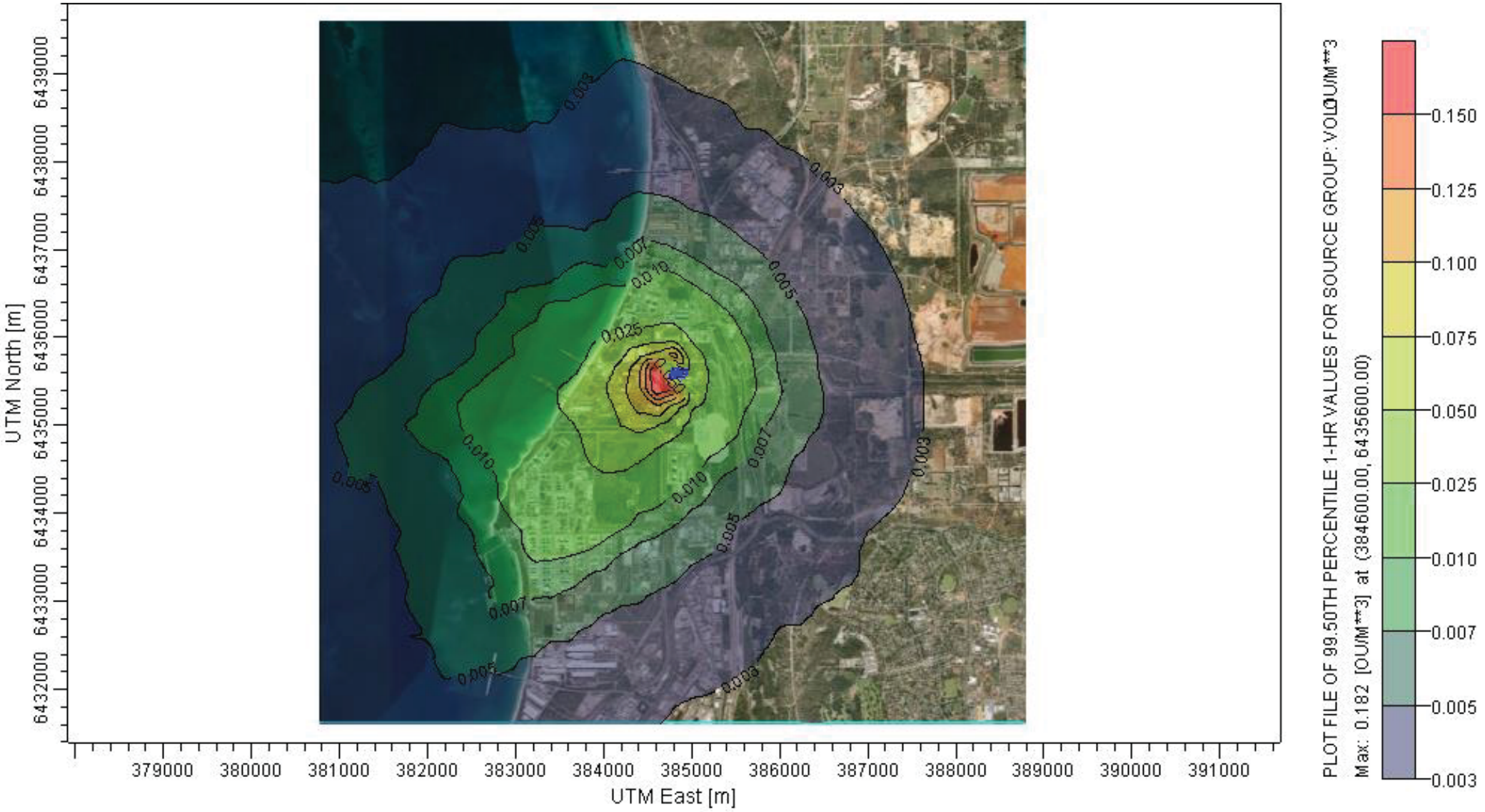
Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Predicted Annual Average $PM_{2.5}$ GLCs (µg/m^3) – Normal Operations (Maximum Emission Limits) DISPMOD 2005; 1980

ENVIRON JOB NO: AS110691 DATE: May 2014 FIGURE 25



Phoenix Energy Kwinana WTE Project - Air Dispersion Modelling Assessment	Maximum Predicted 1-hour Average Dioxins and Furans GLCs (µg-TEQ/m^3) – Normal Operations (Maximum Emission Limits) DISPMOD 2005; 1980

ENVIRON | JOB NO: AS110691 | DATE: May 2014 | FIGURE 26



Phoenix Energy
Kwinana WTE Project - Air Dispersion Modelling Assessment

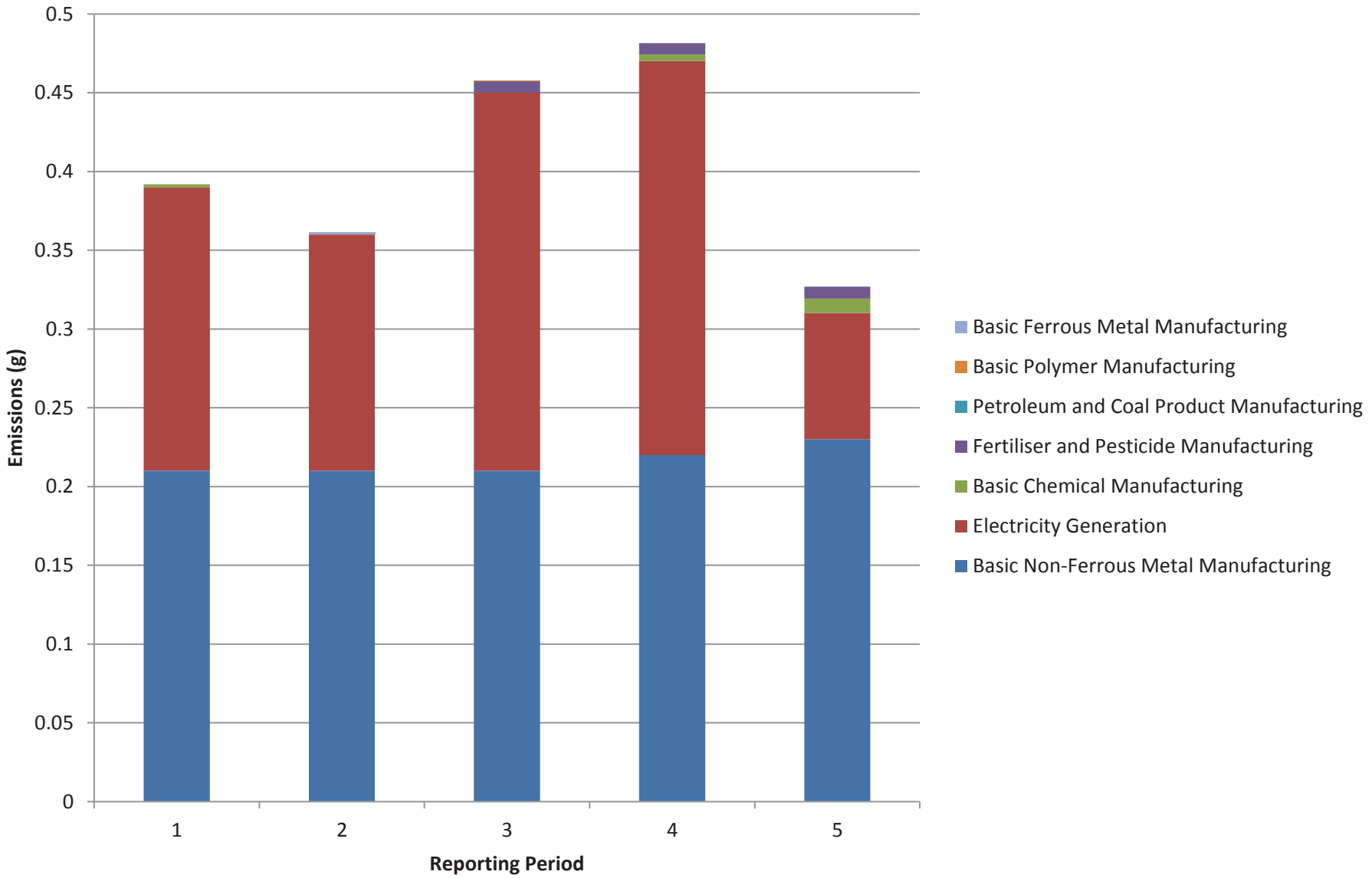
99.5th Predicted 1-hour Average Odour Concentrations (OU) – Normal Operations (Maximum Emission Levels)

ENVIRON

JOB NO: AS110691

DATE: May 2014

FIGURE 27



Note: Reported emissions for Petroleum and Coal Product Manufacturing for the 2008/2009 reporting period (i.e. 0.003 kg) have been replaced with the average of the emissions reported for the source in the following (i.e. 7.6E-09 kg). The 2008/2009 reported emissions are more than 5 orders of magnitude greater than emissions reported between 2009/2010 to 2011/2012 and are considered erroneous.

Phoenix Energy
Kwinana WTE Project - Air Dispersion Modelling Assessment

Summary of NPI Reported Emissions of Polychlorinated Dioxins and Furans within Kwinana Airshed – 2009-2012

ENVIRON

JOB NO: AS110691

DATE: May 2014

FIGURE 28

Appendix A

DISPMOD Input Files

Control File

```
KWINANA EPP  - INDUSTRY PROPOSAL DM_R06
  386350. 6442600. 0100. 18 18 0.2833 -32.0 181.7 360.0   3.0  .083  .047  0.25
 01011996 31121996 0000 2400  3  1 77  1.9  2.3
 35 0.00 0350. 0500. 0700. 1000. 0   5000.
  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1
  1  1  1  1  1  1  1  1  1  1  1  1  1
  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22
 23 24 25 26 27 28 29 30 31 32 33 34 35
  0        ! NUMBER OF STACKS THAT ARE NOT BEING USED
BP VDU 2       48.8 1.50 383170 6434130 0.79 18. 400
BP WEST 10     70.0 4.83 383409 6434491 1.00  0. 395
BP WEST 20     70.0 6.83 383409 6434491 1.00  0. 395
BP WEST 70     70.0 12.7 383409 6434491 1.00  0. 395
BP WEST 200    70.0 21.6 383409 6434491 1.00  0. 395
BP WEST 300    70.0 26.4 383409 6434491 1.00  0. 395
BP CRACKER     80.0 2.85 383185 6434040 1.00  0. 400
BP SRU 1       50.0 0.35 383170 6434300 1.00  0. 425
BP SRU 2       50.0 0.35 383200 6434300 1.00  0. 475
BP THEORETIC   59.2 2.27 383180 6433950 1.00  0. 400
CC KILN 1&2    61.2 2.26 386658 6442312 1.00  0.3000
CC KILN 3      61.6 2.15 386700 6442225 1.00  0.3000
CC KILN 4      80.8 2.15 386755 6442240 1.00  0.3000
CC KILN 5     112.8 2.00 386538 6442680 1.00  0.3000
CC KILN 6     115.5 2.44 386536 6442607 1.00  0.3000
TIWEST BYP 1   27.0 1.20 384280 6433200 1.00  0.1300
TIWEST BYP 2   27.0 1.20 384280 6433200 1.00  0.1300
TIWEST BYP 3   27.0 1.20 384280 6433200 1.00  0.1300
HRSG1A         30.0 3.28 383620 6434098 1.00  0. 800
HRSG1B         30.0 3.28 383568 6434090 1.00  0. 800
KNR SF 123     23.0 1.08 383539 6430718 1.00  0.1025
KNR H2S FLARE  41.5 0.30 383474 6430936 1.00  0. 960
KNR H2S SCRUB  68.7 0.14 383620 6430889 1.00  0.1105
ALC POWERHSE 1 68.6 1.96 384840 6437260 0.54 36. 500
ALC POWERHSE 2 71.6 1.96 384845 6437210 0.54 36. 500
ALC POWERHSE 3 99.7 1.98 384845 6437175 0.52 37. 500
ALC POWERHSE 4108.9 1.98 384845 6437140 0.51 37. 500
ALC CALCINER 1 49.9 3.05 384515 6437510 0.64 28. 250
ALC CALCINER 2 49.9 3.05 384505 6437510 0.64 28. 250
ALC CALCINER 3 37.7 3.05 384510 6437605 0.71 23. 250
SEC STAGE A   114.3 4.27 384425 6436810 1.00  0. 200
SEC STAGE B   137.2 4.27 384450 6436880 1.00  0. 200
SEC STAGE C   189.0 5.33 384390 6436670 1.00  0. 200
HISMELT        65.5 3.30 384100 6435050 1.00  0. 600
WTE STCK       87.5 3.00 384946 6435610 1.00  0. 950
0

TITLE
(A)
XREF,YREF,GINT,NUMX,NUMY,DTSL,ALAT,CSTDIR,ZLSB,SGTHSB,SGPHSB,TIBPEN
(2F9.1,F6.1,2I3,F7.4,3F6.1,3F6.0)
IDS,IMS,IYS,IDF,IMF,IYF,IT1,IT2,IAV,IDATAV,IY1,CSIGON,CSIGOF
(2(1X,3I2),2I5,3I3,2F5.1)
**** NOTE - IAV    = MODEL TIME STEP IN MULTIPLES OF 10 MINUTES (EG. 3 = 30 MIN
                    TIMESTEP.
         - IDATAV = INPUT MET DATA AVERAGING TIME IN MULTIPLES OF 10 MINUTES
                    (EG. 3 = 30 MIN INPUT DATA)
**** NOTE - IAV CANNOT BE LESS THAN IDATAV AND IDATAV MUST BE GREATER THAN 0
NUMSCE,QMIN,ALEV1,ALEV2,ALEV3,ALEV4,I
(I3,F5.1,4F6.0,I2)
**** NOTE - POLPOT MODE IS NOW FOR MULTIPLE SOURCES WITH FIXED EMISSIONS.
READ IN THE NUMBER OF STACKS PER SOURCE GROUP
KSCE(I),I=1,NUMSCE
(22I3)
READ IN THE STACK NUMBERS IN THE ORDER OF USE (.IE SOURCE GROUPING)
(ISTNUM(I),I=1,ISTTOT
READ IN THE NUMBER OF STACKS NOT TO BE USED
NSNTUS
READ IN STACK INFORMATION DATA
C STKHGT - HEIGHT OF STACK
C STKDIA - DIAMETER OF STACK
C STKX   - LATITUDE OF STACK AMG COORDS
C STKY   - LONGITUDE OF STACK AMG COORDS
```

```
C TEMSL  - SLOPE OF THE TEMPERATURE LOSS EQUATION FOR STACK
C TEMIN  - INTERCEPT OF THE TEMPERATURE LOSS EQUATION FOR STACK
C TEMSL AND TEMIN ARE USED TO AMKE ALLOWANCE FOR THE TEMPERATURE LOSS OF
C          FLUE GASES IN THE STACK WHEN GAS TEMPERATURES ARE MEASURED AT
C          THE BASE OF THE STACK
C DCOAST - ARRAY DISTANCE (METRES) FROM THE COAST OF EACH SOURCE GROUP
C Q      - SOURCE STRENGTH (KG/S)
C STKVOL - SOURCE VOLUME (M**3/S) AT STACK TEMP (IE. GAS FLOW RATE)
C STKRHO - EMISSION DENSITY (KG/M**3) AT STACK TEMP
C IBUILD - BUILDING EFFECTS FOR THIS SOURCE (1=YES, 0=NO)
C HBSTK  - HEIGHT OF BUILDING
C WBSTK  - WIDTH OF BUILDING
STKHGT(K),STKDIA(K),STKX(K),STKY(K),DCOAST(K),Q(K),STKVOL(K),STKRHO(K),
IBUILD(K),HBSTK(K),WBSTK(K)
(14X,F5.1,F5.2,F7.0,F8.0,F5.2,F4.0,F6.0,3F8.0,I2,2F4.0)
*** NOTE- WITH BUILDING EFFECTS IT IS ASSUMED THAT THE LAST SOURCE IN THE
        SOURCE GROUP HAS THE BUILDING DIMENSIONS. THIS LAST SOURCE ALSO
        CONTAINS THE LOGICAL (IBUILD) WHICH DETERMINE WHETHER BUILDING
        EFFECTS ARE TO BE USED.
```

Emissions File – Non-statistical Mode

```
RUN06 INDUSTRY PROPOSAL - AVERAGE EMISSION RATES OF ALL CASES
Name              Q      V     Rho  Nd  Nh Int
BP VDU 2        .0248     7.5    .700          1
BP WEST 10       .0050    10.0    .600          1
BP WEST 20       .0100    20.0    .600          1
BP WEST 70       .1800    70.0    .600          1
BP WEST 200      .2800   200.0    .600          1
BP WEST 300      .8600   300.0    .600          1
BP CRACKER       .2000    90.0    .590          1
BP SRU 1        .0293     4.8    .390          1
BP SRU 2        .0371     5.1    .390          1
BP THEORETIC     .1403   16.78    .700          1
CC KILN 1&2      .0240    29.6    .640          1
CC KILN 3        .0350    77.8    .740          1
CC KILN 4        .0350    93.5    .730          1
CC KILN 5        .0120   116.0    .710          1
CC KILN 6       .00044   113.7    .910          1
TIWEST BYP 1     .005      5.9    .347          1
TIWEST BYP 2     .0850    28.5    .347          1
TIWEST BYP 3     .1550    49.1    .347          1
HRSG1A           .0100   173.7    .827          1
HRSG1B           .0100   173.7    .827          1
KNR SF 123       .0020     6.9    .500          1
KNR H2S PLANT    .0070     1.4    .280          1
KNR H2S SCRUB    .0095     0.3    .280          1
ALC POWERHSE 1  .00050    55.1    .735          1
ALC POWERHSE 2  .00055    56.8    .767          1
ALC POWERHSE 3  .00055    65.8    .735          1
ALC POWERHSE 4  .00055    66.2    .731          1
ALC CALCINER 1  .00167    58.1    .614          1
ALC CALCINER 2  .00167    66.8    .614          1
ALC CALCINER 3  .00167    73.9    .614          1
SEC STAGE A      .3400   356.0    .823          0
SEC STAGE B      .0000   354.0    .805          0
SEC STAGE C      .3500   374.0    .840          0
HISMELT          .0350   130.0   1.070          0
WTE STCK        .01932   129.3    .674          0
```

Dispmod Input File

```
dispmod.ctl
z.out
y          ! plume spread in s.b. due to self gen turb?
y          ! use new PDF model for TIBL fumigation?
N          ! account for wind shear in TIBL PDF fumigation?
y          ! use numerical method to calculate TIBL height
95.            ! Tibl integration distance
```

```
y             ! use coastal AMG file
kwinana.coa
Y          ! use pdf for convective dispersion within TIBL & PBL?
N          ! account for wind shear within the TIBL?
N          ! use stability classes? - not with PDF
N          ! plume centreline mode?
4          ! option for lapse rate determination
Y          ! apply seasonal variation to lapse rates?
N          ! use measured sigma theta?
n             ! mixing into TIBL sharper than SGPHI?
y          ! if direction meander sigma greater, use it
n          ! info to screen on big timestep concs?
2          ! plume penetration: 1 ISC, 2 Manins, 3 Ausplume, 4 Aermod (Berkowicz)
n          ! include invers temp jump in pot temp lapse rate for pentration?
y             ! write all concs to disk for post-processing?
wml_0-0_96.dat
pmkwin.dat
dm62z243.emi
w_veer.dat
```

Appendix B

AERMET and AERMOD Input Files

AERMET.IN1

```
************************************************************
** AERMET - STAGE 1 Input Produced by:
** AERMET View Ver. 8.5.1
** Lakes Environmental Software Inc.
** Date: 2014/05/01
** File: G:\AS110691 Kwinana WTE\Revised 2-line
Scenario\Alcoa_Met\Odour\Revised Odour_KIC
Met\AERMET\Alcoa.IN1
************************************************************
JOB
  REPORT      Alcoa.RP1
  MESSAGES    Alcoa.MG1

UPPERAIR

  DATA        DUMMY.FSL FSL
  EXTRACT     Alcoa.UAX
  QAOUT       Alcoa.UQA

  XDATES      2011/01/01 TO 2011/12/31

** Station: ,
  LOCATION    00000001 32.198S    115.825E -8

ONSITE

** Location of the Onsite Data File
** G:\AS110691 Kwinana WTE\Revised 2-line
Scenario\Alcoa_Met\Odour\Revised Odour_KIC
Met\AERMET\ALC_2011.csv
  DATA        ALC_2011.csv
  QAOUT       Alcoa.OQA

  XDATES      2011/01/01 TO 2011/12/31

  LOCATION    00000001 32.198S    115.825E 0 41.00

  OBS/HOUR    6
  THRESHOLD   0.1

  OSHEIGHTS   10
  DELTA_TEMP  1 2.00 10.00

  READ        1  OSYR OSMO OSDY OSHR OSMN DT01
TT01 RH01 NRAD PRES WS01 WD01 PRCP SA01

  FORMAT      1 FREE

  AUDIT       DT01 TT NRAD PRCP PRES RH SA WD
WS

  RANGE       DT01 -2 <= 5 9
  RANGE       TT -30 <= 50 99
  RANGE       NRAD -100 <= 1000 999
  RANGE       PRCP 0 <= 25400 -9
  RANGE       PRES 9000 <= 10999 99999
  RANGE       RH 0 <= 100 999
  RANGE       SA 0 <= 80 99
  RANGE       WD 0 <= 360 999
  RANGE       WS 0 <= 50 999
```

AERMET.IN2

```
************************************************************
** AERMET - STAGE 2 Input Produced by:
** AERMET View Ver. 8.5.1
** Lakes Environmental Software Inc.
** Date: 2014/05/01
** File: G:\AS110691 Kwinana WTE\Revised 2-line Scenario\Alcoa_Met\Odour\Revised Odour_KIC Met\AERMET\Alcoa.IN2
************************************************************
JOB
  REPORT      Alcoa.RP2
  MESSAGES    Alcoa.MG2

UPPERAIR

  QAOUT       Alcoa.UQA

ONSITE

  QAOUT       Alcoa.OQA

MERGE

  OUTPUT      Alcoa.MRG

  XDATES      2011/01/01 TO 2011/12/31
```

AERMET.IN3

```
**********************************************************
** AERMET - STAGE 3 Input Produced by:
** AERMET View Ver. 8.5.1
** Lakes Environmental Software Inc.
** Date: 2014/05/01
** File: G:\AS110691 Kwinana WTE\Revised 2-line
Scenario\Alcoa_Met\Odour\Revised Odour_KIC
Met\AERMET\Alcoa.IN3
**********************************************************
JOB
  REPORT     Alcoa.RP3
  MESSAGES   Alcoa.MG3

METPREP

  DATA       Alcoa.MRG
  MODEL      AERMOD

  OUTPUT     aermet.sfc
  PROFILE    aermet.pfl

  XDATES     2011/01/01 TO 2011/12/31

  METHOD     WIND_DIR  NORAND
  METHOD     STABLEBL  BULKRN
  METHOD     STABLEBL  ADJ_U*

** Primary Surface Characteristics
  FREQ_SECT   MONTHLY 5
  SECTOR      1   0 135
  SECTOR      2 135 180
  SECTOR      3 180 225
  SECTOR      4 225 315
  SECTOR      5 315 360

** Period - Sector - Albedo - Bowen Ratio - Surface
Roughness

  SITE_CHAR    1  1   0.1800  0.4000  0.30000
  SITE_CHAR    2  1   0.1800  0.4000  0.30000
  SITE_CHAR    3  1   0.1800  0.4000  0.30000
  SITE_CHAR    4  1   0.1800  0.4000  0.30000
  SITE_CHAR    5  1   0.2000  1.0000  0.30000
  SITE_CHAR    6  1   0.2000  1.0000  0.30000
  SITE_CHAR    7  1   0.2000  1.0000  0.30000
  SITE_CHAR    8  1   0.2000  1.0000  0.30000
  SITE_CHAR    9  1   0.2000  1.0000  0.30000
  SITE_CHAR   10  1   0.2000  1.0000  0.30000
  SITE_CHAR   11  1   0.2000  1.0000  0.30000
  SITE_CHAR   12  1   0.1800  0.4000  0.30000
  SITE_CHAR    1  2   0.1800  1.0000  0.30000
  SITE_CHAR    2  2   0.1800  1.0000  0.30000
  SITE_CHAR    3  2   0.1800  1.0000  0.30000
  SITE_CHAR    4  2   0.1800  1.0000  0.30000
  SITE_CHAR    5  2   0.1800  1.5000  0.30000
  SITE_CHAR    6  2   0.1800  1.5000  0.30000
  SITE_CHAR    7  2   0.1800  1.5000  0.30000
  SITE_CHAR    8  2   0.1800  1.5000  0.30000
  SITE_CHAR    9  2   0.1800  1.5000  0.30000
  SITE_CHAR   10  2   0.1800  1.5000  0.30000
  SITE_CHAR   11  2   0.1800  1.5000  0.30000
  SITE_CHAR   12  2   0.1800  1.0000  0.30000
  SITE_CHAR    1  3   0.2000  1.5000  0.30000
  SITE_CHAR    2  3   0.2000  1.5000  0.30000
  SITE_CHAR    3  3   0.2000  1.5000  0.30000
  SITE_CHAR    4  3   0.2000  1.5000  0.30000
  SITE_CHAR    5  3   0.2000  1.5000  0.30000
  SITE_CHAR    6  3   0.2000  1.5000  0.30000
  SITE_CHAR    7  3   0.2000  1.5000  0.30000
  SITE_CHAR    8  3   0.2000  1.5000  0.30000
  SITE_CHAR    9  3   0.2000  1.5000  0.30000
  SITE_CHAR   10  3   0.2000  1.5000  0.30000
  SITE_CHAR   11  3   0.2000  1.5000  0.30000
  SITE_CHAR   12  3   0.2000  1.5000  0.30000
  SITE_CHAR    1  4   0.1800  1.0000  0.30000
  SITE_CHAR    2  4   0.1800  1.0000  0.30000
  SITE_CHAR    3  4   0.1800  1.0000  0.30000
  SITE_CHAR    4  4   0.1800  1.0000  0.30000
  SITE_CHAR    5  4   0.1800  1.5000  0.30000
  SITE_CHAR    6  4   0.1800  1.5000  0.30000
  SITE_CHAR    7  4   0.1800  1.5000  0.30000
  SITE_CHAR    8  4   0.1800  1.5000  0.30000
  SITE_CHAR    9  4   0.1800  1.5000  0.30000
  SITE_CHAR   10  4   0.1800  1.5000  0.30000
  SITE_CHAR   11  4   0.1800  1.5000  0.30000
  SITE_CHAR   12  4   0.1800  1.0000  0.30000
  SITE_CHAR    1  5   0.1800  0.4000  0.30000
  SITE_CHAR    2  5   0.1800  0.4000  0.30000
  SITE_CHAR    3  5   0.1800  0.4000  0.30000
  SITE_CHAR    4  5   0.1800  0.4000  0.30000
  SITE_CHAR    5  5   0.2000  1.0000  0.30000
  SITE_CHAR    6  5   0.2000  1.0000  0.30000
  SITE_CHAR    7  5   0.2000  1.0000  0.30000
  SITE_CHAR    8  5   0.2000  1.0000  0.30000
  SITE_CHAR    9  5   0.2000  1.0000  0.30000
  SITE_CHAR   10  5   0.2000  1.0000  0.30000
  SITE_CHAR   11  5   0.2000  1.0000  0.30000
  SITE_CHAR   12  5   0.1800  0.4000  0.30000
```

AERMOD.ADI

```
**
**********************************
**
** AERMOD Input Produced by:
** AERMOD View Ver. 8.5.1
** Lakes Environmental Software Inc.
** Date: 1/05/2014
** File: G:\AS110691 Kwinana WTE\Revised 2-line
Scenario\Alcoa_Met\Odour\Revised Odour_KIC
Met\Revised Odour_KIC Met.ADI
**
**********************************
**
**
**********************************
** AERMOD Control Pathway
**********************************
**
**
CO STARTING
  TITLEONE G:\AS110691 Kwinana WTE\Revised 2-line
Scenario\Alcoa_Met\WtE_Alcoa_
  TITLETWO Odour emissions
  MODELOPT CONC FLAT  WARNCHKD BETA
LOWWIND2
  AVERTIME 1
  POLLUTID UNIT
  RUNORNOT RUN
  ERRORFIL "Revised Odour_KIC Met.err"
CO FINISHED
**
**********************************
** AERMOD Source Pathway
**********************************
**
**
SO STARTING
** Source Location **
** Source ID - Type - X Coord. - Y Coord. **
  LOCATION VOL1        VOLUME     384819.400
6435605.579         0.0
** Source Parameters **
  SRCPARAM VOL1            545.0     7.250    14.260
3.625
  CONCUNIT 1 OU/S OU/M**3
  SRCGROUP VOL1     VOL1
  SRCGROUP ALL
SO FINISHED
**
**********************************
** AERMOD Receptor Pathway
**********************************
**
**
RE STARTING
  GRIDCART UCART1 STA
                XYINC 380800.00 41 200.00 6431600.00 41
200.00
  GRIDCART UCART1 END
RE FINISHED
**
**********************************
** AERMOD Meteorology Pathway
**********************************
**
**
ME STARTING
  SURFFILE Alcoa.SFC
  PROFFILE Alcoa.PFL
  SURFDATA 0 2011
  UAIRDATA 1 2011
  SITEDATA 1 2011
  PROFBASE 5.0 METERS
ME FINISHED
**
**********************************
** AERMOD Output Pathway
**********************************
**
**
OU STARTING
  RECTABLE ALLAVE 1ST
  RECTABLE 1 1ST
  DAYTABLE ALLAVE
** The next line is commented because it conflicts with
Percentile / Rolling Average Option
**    POSTFILE 1 VOL1 UNFORM "REVISED
ODOUR_KIC MET.AD\01_GSTKA.POS" 31
** 1-Hour Binary POSTFILE for the Percentile/Rolling
Average Option or NAAQS
  POSTFILE 1 VOL1 UNFORM "Revised Odour_KIC
Met.AD\1HG001UN.POS" 32
** Auto-Generated Plotfiles
  PLOTFILE 1 VOL1 1ST "Revised Odour_KIC
Met.AD\01H1G001.PLT" 33
  SUMMFILE "Revised Odour_KIC Met.sum"
OU FINISHED
**
**
**********************************
** Percentile/Rolling Average
**********************************
** PERCOPTN ON
** ROLLOPTN OFF
** SKIPCALM OFF
** ROLLPATH G:\AS110691 Kwinana WTE\Revised 2-line
Scenario\Alcoa_Met\Odour\Revised Odour_KIC
Met\Revised Odour_KIC Met.AD\Percentile\
** PERVALUE = 99.50
**
**
**********************************
** Project Parameters
**********************************
** PROJCTN  CoordinateSystemUTM
** DESCPTN  UTM: Universal Transverse Mercator
** DATUM    World Geodetic System 1984
** DTMRGN   Global Definition
** UNITS    m
** ZONE     -50
** ZONEINX  0
****
```

AERMOD.ISC

[info]
version=8.2.0
closeok=1

[DEM_AERMAP]
file_count=0
import_minx=380300
import_miny=6431100
import_maxx=389300
import_maxy=6440100
resample=100

[SRTM_IMPORT]
file_count=1
file_name_0=C:\Users\airmodelling\Documents\Lakes\Shared Files\cache_Maps\SRTM3\Australia\S33E115.hgt
poly_count_0=1
poly_point_count_0_0=8
poly_x_0_0_0=3.13152777211669E+0005
poly_y_0_0_0=6.34693649566012E+0006
poly_x_0_0_1=3.12105408800475E+0005
poly_y_0_0_1=6.40237843942572E+0006
poly_x_0_0_2=3.11072361930724E+0005
poly_y_0_0_2=6.45781650885097E+0006
poly_x_0_0_3=3.58309832388611E+0005
poly_y_0_0_3=6.45858131656457E+0006
poly_x_0_0_4=4.05542536597695E+0005
poly_y_0_0_4=6.45912746857557E+0006
poly_x_0_0_5=4.06058798701163E+0005
poly_y_0_0_5=6.40370038538527E+0006
poly_x_0_0_6=4.06582221792208E+0005
poly_y_0_0_6=6.34826902583957E+0006
poly_x_0_0_7=3.59869686658028E+0005
poly_y_0_0_7=6.34771388509941E+0006
import_minx=380300
import_miny=6431100
import_maxx=389300
import_maxy=6440100
resample=100

[DEBUG_OPTIONS]
source_debug_opt=F
receptor_debug_opt=F
hill_debug_opt=F
dem_check_opt=F
dem_fillgaps_opt=T
tiffdebug_opt=F
aermap_dom_user=F

[GRID_ELEVATIONS]
sampling=0

[DEM_OPTIONS]
elev_option=1
elev_points=4

Appendix C

Predicted GLCs using WID Emission Limits: NO_2 and Metals

Predicted GLCs using WID Emission Limits: NO_2 and Heavy Metals

C.1 Emission Estimates

Phoenix Energy provided ENVIRON with a list of emissions rates for various compounds expected from the plant under normal operating conditions. The emission rates provided for NO_x and the heavy metals antimony, arsenic, cadmium, chromium VI, copper, lead, manganese, mercury and nickel were based on stack testing data from Martin reference facilities provided by Phoenix Energy. Emission rates for the remaining modelled compounds (SO_2, CO, PM, HF, HCl and dioxins and furans) were derived from WID Emission Limits (refer to Section 4).

The WID Emission Limits for NO_x are considered by Phoenix Energy to be overly conservative in relation to the anticipated emissions from the proposed Kwinana WtE facility. The WID Emission Limits are designed to cover a range of Best Available Techniques (BAT), of which the SCR technology proposed for NO_x abatement is but one BAT, albeit the most effective option. As such, the WID Emission Limits are not considered by Phoenix Energy to provide a realistic indication of the expected performance of the SCR technology that will be utilised by the Kwinana WtE facility to reduce NO_x emissions in the flue gas (refer to Section 2.3). Similarly, the WID Emission Limits for heavy metals do not provide a true reflection of the effectiveness of air pollution control equipment in reducing such emissions and are also considered by Phoenix Energy to be overly conservative in relation to the proposed Kwinana WtE facility. Furthermore, applying the WID limit values implies that both Martin grate lines, which will operate independently and in parallel, are simultaneously at their maximum allowable emission rates under the WID, which is an extremely conservative assumption.

The WID aggregates Group III metals (antimony, arsenic, chromium VI, copper, lead, manganese, and nickel), providing a total limit value. The UK Environment Agency (UKEA) recommends apportioning 11% of the total WID Emission Limit to each individual metal (UKEA, 2012). However, stack testing data provided by Phoenix Energy indicates that heavy metal emissions from comparable facilities with similar heavy metal abatement technology as proposed by Phoenix Energy (i.e. activated carbon injection upstream of a baghouse), are equal to a fraction of the emission rates derived from the 11% apportionment of the WID Emission Limits for each Group III metal.

A summary of the NO_2 and heavy metal emission rates derived from WID Emission Limits is provided in Table C1. The Group III emission rates are assumed to be equal to 11% of the total WID Emission Limit provided for these „Group 3" metals, as per the recommendations of the UKEA (2012).

Table C1: Summary of WID Emission Limit based Emission Estimates for Proposed Kwinana WtE Facility	
Modelled Compound	**Emission Rate**
NO_x	39 g/s
Antimony	0.005 g/s
Arsenic	0.005 g/s
Cadmium	0.001 g/s
Chromium VI	0.005 g/s
Copper	0.005 g/s
Lead	0.005 g/s
Manganese	0.005 g/s
Mercury	0.001 g/s
Nickel	0.005 g/s

C.2 Model Predicted GLCs

A summary of the predicted NO_2 and heavy metal GLCs based on the WID derived emission rates is presented in Table C2. The relevant ambient air quality criteria are provided for comparison.

Table C2: Summary of Predicted GLCs for Normal Operations (WID Emission Limits)

Compound	Averaging Period	Maximum Predicted GLC (µg/m^3) for Modelled Year			Guideline (µg/m^3)[1]	% Guideline Value[2]
		1980	1995	1996		
NO_2[3]	1-hour	57	46	52	246	23%
	Annual	1.1	0.8	1.1	62	1.7%
Lead	Annual	0.0002	0.0002	0.0002	0.5	0.04%
Cadmium	1-hour	0.003	0.002	0.002	0.0196	14%
	24-hour	0.0004	0.0004	0.0004	0.022	1.8%
	Annual	0.00005	0.00004	0.00005	0.011	0.5%
Mercury	1-hour	0.003	0.002	0.002	0.65	0.5%
	Annual	0.00005	0.00004	0.00005	0.22	0.02%
Antimony	1-hour	0.01	0.01	0.01	0.98	1.1%
	Annual	0.0002	0.0002	0.0002	0.033	0.6%
Arsenic	1-hour	0.01	0.01	0.01	0.098	10%
	24-hour	0.002	0.002	0.002	0.033	6.1%
	Annual	0.0002	0.0002	0.0002	0.0033	6.1%
Copper	1-hour	0.01	0.01	0.01	20	0.05%
	24-hour	0.002	0.002	0.002	1.1	0.2%
Chromium VI	1-hour	0.01	0.01	0.01	0.098	10%
	24-hour	0.002	0.002	0.002	0.33	0.6%
	Annual	0.0002	0.0002	0.0002	0.0002	100%
Manganese	1-hour	0.01	0.01	0.01	20	0.05%
	24-hour	0.002	0.002	0.002	0.16	1.3%
Nickel	1-hour	0.01	0.01	0.01	0.19	5.3%
	24-hour	0.002	0.002	0.002	0.15	1.3%
	Annual	0.0002	0.0002	0.0002	0.0033	6.1%

Notes
1. Referenced to 0ºC, and 1013.25 hPa.
2. Comparison of maximum predicted GLC for the three modelled years against the relevant guideline value.
3. NO_x:NO_2 ratio based on Dames and Moore (1993) equation as described in Section 5.5.

The data presented in Table C2 indicates that the maximum predicted 1-hour average NO_2 GLCs are expected to represent no more than 23% of the corresponding NEPM Standard. However, as noted above, the WID emission limits are considered to be overly conservative in relation to the anticipated emissions from the proposed Kwinana WtE facility and do not reflect the effectiveness of the SCR technology that will be utilised by Phoenix Energy to reduce NO_x emissions in the flue gas.

Exceedences of the annual average chromium VI DoH guideline are predicted using the WID derived emission rates, although the maximum 1-hour and 24-hour average GLCs comply comfortably with the corresponding guidelines. However, as also noted above, application of the WID Emission Limit values (and 11% apportionment of the total emission limit for Group III metals) is considered to be highly conservative and unrepresentative of the emission concentrations anticipated from the proposed Kwinana WtE facility.

The maximum short- and long-term GLCs predicted for lead, cadmium, mercury, antimony, arsenic, copper, manganese and nickel comply with the applicable air quality criteria. However it is noted that these results are also considered to be highly conservative and unrepresentative of the emission concentrations anticipated from the proposed Kwinana WtE facility.

Appendix D

Predicted GLCs for Independent Plumes from Multi-Flue Stack

Predicted GLCs for Independent Plumes from Multi-Flue Stack

D.1 Source Parameters

As described in Section 5.4, the multi-flue stack has been modelled as a single stack source using exhaust parameters provided by Phoenix Energy and an effective stack diameter was calculated based on the exit velocity and combined volumetric flow rate for each flue. However, as the combination of multi-flue emissions can be dependent on wind direction, an additional model run has been completed assuming no buoyancy enhancement between the two plumes. A summary of the source parameters adopted for this run are presented in Table D1.

Table D1: Summary of Source Parameters for Independent Plume Assessment

Parameter	Unit	Stack
Easting	m	384,946
Northing	m	6,435,610
Release Height	m	87.5
Effective Stack Diameter[1]	m	2.12
Exit Velocity	m/s	18.3
Exit Temperature	K	405
Volumetric Flowrate	m^3/s	64.7

Notes
1. Effective stack diameter calculated based on the exit velocity and volumetric flow rate for a single flue.

The emission rates applied in this assessment are as per those presented in Table 9 of the report. This approach is considered conservative as it assumes there is no mixing of the two plumes and therefore no enhancement in momentum buoyancy; however the emission rates applied are based on the total exhaust from the two flues.

D.2 Model Predicted GLCs

A summary of the predicted GLCs assuming no buoyancy enhancement and conservatively applying the combined mass emission rates for the two flues is presented in Table D2. The relevant ambient air quality criteria are provided for comparison.

Table D2: Comparison of Predicted GLCs for Enhanced and Non-Enhanced Plume Buoyancy

Compound	Averaging Period	Guideline Value[1]	Maximum Predicted GLCs ($\mu g/m^3$)[2]		% Guideline Value	
			Enhanced Plume Buoyancy	Non-Enhanced Plume Buoyancy	Enhanced Plume Buoyancy	Non-Enhanced Plume Buoyancy
NO_2	1-hour	246	13	13	5.3%	5.3%
	Annual	62	0.2	0.3	0.3%	0.5%
CO	8-hour	11,254	9.3	12	0.08%	0.1%
TSP[3]	1-hour	758[4]	7.7	7.5	1.0%	1.0%
$PM_{2.5}$	24-hour	25	1.0	1.5	4.0%	6.0%
	Annual	8	0.1	0.1	1.3%	1.3%
HF	1-hour	262	1.0	1.0	0.4%	0.4%
	24-hour	1.5[5]/2.9[6]	0.1	0.2	3.4%[6]	6.9%[6]
HCl	1-hour	153	16	15	10%	9.8%
	Annual	10	0.3	0.3	3.0%	3.0%
Lead	Annual	0.5	0.00001	0.00001	0.002%	0.002%
Cadmium	1-hour	0.0196	0.0001	0.0001	0.5%	0.5%
	24-hour	0.022	0.00002	0.00002	0.1%	0.1%
	Annual	0.011	0.000002	0.000002	0.02%	0.02%
Mercury	1-hour	0.65	0.004	0.004	0.6%	0.6%
	Annual	0.22	0.00007	0.00008	0.03%	0.04%
Antimony	1-hour	0.98	0.0002	0.0002	0.02%	0.02%
	Annual	0.033	0.000003	0.000002	0.009%	0.006%
Arsenic	1-hour	0.098	0.0002	0.0002	0.2%	0.2%
	24-hour	0.033	0.00002	0.00004	0.06%	0.1%
	Annual	0.0033	0.000003	0.000003	0.09%	0.09%
Copper	1-hour	20	0.0003	0.0003	0.002%	0.002%
	24-hour	1.1	0.00004	0.00006	0.004%	0.005%
Chromium VI	1-hour	0.098	0.0001	0.0003	0.1%	0.3%
	24-hour	0.33	0.00002	0.00003	0.006%	0.009%
	Annual	0.00022	0.000002	0.000002	1.0%	1.0%
Manganese	1-hour	20	0.0005	0.0005	0.003%	0.003%
	24-hour	0.16	0.00006	0.00009	0.04%	0.06%
Nickel	1-hour	0.19	0.0005	0.0005	0.3%	0.3%
	24-hour	0.15	0.00007	0.0001	0.05%	0.07%
	Annual	0.0033	0.000009	0.00001	0.3%	0.3%
Dioxins and Furans	1-hour	0.0000022	3.0E-08	2.5E-08	1.4%	1.1%

Notes

1. Referenced to 0ºC, and 1013.25 hPa.
2. Maximum predicted GLC of the three modelled years.
3. The maximum predicted $PM_{2.5}$ GLCs have been assessed as representative of TSP and PM_{10}.
4. Based on the Kwinana EPP 15-minute Area C Standard for TSP.
5. Specialised land use criteria, including all areas sensitive to fluoride.
6. General land use criteria, including residential.

The data presented in Table D2 indicates that the maximum GLCs predicted assuming there is no mixing of the two plumes and therefore no enhancement of plume buoyancy, do not significantly differ from the GLCs predicted assuming enhanced plume buoyancy.

The greatest increase in comparison to the applicable guideline is evident for HF; the maximum 24-hour average HF GLC predicted without enhanced plume buoyancy is equal to 6.9% of the ANZECC general land use criteria, while the maximum 24-hour average HF GLC predicted with enhanced plume buoyancy is equal to 3.4% of the general land use criteria (Table D2). The maximum 1-hour average HF GLC predicted with and without enhanced plume buoyancy remains unchanged (Table D2).

The maximum 24-hour average $PM_{2.5}$ GLC predicted without enhanced plume buoyancy represents 6.0% of the relevant guideline, slightly higher than the maximum 24-hour average $PM_{2.5}$ GLC predicted with enhanced plume buoyancy, which equals 4.0% of the guideline value. The maximum annual average $PM_{2.5}$ GLCs predicted with and without enhanced plume buoyancy, however, remains unchanged (Table D2).

Minor increases are also predicted for the maximum 1-hour average chromium VI GLC, maximum 8-hour average CO GLC, maximum 24-hour average arsenic, copper, chromium VI, manganese and nickel GLCs and the annual average NO_2, mercury and nickel GLCs although it is noted these are minor (i.e. less than 0.2 percentage points). The remaining GLCs predicted without enhanced plume buoyancy are either unchanged or slightly lower than those predicted with enhanced plume buoyancy (Table D2).

The results presented in Table D2 indicate that limited mixing of emissions from the multi-flue stack, with no enhancement of momentum buoyancy, is not expected to result in unacceptable air quality impacts.