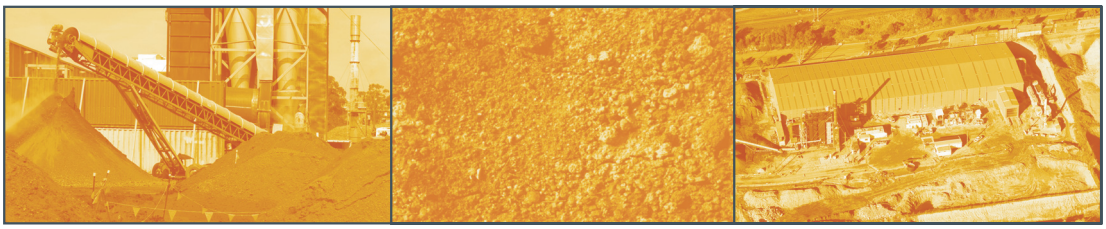

a p p e n d i x e

air quality assessment

FINAL REPORT

Air Quality Impact Assessment for Remediation of the Car Park Waste Encapsulation at the Botany Industrial Park

HLA-Envirosciences Pty Limited

22 May 2007 Job No 2244

PACIFIC AIR & ENVIRONMENT

PROJECT TITLE:	Air Quality Impact Assessment for Remediation of the Car Park Waste Encapsulation at the Botany Industrial Park
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ES1 EXECUTIVE SUMMARY

Pacific Air & Environment Pty. Ltd. (PAE) has been commissioned by HLA Envirosciences Pty Ltd (HLA) on behalf of Orica Australia Pty Ltd (Orica) to prepare an air quality impact assessment for the remediation of the Car Park Waste Encapsulation (CPWE) at the Botany Industrial Park (BIP), Sydney. HLA is preparing the Environmental Assessment (EA) for this project and this air quality impact assessment will form part of the EA. Results from the air quality impact assessment will also be used in the Human Health Impact Assessment (HHIA) and Preliminary Hazard Analysis (PHA) for the project.

The CPWE contains an encapsulation of approximately 45,000m³ of contaminated waste beneath the car park, which consists of a sandy ash soil contaminated primarily with hexachlorobutadiene (HCBD) and other chlorinated organic compounds. The waste is encapsulated in a Hypalon® liner, filled over and capped with bitumen.

While Orica has reviewed and evaluated a number of different remediation technologies, this impact assessment covers the use of the Directly-heated Thermal Desorption (DTD) technology.

The contaminated material must first be excavated before being passed through the DTD Plant. Excavation at the CPWE will be done within an enclosure in the form of a large shed, known as the Excavation Soil Building (ESB). The excavated material would be transported from the ESB to the Feed Soil Building (FSB) using trucks. It would be stockpiled inside the FSB before being gradually loaded into the feed hopper of the DTD Plant for treatment.

DTD technology involves a process called thermal desorption (separation of the contaminants from soil in a rotary dryer under oxidising conditions) followed by treatment of the gas stream in a cyclone, then by a thermal oxidiser (a destructive process), quench, baghouse and acid gas scrubber. The treated soil would then be stockpiled for reuse. This process has been used extensively in the United States (US) to treat soil contaminated with chlorinated organic compounds and other hazardous wastes.

Thiess Services Pty Ltd (Thiess) has been commissioned by Orica to provide assistance with the feasibility studies and design for the remediation technology. The information provided to PAE on the plant design and expected air emissions has been used in a quantitative air dispersion modelling study to evaluate the potential impacts on local air quality due to the construction and operation of the proposed remediation project.

Conservatively estimated emission rates were used as input data for atmospheric dispersion modelling. The modelling techniques were based on a combination of the TAPM prognostic meteorological model (developed by CSIRO), and the CALMET-CALPUFF model suite, a fully three-dimensional puff dispersion modelling package (developed in the US and endorsed by the US Environmental Protection Agency, EPA). This combination represents the current best practice for assessing the dispersion of air pollutants and accommodates the latest best practices relating to terrain and land use data resolution (i.e. 100 m grid spacing), deposition and all available monitored meteorological data.

An emissions inventory for existing sources at the BIP site was compiled and these emissions have been included in the dispersion modelling as well as background concentrations for pollutants, where relevant data was available, to assess cumulative impacts.

The atmospheric dispersion modelling results have been assessed against New South Wales (NSW) Department of Environment and Conservation (DEC) air quality assessment criteria to provide an air quality impact assessment for the normal operation of the proposed CPWE remediation project.

The modelling study involved an iterative process. Where original model runs identified potential breaches of air quality criteria, the source parameters such as stack heights and emission rates were amended and the model was re-run to determine source parameters that would result in acceptable air quality at the nearest discrete receptor.

Emissions were also estimated for two abnormal plant upset scenarios and the results for the abnormal operating conditions have informed the HHIA and the PHA for this project.

Based on the results of the modelling study as described above, under normal operating conditions, the emissions from the proposed CPWE remediation are not predicted to have a significant impact on air quality in the surrounding area. It is also noted that this assessment has been based on the minimum performance specifications and they therefore represent conservative estimates.

In addition, the proposed remediation operations would only exist for a temporary period until the CPWE remediation works are completed. When remediation is completed, emissions from the works will no longer exist and any volatilisation of chlorinated organic compounds from the existing CPWE will have been removed.

Odour was assessed by comparing predicted concentrations of modelled odorous volatile chlorinated organic compounds against reported odour thresholds, or detection limits. The result is an approximate odour concentration for each compound. The cumulative odour concentration can be estimated by the sum of each compound's odour concentration. This analysis involves no odour sampling, so should only be relied on as a screening analysis. The cumulative effect of volatile chlorinated organic compounds can be estimated as having a maximum impact, which is well within the NSW DEC odour guideline.

Dust emissions from the construction phases of the project would not be expected to result in offsite nuisance impacts. The construction periods for dust generating activities are relatively short, access roads are sealed and the site is compact. Dust mitigation measures would be specified in the Construction Environment Management Plan (CEMP) for the CPWE remediation project to minimise the potential for any emissions from construction activities.

During operations, dust emissions from activities in the ESB and FSB will be contained inside those buildings, which will operate so that airflow is inwards through louvres and exhausted via the Emission Control System (ECS). Wheel-generated dust from truck and machinery movements outside of the buildings would not be expected to cause nuisance and these would be controlled by water sprays, if necessary.

A monitoring program would be designed for each of the proposed ECSs and stacks to manage air emissions. An ambient monitoring program may also be conducted to ensure that fugitive emissions are controlled and unacceptable impacts are not experienced off-site.

No residual air quality impacts are expected from the proposed CPWE remediation works, provided that emissions are kept below those used in this assessment. The plant will be designed so that actual emission rates will be below those used in the dispersion modelling for this assessment, as they are based on a number of conservative assumptions in order to provide a conservative assessment.

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1 INTRODUCTION

Pacific Air & Environment (PAE) has been commissioned by HLA Envirosciences Pty Ltd (HLA) on behalf of Orica Australia Pty Ltd (Orica) to prepare an air quality impact assessment for the remediation of the Car Park Waste Encapsulation (CPWE) at the Botany Industrial Park (BIP), Sydney. HLA is preparing the Environmental Assessment (EA) for this project and this air quality impact assessment will form part of the EA. Results from the air quality impact assessment will also be used in the human health impact assessment (HHIA) and preliminary hazard analysis (PHA) for the project.

The air quality impact assessment is based on project information and data provided by Orica, HLA, Thiess Services Pty Ltd (Thiess), Focus Environmental Inc (Focus) and GHD Pty Ltd (GHD). Thiess has been commissioned by Orica to provide assistance with the feasibility studies and design for the remediation technology. The information provided to PAE on the plant design and expected air emissions has been used in a quantitative air dispersion modelling study to evaluate the potential impacts on local air quality due to the construction and operation of the proposed remediation project.

While Orica has reviewed and evaluated a number of different remediation technologies, this impact assessment covers the use of Directly-Heated Thermal Desorption (DTD) technology.

2 THE PROPOSED DEVELOPMENT

2.1 The Site

The proposed remediation works are to take place within the BIP, located north east of Botany Bay, south of Sydney Central Business District (CBD). The BIP occupies an area of approximately 74 ha and is located within the Botany Bay Local Government Area.

The remediation works will take place in two main locations on the BIP, i.e. the CPWE area and the former Propathene Plant area. The CPWE is an L-shaped area in the northeast of the BIP (see Figure 2.1). It is bounded by industrial and commercial land to the north, Corish Circle and Hensley Athletics Field to the east, the former Propathene administration building, Gate 4 and Olefines administration building to the south and the lower tier of the Olefines administration building and a new industrial estate further to the west. The former Propathene Plant area is located southwest of the CPWE, within the BIP, between 11th Street and 9th Street. The Propathene Plant has been previously demolished and the area is effectively clear.

The CPWE contains an encapsulation of approximately 45,000m³ of contaminated waste beneath the car park (For project background, see Appendix A.1.1). The CPWE consists of a sandy soil with some ash and peat, contaminated primarily with hexachlorobutadiene (HCBD) at an indicative mean concentration of 1,400 mg/kg and other chlorinated organic compounds at lower concentrations. Small quantities of foreign materials such as steel, timber, crushed drums, polythene pellets and peat are also evident in the waste. The waste is encapsulated in a Hypalon® liner, filled over and capped with bitumen. Monitoring on the site indicates that low concentrations of HCBD are present in surrounding soil.

2.2 Surrounding Land Uses

The nearest residential areas are in Denison Street, approximately 160 m to the east-southeast of the CPWE and in Eastlakes/Pagewood approximately 400 m to the northwest.

Banksmeadow Primary School is located approximately 1 km southwest, Matraville Primary School is located approximately 800 m southeast and Pagewood Primary school is located approximately 600 m northwest of the site. Hensley Athletics Field is located immediately to the east of the site, on the other side of Corish Circle. This field is used frequently during the week and weekend for sports and outdoor activities, often by young children.

Kellogg (Aust.) Pty Ltd (Kellogg's) operates a food manufacturing facility (snack foods, cereals etc.) located approximately 800 m west of the proposed remediation facility (DTD Plant) and 1 km west of the CPWE. A juice factory (Nudie Juice) has also reopened on Corish Circle, approximately 300 m north of the proposed remediation facility and approximately 150 m north of the CPWE. A food manufacturing facility exists within 19A Baker Street, producing and distributing soy products. This is located approximately 400 m to the west of the CPWE and approximately 400 m northwest of the proposed remediation facility. A

bakery/patisserie is also located approximately 500 m northwest of the CPWE and approximately 600 m northwest of the remediation facility. Immediately north of the CPWE is an industrial building leased out to various industrial users. These are of a general industrial non-hazardous nature.

A food distribution company (Gazelle Foods Pty Ltd) has previously operated in Denison Street, near the corner of Smith Street and opposite Hensley Athletics Field, however the facility no longer exists and the site has been cleared awaiting development.

Eastgardens shopping centre, located across Wentworth Avenue, also has typical food outlets. None of these are food manufacturing or repackaging facilities. A childcare centre is located at the shopping centre.

Sensitive land uses in the surrounding area are shown in Figure 2.1.

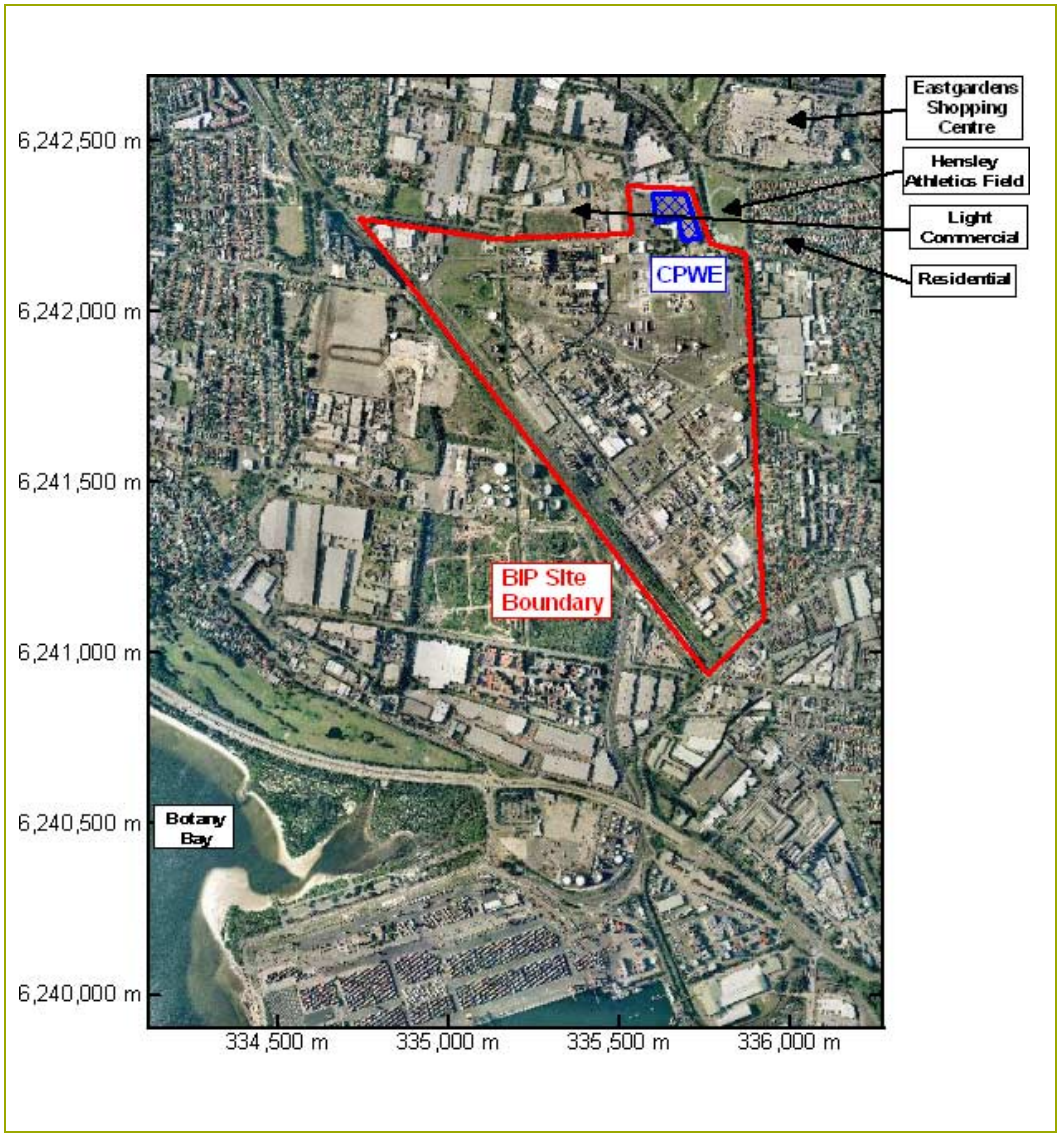


Figure 2.1: Site Location

2.3 Project Overview

The following project description outlines the options that have been assessed for the project. The air quality impact assessment has been based on those options expected to have the greatest potential for air quality impacts, in order to provide a conservative assessment.

DTD technology involves a process called thermal desorption (separation of the contaminants from soil) followed by treatment of the gas stream in a cyclone, then by a thermal oxidiser (a destructive process) and associated Emission Control System (ECS). This process has been used extensively in the United States (US) to treat soils contaminated with chlorinated organic compounds and other hazardous wastes.

The contaminated material must first be excavated and undergo a pre-treatment process (essentially screening and blending to achieve a consistent feed) before being passed through the DTD Plant. Excavation at the CPWE will be done within an enclosure in the form of a large shed, known as the Excavation Soil Building (ESB). The ESB is shown in Figure 2.2 with the site layout that has been assumed for the assessment.

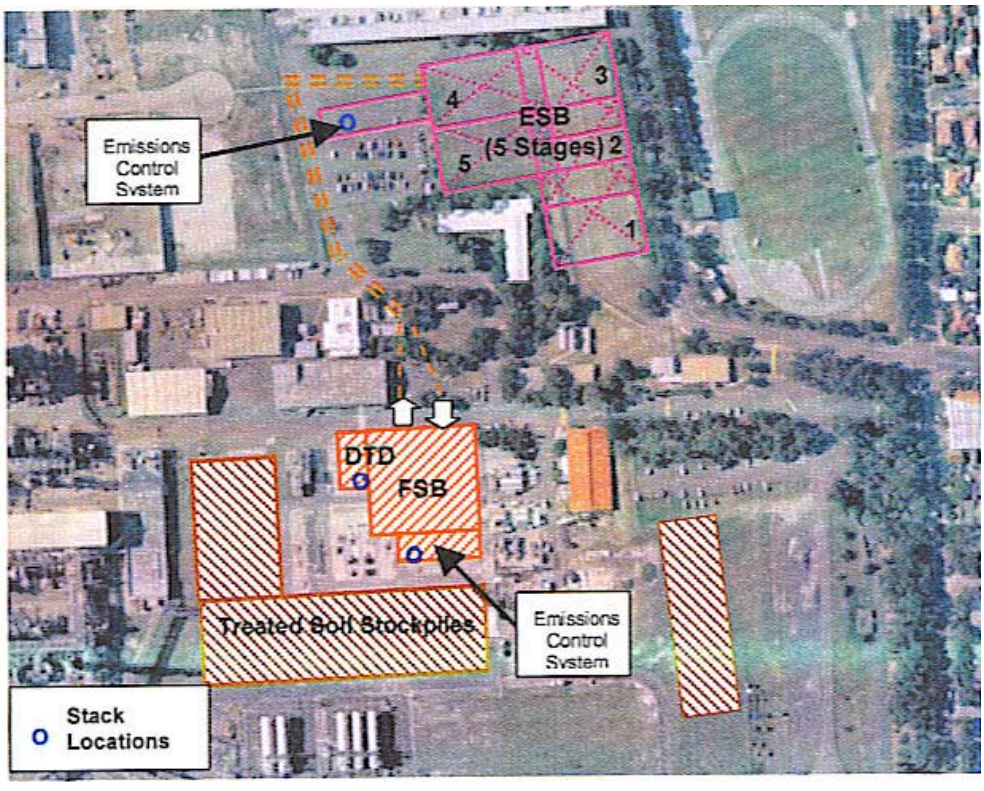


Figure 2.2: Site Layout Assumed for Assessment

The excavated soil would be transported from the ESB to the Feed Soil Building (FSB) where it would undergo pre-treatment, including initial screening, dewatering, drying, pulverising and shredding of oversized materials and blending. The pre-treated soil would then be stockpiled inside the FSB before being gradually loaded into the feed hopper of the DTD Plant for treatment.

DTD treatment involves desorption of contaminants (separating or vaporising) from soil at a temperature of approximately 300°C to 450°C in a rotary dryer under oxidising conditions. This is followed by treatment of the gas stream in a cyclone (to remove large dust particles), thermal oxidiser, quench, baghouse and acid gas scrubber. The treated soil would then be stockpiled for reuse.

A more detailed description of the proposed remediation works is provided in Appendix A.1.2.

The remediation is expected to take approximately 18 months including site establishment, pre-treatment, treatment, validation, reinstatement and demobilisation.

3 IDENTIFICATION OF AIR EMISSION SOURCES

The proposed remediation works have the potential to result in a range of emissions from the site. These are discussed in Appendix A.1.2 and summarised Table 3.1.

Table 3.1: Emissions Identified for Assessment

Source	Emissions			
	Dust from contaminated soil	Chlorinated organic compound vapours	Fuel combustion products	Dust from treated soil
ESB:				
Exposed face of contaminated soil	✓	✓		
Emission control system stack		✓	✓	
Transport:				
Contaminated soil		✓	✓	
Treated soil			✓	
FSB:				
Contaminated soil stockpile		✓		
Emission control system stack		✓	✓	
DTD Plant:				
Stack		✓	✓	
Treated soil stockpile:				
Loading			✓	
Windblown emissions				✓
Treated soil reinstatement:				
Earthworks			✓	✓

4 REGULATORY REQUIREMENTS

4.1 Overview

The Protection of the Environment Operations Act 1997 (POEO Act), which combines earlier legislation regulating air, water, noise, waste and licensing, came into effect from 1 July 1999. Orica is the holder of Environment Protection Licence (EPL) No. 2148 issued by the New South Wales (NSW) Department of Environment and Conservation (DEC) under the POEO Act, which regulates (amongst other issues) air emissions from Orica's activities within the BIP.

EPL No. 2148 contains Conditions pertaining to the CPWE, which are outlined in section 0 below. Qenos Pty Ltd (Qenos) and Huntsman Chemical Company Australia (Huntsman) also hold separate EPL's, which address emissions from their facilities at the BIP.

Action for Air: The NSW Government's 25-Year Air Quality Management Plan published by the NSW Environment Protection Authority (EPA, now known as the DEC) in 1998 (and reviewed triennially, i.e. 2001, 2004 and was updated in August 2006), provides the strategic framework for improving air quality in the Greater Metropolitan Regions of NSW. The Action Plan includes a range of strategies including transport, education and regulatory initiatives as well as actions to reduce household and industrial emissions. The specific objectives applicable to the BIP relate to the promotion of cleaner business and reducing industrial emissions. These objectives are detailed further in Appendix B.1.1.

4.2 Existing Licence Requirements

EPL No. 2148 sets emission concentration limits for seven air emission points under Orica's control at the BIP. It also requires emissions monitoring to be conducted on these. These requirements are detailed further in Appendix B.1.2.

No annual load limits for discharges to air from Orica's activities at the site are specified in the EPL.

In addition to the emissions monitoring and concentration limits mentioned above, EPL No. 2148 also contains Conditions E1, E2 and E3, which require the remediation of the CPWE. The CPWE is defined in the EPL as the encapsulation cell that lies beneath the car park on the northeast boundary of the BIP. Specifically, condition E3 of the licence requires the submission of an EA for the remediation works to the DEC by November 2006. The proposed project comprises the remediation of this CPWE in accordance with these licence conditions.

4.3 Director-General's Assessment Requirements

The Director-General's Environmental Assessment Requirements (EARs) were issued by the Department of Planning (DoP) on 29th August 2006 and included the following key issues in relation to air quality:

"Air Quality Impacts – the Environmental Assessment must include a comprehensive air quality impact prepared in accordance with the assessment and modelling of air quality and odour impacts in accordance with the 'Approved Methods for Modelling and Assessment of Air Pollutants in NSW (EPA, 2005)' and having relevant regard to 'Assessment and Management of Odour from Stationary Sources in NSW (EPA, 2001)', Technical Notes: 'Draft Policy: Assessment and Managements of Odour from Stationary Sources in NSW (EPA, 2001)' and 'Load Calculation Protocol for use by holders of NSW Environment Protection Licences when calculating Assessable Pollutant Loads (EPA, 1999)'.

The Environmental Assessment must:

- *Describe baseline conditions at the site and surroundings including existing air quality (using existing information and site ambient monitoring data), meteorology, topography, surrounding landuses and description of surrounding structures that may effect plume dispersion;*
- *Provide details of all air discharge points and characteristics (eg. Number and height of stacks, discharge velocities, residence time, etc) and of fugitive emissions;*
- *Include all identified emissions and pollutants of concern, assessed additively with background levels, cumulatively with other potential emission sources at the time of remediation (eg. HCB repacking, GWTP), and considering the effects and significance of estimated pollutant concentrations on the environment, human health, amenity and regional ambient air quality and goals;*
- *Provide details of the proposed air quality and odour control equipment and management for point and fugitive emissions and the proposed monitoring program (ambient and point discharge monitoring);*
- *Include contingency plans for air emission controls in the event of loss of power or other incident or upset that may affect air emissions performance;*
- *Include a detailed dust impact assessment from soil disturbance and other remediation activities in the area;*
- *Include dust management controls with particular attention to the management of contaminated material outside the encapsulation in the eastern embankment and near Corish Circle."*

4.4 Assessment Criteria

There are three main types of air quality criteria relevant to industrial developments such as the proposed CPWE remediation project, i.e.:

- **Emission Standards** - maximum allowable pollutant emission concentrations (stack concentrations) specified for particular types of equipment;
- **Ambient Air Quality Standards** – standards against which ambient air quality monitoring results may be assessed; and
- **Air Impact Assessment Criteria** – criteria designed for use in air dispersion modelling studies and air quality impact assessments for new or modified emission sources.

In general, emission standards and ambient air quality design criteria are used to evaluate the predicted impact of air emissions on air quality and the effectiveness of plant design and any associated mitigation measures. The main objective of these criteria is to ensure that the resulting local and regional ambient air quality meets the relevant ambient air quality standards.

4.4.1 Emission Standards

Table B.2 in Appendix B.1.3 (compiled by Thiess), presents a summary of stack emission standards from recent hazardous waste treatment consents in Australia. It also presents a summary of relevant Australian (POEO (Clean Air) Regulation 2002) and European Union (2000/76/EC) emission limit regulations. The project from Table B.2 with characteristics most similar to the Orica CPWE remediation project is the Allied Feeds project at the Rhodes Peninsula, NSW. The Allied Feeds project involves the use of DTD technology to treat soil containing high concentrations of chlorinated compounds.

4.4.2 Ambient Air Quality Standards

In the NSW DEC's *Action for Air - the NSW Government's 25-year Air Quality Management Plan*, the DEC adopted a number of regional ambient air quality goals for a range of air pollutants.

In June 1998 the National Environment Protection Council (NEPC) also released a National Environment Protection Measure (NEPM) for Ambient Air Quality, setting out national standards and goals for six common ambient air pollutants (known as the "criteria" air pollutants). These are sulphur dioxide (SO_2), particulate matter as PM_{10}[a], carbon monoxide (CO), lead (Pb), ozone (O_3) and nitrogen dioxide (NO_2). In May 2003, the NEPC also released a Variation to the Ambient Air Quality NEPM, which introduced advisory reporting standards for $PM_{2.5}$[b]. These advisory reporting standards have been designed to assist in gathering sufficient data nationally on

[a] Particulate matter up to 10 microns in aerodynamic diameter

[b] Particulate matter up to 2.5 microns in aerodynamic diameter

fine particles, with the information used to inform the review process for the Ambient Air Quality NEPM.

When reviewing the standards and goals set out in the NEPM for Ambient Air Quality, it should be noted that they are designed for use in assessing regional air quality and are not intended for use as site boundary or atmospheric dispersion modelling criteria.

Ambient air quality guidelines for air pollutants associated with the proposed development are presented in Table 4.1. These pollutants are discussed further in Appendix B.1.4.

Table 4.1: Ambient Air Quality Guidelines

Pollutant	Concentration (ppm)	Concentration ($\mu g/m^3$, 0°C)	Averaging Period	Agency	Maximum Number of Allowable Exceedances
SO_2	0.20	572	1 hour	NEPC (NEPM)	1 day per year
	0.08	229	24 hours		1 day per year
	0.02	57	Annual		
NO_2	0.12	246	1 hour	NEPC (NEPM)	1 day per year
	0.03	62	Annual		
Ozone	0.10	214	1 hour	NEPC (NEPM)	1 day per year
	0.08	171	4 hours		
CO	9	11,250	8 hours	NEPC (NEPM)	1 day per year
Total Suspended Particulates (TSP)	-	90 [a]	Annual	NSW EPA	
PM_{10}	-	50	24 hours	NEPC & NSW EPA	5 days per year
	-	30	Annual	NSW EPA	
$PM_{2.5}$	-	25 [b]	24 hours	NEPC	
	-	8 [B]	Annual	NEPC	

a. Set to protect against amenity loss
b. Advisory Reporting Standard

4.4.3 Air Impact Assessment Criteria

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* ("the Approved Methods") was revised by the DEC on 26 August 2005. The Approved Methods provides guidance for the selection and configuration of air dispersion models, methodologies to be used to compile meteorological datasets and emissions data, and specifies the assessment criteria to be used to evaluate compliance.

The DEC impact assessment criteria set for those pollutants relevant to the activities proposed for the CPWE remediation project are shown in Table 4.2 to Table 4.5.

Table 4.2: NSW DEC Assessment Criteria for SO_2, NO_2, PM_{10}, TSP, CO and HF

Pollutant	Concentration (ppm)	Concentration ($\mu g/m^3$)	Averaging Period
SO_2	0.25	712	10 minutes
	0.20	570	1 hour
	0.08	228	24 hours
	0.02	60	Annual
NO_2	0.12	246	1 hour
	0.03	62	Annual
PM_{10}	-	50	24 hour
	-	30	Annual
TSP	-	90	Annual
CO	87	100,000	15 minutes
	25	30,000	1 hour
	9	10,000	8 hours
Hydrogen Fluoride (HF) [a]	-	0.5	90 days
	-	0.84	30 days
	-	1.7	7 days
	-	2.9	24 hours

Source: Table 7.1 Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, NSW DEC (August 2005).

a. General land use, which includes all areas other than specialised land use. Specialised land use includes all areas with vegetation sensitive to fluoride, such as grape vines and stone fruits.

Table 4.3: NSW DEC Assessment Criteria for Deposited Dust

Pollutant	Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Deposited Dust [a]	Annual	2 g/m^2/month	4 g/m^2/month

Source: Table 7.1 Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, NSW DEC (August 2005).

a. Dust is assessed as insoluble solids as defined by AS 3580.101-1991 (AM-19).

Table 4.4: NSW DEC Assessment Criteria for Toxic Air Pollutants

Pollutant	Concentration (ppm)	Concentration ($\mu g/m^3$)	Averaging Period
Cadmium (Cd)	-	0.018	1 hour
1,2-Dichloroethane (EDC)	0.018	70	1 hour
Dioxins and Furans [c]	-	2.0×10^{-6}	1 hour
Trichloroethylene (TCE)	0.09	500	1 hour
Vinyl Chloride (VCM)	0.009	24	1 hour
Chlorine (Cl_2)	0.018	50	1 hour
Chloroform ($CHCl_3$)	0.18	900	1 hour
Chloromethane (CM)	0.9	1,900	1 hour
1,2-Dichloroethylene (1,2-DCE)	3.7	14,400	1 hour
Hydrogen Chloride (HCl)	0.09	140	1 hour
Mercury (organic) (Hg)	-	0.18	1 hour
Mercury (inorganic) (Hg)	-	1.8	1 hour
Methylene Chloride (DCM)	0.9	3,190	1 hour
Sulphuric Acid (H_2SO_4)	-	18	1 hour
1,1,2 Trichloroethane (TCA)	0.18	1,000	1 hour

Source: Table 7.2a and Table 7.2b Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, NSW DEC (August 2005).

a. Toxic equivalent as defined in clause 29 of the Regulation.

Table 4.5: NSW DEC Assessment Criteria for Odorous Air Pollutants

Pollutant	Concentration (ppm)	Concentration ($\mu g/m^3$)	Averaging Period
Tetrachloroethylene (PCE)	0.52	3,500	1 hour

Source: Table 7.4a Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, NSW DEC (August 2005).

The Approved Methods does not provide any guidance for when a quantitative modelling assessment is required for a given development. For example, a modelling study may not be appropriate or warranted for an activity that will give rise to emissions with a low potential for adverse health or environmental impacts due to their low concentration or low toxicity. For such developments, a detailed review of the emission control and monitoring systems may be more appropriate.

The DEC has set ambient air criteria for dioxins, however it does not approve the use of ambient dioxin goals for the assessment of dioxin health risks. This is because ambient dioxin goals are not able to address the long-term, chronic exposure effects and carcinogenic impacts which are associated with dioxin exposures. Additionally, ambient air quality criteria only consider the inhalation exposure pathway. For some pollutants, such as dioxins, other pathways are often the main contributor to carcinogenic risk. Thus for pollutants such as dioxins, the DEC requires a quantitative HHIA be conducted.

Modelling of proposed dioxin emissions has been included as part of the air quality impact assessment, however as required by the DEC, a quantitative HHIA has been

carried out to assess the implications of the modelling results for public health. The HHIA is reported separately and readers are referred to the EA.

In addition, the Approved Methods does not provide air impact assessment criteria for some pollutants of concern that are included in this study, such as HCBD, hexachlorobenzene (HCB), polychlorinated biphenyls (PCBs) octachlorostyrene (OCS), hexachloroethane (HCE), 1,1-dichloroethane (DCA), 1,1-dichloroethene (1,1-DCE), 1,2-dichloroethene (1,2-DCE) and perchlorobenzene (PER).

The HHIA provides the assessment of health risks for these pollutants as well as the other pollutants of concern.

4.4.4 HCB/PCB Management Plans Design Level Concentration Limits

Ambient design level concentration limits are referred to in the HCB Waste Management Plan (HCB WMP) and the PCB Management Plan (PCB MP). Under these management plans, emissions from point sources must be treated using best practice control technology, such that the 3-minute design level concentrations at the site boundary are less than 1/30th of time weighted exposure averages (TWAs). The TWAs set out in the management plans are:

- 0.025 mg/m^3 for HCB and 0.21 mg/m^3 for HCBD, in the HCB WMP; and
- 1 µg/m^3 for PCB, in the PCB MP.

4.4.5 Odour Impact Assessment Criteria

Odour is probably the most widespread and complex local air pollution problem in Australia. It accounts for the majority of complaints received by environmental authorities and can be a major source of annoyance and stress in affected communities.

In November 2006, DEC released two documents entitled *Technical framework* and *Technical notes* for the *Assessment and Management of Odour from Stationary Sources in NSW*. These documents outline the DEC's proposed approach for the assessment of odour emissions, using a three-level system of odour impact assessment of increasing complexity and detail.

- Level 1 is a simple screening exercise to identify the potentially affected zone and site suitability for a proposed facility or expansion of an existing facility.
- Level 2 is a simple dispersion modelling procedure. A Level 2 assessment is required as a minimum for any odour-emitting development for which an EA or EPA licence is required. A Level 2 assessment uses worst case meteorological data (this can be a synthetic dataset, i.e. the Metsamp data file included with AUSPLUME) and worst-case odour emission rates. A Level 2 assessment is a conservative screening level assessment and if odour criteria are met, no further assessment is required. Failure to meet the design odour criteria, however, means that a more detailed and refined Level 3 assessment is required.

- Level 3 is a more refined, comprehensive dispersion modelling assessment. A Level 3 assessment is required when a Level 2 assessment has indicated non-compliance with the odour design criteria. A Level 3 assessment includes the use of hourly averaged site-specific meteorological data and a robust emissions data set.

Potential odour impacts from the CPWE were assessed as part of this study using a comprehensive dispersion modelling study. However, due to the complexity with determining odour thresholds for the chlorinated organic compounds (and hence the confidence that can be assigned to the odour threshold data), it is probably more appropriate to consider this odour assessment as Level 1 or 2.

The Approved Methods specifies ground level concentration (GLC) criteria for a number of odorous air pollutants, but it does not provide odour thresholds for all of the pollutants of concern in this study. Therefore a literature search was performed to identify odour threshold data for the pollutants of concern.

Odour threshold limits were found for fourteen of the eighteen chlorinated organic compounds included in the study. No available literature quoted threshold levels for OCS, HCB, PCB or PER. These compounds have thus been excluded from this analysis, and from the lack of data it can be assumed that these compounds are not particularly odorous.

5 STUDY APPROACH

5.1 General

5.1.1 Air Quality

5.1.1.1 Normal Operations

Based on design data provided by Orica, Thiess and Focus, an inventory of emissions from the proposed CPWE remediation project has been compiled, including details for stack conditions (temperatures, exhaust flow rates etc) and expected pollutant concentrations and discharge rates for both stack and fugitive emissions. These emissions have been estimated based on the maximum capacity of the treatment plant and the minimum performance specifications provided to the plant designers for the off-gas treatment systems, in order to provide a conservative assessment of likely air quality impacts under normal operating conditions.

Estimated emission rates were used as input data for atmospheric dispersion modelling. The modelling techniques were based on a combination of the TAPM prognostic meteorological model (developed by CSIRO), and the CALMET-CALPUFF model suite, a fully three-dimensional puff dispersion modelling package (developed in the US and endorsed by the US EPA). This combination represents the current best practice for assessing the dispersion of air pollutants and accommodates the latest best practices relating to terrain and land use data resolution (i.e. 100 m grid spacing), deposition and all available monitored meteorological data.

The atmospheric dispersion modelling results have been assessed against air quality assessment criteria to provide an air quality impact assessment for the normal operation of the proposed CPWE remediation project. The modelling study involved an iterative process. Where original model runs identified potential breaches of air quality criteria, the source parameters such as stack heights and emission rates were amended and the model was re-run to determine source parameters that would result in acceptable air quality at the nearest discrete receptor.

The atmospheric dispersion modelling that was performed for this study is outlined in section 8 and further details of the modelling methodology are provided in Appendix D.1.

5.1.1.2 Abnormal Operations

Emissions were also estimated for two abnormal plant upset scenarios, i.e.:

- For loss of natural gas supply or loss of power leading to loss of natural gas supply (and controlled shutdown using the backup diesel supply) to the DTD Plant, where the thermal oxidiser burner is not operating and exhaust gases from the rotary dryer are not completely combusted and only partially treated in the downstream ECS equipment; and

- Acid gas scrubber failure, where the thermal oxidiser is working normally, but the scrubber fails (eg. loss of circulation or scrubber liquor) resulting in breakthrough of HCl gas from the DTD Plant stack at the rate that it is being generated in the thermal oxidiser.

Emissions during these abnormal operating scenarios are assumed to occur for a maximum of 15 minutes, since the isolation of the feed source to the rotary dryer automatically occurs on power or natural gas loss or loss of a critical system and it takes 15 minutes for the material inside the dryer to pass along the length of the dryer. The scenario is conservative, because in reality, emergency power would be re-established within 15 minutes to allow a controlled shutdown of the plant.

For the upset events, dispersion results are presented as short-term average (i.e. 15 minute average) predicted concentrations based on the abnormal emission rate occurring for the entire 15 minute period and an hourly average based on 45 minutes of normal operations followed by 15 minutes of upset conditions, before a controlled shutdown of the plant.

The results for the abnormal operating conditions have informed the HHIA and the PHA for this project.

5.1.2 Odour

Odour was assessed by comparing predicted concentrations of modelled odorous compounds against reported odour thresholds, or detection limits. This analysis involves no odour sampling, so should only be relied on as a screening analysis. Although all the chlorinated organic compounds have been assessed, it is possible that the modelling did not include other compounds or combinations of compounds that are 'unknown' to exist in the CPWE but may be responsible for objectionable off-site odour. Therefore there is a chance that the results presented here underestimate the odour impacts.

By definition one odour unit is the concentration of a compound (or a mixture of compounds) required for 50% of a population to detect its odour in air under controlled laboratory conditions. This definition leads to the assumption that the odour detection limit, or odour threshold is equivalent to one odour unit, or:

$$1 \text{ ou} \approx \text{odour threshold } (\mu g/m^3)$$

There were 18 potentially odorous chlorinated organic compounds modelled for the site. For each of these compounds, an appropriate odour threshold was researched in the available literature. The maximum modelled GLC was scaled to find the peak concentration (nose-response time) and then compared to the corresponding threshold value.

The result is an approximate odour concentration for each compound. The cumulative odour concentration can be estimated by the sum of each compound's odour concentration.

5.2 Cumulative Impacts

In quantitatively assessing air quality impacts from a proposed development at an existing industrial site, there are three components that need to be addressed:

- Air emissions from the proposed new development itself;
- Air emissions from the plant and equipment already operating at the BIP; and
- Background pollutant concentrations from other emission sources in the regional airshed (i.e. other industries, vehicles, domestic sources, natural sources etc).

The cumulative impacts of these three contributing source groups need to be assessed on a pollutant-by-pollutant basis. For example, if the pollutants that are to be emitted by the proposed development are not emitted elsewhere at the site, then only the regional background levels need to be accounted for. And if it is a pollutant not commonly found in the airshed, then the regional background levels may also be assumed to be negligible.

Assuming that all three sources are relevant, there are two main ways in which their contributions may be accounted for in an air dispersion modelling study:

- If adequate ambient monitoring data is available for the area immediately surrounding the site, it can be concluded that it already includes the impact of existing emission sources at the site. Thus only the incremental impact of the proposed new development needs to be modelled and added to the regional background data in order to investigate potential cumulative impacts.
- If there is inadequate ambient monitoring data available in the vicinity of the site, then emissions from the entire site should be modelled and then added to regionally representative background data in order to assess the cumulative impacts from the site.

In the case of the BIP, the nearest appropriate DEC ambient monitoring site is located in Randwick (see section 7.3). This site is situated in a residential area approximately 3 km from the BIP. In addition to this, some monitoring of volatile organic compounds (VOCs) and dioxin levels has been completed in areas adjacent to the BIP (see section 7.2).

The approach used in this assessment has been to include air emissions data for existing process related sources within the BIP in the air dispersion modelling. Based on information provided on expected emissions from the CPWE remediation project and the existing Huntsman, Qenos and Orica process plants at the BIP, an emissions inventory has been compiled for the existing process related and proposed emission sources in the BIP (see section 6). This stack and emissions data has formed the basis of the atmospheric dispersion modelling study and associated air quality impact assessment.

The modelling has also included regional background pollutant data collected at the DEC's Randwick monitoring site, which is located a similar distance inland from the coast as the BIP, in order to provide a thorough assessment of cumulative impacts. Hourly background NO_X, PM_{10} and SO_2 concentration data files were compiled from data monitored at this site in 2001. For the other pollutants, a "typical Sydney" background level has been estimated based on publicly available information or, if appropriate, ambient concentrations have been assumed to be negligible.

6 EMISSIONS ESTIMATION

6.1 CPWE Remediation Works

As outlined in Section 3 the following emission sources have been identified for assessment of the CPWE remediation works:

- The stack venting treated air from the ECS on the ESB;
- The stack venting treated air from the ECS on the FSB;
- The stack air from the DTD Plant;
- Fugitive chlorinated organic compound emissions from the ESB during relocation of the enclosure between stages;
- Fugitive chlorinated organic compound emissions from the covered trucks transporting contaminated waste from the ESB to the FSB;
- Fugitive dust emissions from the treated soil stockpiles;
- Fugitive dust emissions from the trucks transporting treated soil from the stockpiles to the car park for reinstatement; and
- Fugitive dust emissions from the treated soil reinstatement activities at the car park.

6.1.1 Excavation Soil Building

The ESB will be operated so that the airflow will be inwards through louvres and all emissions from inside the building will be vented through the ECS. The ECS comprises dust filters, activated carbon beds and a 30 m high stack. ESB stack parameters are provided in Table 6.1.

Table 6.1: ESB Stack Parameters used in Dispersion Modelling

Stack Parameters	Units	
Stack Location (MGA)	(mE, mN)	[335,585 6,242,304]
Ground Elevation	(m)	17.7
Stack Height above Ground Level	(m)	30
Diameter	(m)	1.30
Exit Velocity	(m/s)	15.0
Exit Temp	(°C)	20
Exit Temp	(K)	293
Moisture Content	(%)	1.5
Oxygen Content	(%)	20.9
Gas Flowrate (0°C, 1 atm, wet)	(m^3/s)	18.6
Gas Flowrate (0°C, 1 atm, dry gas)	(Nm^3/s)	18.3

Potential emission sources from within the ESB that are included in this assessment include:

- Volatile chlorinated organic compounds from contaminated soil;
- Vehicle and machinery exhaust; and
- Dust emissions from mechanical operations.

No upset condition (plant failure) emission scenario has been assessed for the ESB. This is because a loss of power would result in shutdown of the works, the building and the ECS, with ongoing containment of the emissions within the building. There would be no release of emissions to atmosphere in this situation.

6.1.1.1 Volatile Chlorinated Organic Compound Emissions

The release of vapours of chlorinated organic compounds from within the ESB will occur from the following sources:

- Vaporisation from the exposed excavation base;
- Soil gas release from excavation during digging; and
- Soil gas release from stockpile during earthmoving and coarse screening.

Thiess provided vapour emission rates for each of these sources based on calculations by GHD. The detailed methodology and the calculations used by GHD to achieve these estimates are outlined in Thiess 2005, and can be provided upon request.

Soil gas release rates were calculated by estimating the equilibrium gas concentration in the soil media and multiplying by the void fraction in the soil and the excavation rate. Volatilisation rates were assumed by using the Johnson Ettinger equation presented in the ASTM RBCA guidance (see Thiess 2005, for further detail).

The four primary considerations in estimating the rate of volatile emissions from the soil are;

- The average concentration of compounds in the feed soil;
- The average area exposed during the excavation;
- The average exposure time (to air); and
- Air movement over the excavation.

The volatile emissions from sources within the ESB will be collected by the ventilation system and passed through the ECS prior to discharge to atmosphere. The resulting emission rates for the stack are provided in Table 6.2, which assumes that the air treatment system operates at 95% minimum control efficiency, which is a conservative assumption (based on advice from Thiess).

Table 6.2: Estimated Volatile Emission Rates from within the ESB

Pollutant	Abbreviation	Concentration (mg/m^3) [a]	Emission Rate (kg/hr)
Hexachlorobutadiene	HCBD	0.07	4.66×10^{-3}
Octachlorostyrene	OCS	2.5×10^{-5}	1.66×10^{-6}
Hexachlorobenzene	HCB	0.0003	2.20×10^{-5}
Tetrachloroethylene	PCE	0.06	3.83×10^{-3}
Hexachloroethane	HCE	0.0004	2.80×10^{-5}
Polychlorinated Biphenyls	PCB	1.05×10^{-6}	6.93×10^{-8}
Chloroform	$CHCl_3$	0.0004	2.54×10^{-5}
Chloromethane	CM	0.0016	1.09×10^{-4}
1,1-Dichloroethane	1,1-DCA	0.0006	3.74×10^{-5}
1,2-Dichloroethane	EDC	0.0001	7.54×10^{-6}
1,1-Dichloroethylene	1,1-DCE	0.0024	1.56×10^{-4}
cis-1,2-Dichloroethylene	1,2-DCE (cis)	0.0062	4.11×10^{-4}
trans-1,2-Dichloroethylene	1,2-DCE (trans)	0.0008	5.04×10^{-5}
Methylene Chloride	DCM	0.0005	3.04×10^{-5}
Pentachlorobenzene	PER	1.16×10^{-5}	7.63×10^{-7}
1,1,2-Trichloroethane	1,1,2-TCA	0.0014	9.08×10^{-5}
Trichloroethylene	TCE	0.011	7.21×10^{-4}
Vinyl Chloride Monomer	VCM	0.0033	2.18×10^{-4}

a. Reference conditions: dry, 0°C, 101.3 kPa and at ambient O_2

6.1.1.2 Vehicle and Machinery Exhaust Emissions

Exhaust emissions of NO_X, SO_2, and CO from vehicles and machinery operating within the ESB have been estimated using emission estimation techniques published in the National Pollutant Inventory (NPI) Emission Estimation Technique (EET) Manual for Combustion Engines. Activity data for vehicle and machinery operations was provided by Thiess.

PM_{10} emissions (from vehicle and machinery exhaust and from mechanical disturbances of the soil) were estimated from stack tests for a similar operation to the proposed CPWE remediation works, i.e. Allied Feeds, which uses the same ECS. The predicted concentration of PM_{10} that is likely to be discharged from the ESB stack was provided by Thiess, based on the Allied Feeds operation, and the likely PM_{10} emission rate from the ESB stack calculated using the ESB stack parameters.

The exhaust emissions will be collected by the ESB ventilation system and passed through the ECS prior to discharge to atmosphere. However, it has been assumed the ECS provides no control for these emissions.

Emission rates that were used in the assessment for NO_X, SO_2, CO and PM_{10} from the ESB stack are provided in Table 6.3.

Table 6.3: Estimated Emission Rates due to Combustion Engines in the ESB

Pollutant	Abbreviation	Concentration (mg/m^3) [a]	Emission Rate (kg/hr)
Oxides of Nitrogen	NO_X	51.8	3.4
Sulphur Dioxide	SO_2	4.9	0.32
Carbon Monoxide	CO	16.8	1.11
Particulate Matter	PM_{10}	2.0	0.13

a. Reference conditions: dry, 0°C, 101.3 kPa and at ambient O_2

6.1.1.3 Dust Emissions

The ESB will be completely enclosed and operated so that airflow will be inwards through louvres and exhausted through the ECS during operations. Therefore, any potential emissions of dust from mechanical operations (i.e. excavation, loading trucks and stockpiles etc.) will be contained and resettle within the building.

Any fine particles (PM_{10}) that could pass through the ECS have been included in the estimate using stack test data, as mentioned above.

6.1.2 Feed Soil Building

Similarly to the ESB, the FSB will be operated so that the airflow will be inwards through louvres. All emissions from inside the building will be vented through the ECS, which comprises dust filters, activated carbon beds and a 30 m high stack.

The FSB stack parameters are provided in Table 6.4.

Table 6.4: FSB Stack Parameters used in Dispersion Modelling

Stack Parameters	Units	
Stack Location (MGA)	(mE, mN)	[335,614 6,242,061]
Ground Elevation	(m)	16.7
Stack Height above Ground Level	(m)	30
Diameter	(m)	1.30
Exit Velocity	(m/s)	15.0
Exit Temp	(°C)	20
Exit Temp	(K)	293
Moisture Content	(%)	1.5
Oxygen Content	(%)	20.9
Gas Flowrate (0°C, 1 atm, wet)	(m^3/s)	18.6
Gas Flowrate (0°C, 1 atm, dry gas)	(Nm^3/s)	18.3

Potential emission sources from within the FSB that are included in this assessment include:

- Volatile chlorinated organic compounds from contaminated soil;
- Vehicle and machinery exhaust; and
- Dust emissions from mechanical operations.

No upset condition (plant failure) emission scenario has been assessed for the FSB. This is because a loss of power would result in shutdown of the works, the building and the ECS, with ongoing containment of the emissions within the building. There would be no release of emissions to atmosphere in this situation.

6.1.2.1 Volatile Chlorinated Organic Compound Emissions

The release of vapours of chlorinated organic compounds from within the FSB will occur from the following sources:

- Volatilisation from treatment stockpile; and
- Soil gas release from stockpile as material is handled and screened.

Thiess provided vapour emission rates for each of these sources based on calculations by GHD. The detailed methodology and the calculations used by GHD to achieve these estimates are outlined in Thiess 2005, and can be provided upon request. The methodology for estimating volatile organic compounds from the FSB is the same as the approach for the ESB. Section 6.1.1.1 provides a summary of the approach.

The volatile organic compound emissions from sources in the FSB will be collected by the ventilation system and passed through the ECS prior to discharge to atmosphere. The emission rates for the stack are provided in Table 6.5, which assumes that the air treatment system operates at 95% control efficiency, which is a conservative assumption (based on advice from Thiess).

Table 6.5: Estimated Volatile Emission Rates from within the FSB

Pollutant	Abbreviation	Concentration (mg/m^3) [a]	Emission Rate (kg/hr)
Hexachlorobutadiene	HCBD	0.19	1.27×10^{-2}
Octachlorostyrene	OCS	1.3×10^{-5}	8.71×10^{-7}
Hexachlorobenzene	HCB	0.0006	3.85×10^{-5}
Tetrachloroethylene	PCE	0.13	8.64×10^{-3}
Hexachloroethane	HCE	0.0014	9.04×10^{-5}
Polychlorinated Biphenyls	PCB	8.6×10^{-7}	5.66×10^{-8}
Chloroform	$CHCl_3$	0.0012	7.71×10^{-5}
Chloromethane	CM	0.0053	3.48×10^{-4}
1,1-Dichloroethane	1,1-DCA	0.0018	1.17×10^{-4}
1,2-Dichloroethane	EDC	0.0003	2.10×10^{-5}
1,1-Dichloroethylene	1,1-DCE	0.0077	5.04×10^{-4}
cis-1,2-Dichloroethylene	1,2-DCE (cis)	0.019	1.26×10^{-3}
trans-1,2-Dichloroethylene	1,2-DCE (trans)	0.0024	1.59×10^{-4}
Methylene Chloride	DCM	0.0014	9.32×10^{-5}
Pentachlorobenzene	PER	1.86×10^{-5}	1.22×10^{-6}
1,1,2-Trichloroethane	1,1,2-TCA	0.0037	2.42×10^{-4}
Trichloroethylene	TCE	0.034	2.25×10^{-3}
Vinyl Chloride Monomer	VCM	0.011	7.06×10^{-4}

a. Reference conditions: dry, 0°C, 101.3 kPa and at ambient O_2

6.1.2.2 Vehicle and Machinery Exhaust Emissions

Emissions of NO_X, SO_2, and CO from exhaust emissions of vehicles and machinery operating within the FSB have been estimated as outlined for the ESB (in section 0).

Similarly, PM_{10} emissions (from vehicle and machinery exhaust and from mechanical disturbances of the soil) were estimated from stack tests for a similar operation, i.e. Allied Feeds (as in section 0).

Exhaust emissions will be collected by the FSB ventilation system and passed through the ECS prior to discharge to atmosphere. However, it has been assumed the ECS provides no control for these emissions. Emission rates for NO_X, SO_2, CO and PM_{10} from the FSB stack are provided in Table 6.6.

Table 6.6: Estimated Emission Rates due to Combustion Engines in the FSB

Pollutant	Abbreviation	Concentration (mg/m^3) [a]	Emission Rate (kg/hr)
Oxides of Nitrogen	NO_X	32.4	2.13
Sulphur Dioxide	SO_2	3.1	0.20
Carbon Monoxide	CO	10.9	0.7
Particulate Matter	PM_{10}	2.0	0.13

a. Reference conditions: dry, 0°C, 101.3 kPa and at ambient O_2

6.1.2.3 Dust Emissions

As previously outlined for the ESB (see section 0), the FSB will be completely enclosed and operate so that air flows inwards through louvres and exhausts through the ECS during operations. Therefore, any potential emissions of dust from mechanical operations (i.e. unloading trucks onto stockpiles and loading from stockpiles to the rotary dryer etc.) will be contained and resettle within the building.

Any fine particles (PM_{10}) that would be extracted through the ECS have been estimated using stack test data, as mentioned above.

6.1.3 Directly-Heated Thermal Desorption Plant

Emissions from the DTD Plant pass through a series of control technologies, as outlined in Appendix A.1.2. The treated exhaust stream is released from a 30 m high stack. The DTD Plant stack parameters are provided in Table 6.7, for normal operations and for the upset condition if a loss of natural gas supply occurs. The DTD Plant stack parameters for the upset condition, where the acid gas scrubber fails, are the same as the normal operation parameters.

Emission rates have been derived for the DTD Plant under normal conditions, using data provided by Thiess and Focus and based on the following factors:

- Site-specific waste composition information;
- Site-specific waste quantity and processing rate information;
- Mass and energy balance calculations;

- A site specific thermal treatability study; and
- Empirical data (i.e. information learnt from other similar projects).

Table 6.7: DTD Plant Stack Parameters used in Dispersion Modelling

Stack Parameters	Units	Normal Operation	Upset Condition (Loss of Natural Gas)
Stack Location (MGA)	(mE, mN)	[335,541 6,242,092]	[335,541 6,242,092]
Ground Elevation	(m)	16.1	16.1
Stack Height above Ground Level	(m)	30	30
Diameter	(m)	1.34	1.34
Exit Velocity	(m/s)	18.3	3.9
Exit Temp	(°C)	84	78
Exit Temp	(K)	357	351
Moisture Content	(vol%)	55.6	43.5
Oxygen Content	(%wet)	6.7	-
Oxygen Content	(%dry)	15.1	-
Gas Flowrate (0°C, 1 atm, wet)	(m^3/s)	19.7	4.3
Gas Flowrate (0°C, 1 atm, dry gas)	(Nm^3/s)	8.8	2.4

The emission rates were based on conservative high side soil concentrations and/or soil removal efficiencies in the rotary dryer, for sulphur, chlorine, nitrogen and mercury. Empirical data (and theoretical calculations) were used to predict parameters such as:

- Partitioning of sulphur in the thermal oxidiser into SO_2 and sulphur trioxide (SO_3);
- Partitioning of chlorine in the thermal oxidiser into HCl and chlorine;
- Conversion of nitrogen in the thermal oxidiser into NO_x and NO_2; and
- The efficiency of the acid gas scrubber for the removal of SO_2 and HCl.

Emission rates for chlorinated compounds were estimated assuming a destruction and removal efficiency of 99.9999% for the compounds in the stack gas relative to the feed soil.

Emissions during the upset operating condition, where the thermal oxidiser flame is extinguished due to loss of natural gas supply (typically triggered by power loss), have been provided by Focus. This scenario assumes that some uncombusted volatile chlorinated organic compounds are substantially removed in the quench and acid gas scrubber by cooling the off gas and condensing contaminants, and the remainder are exhausted via the DTD Plant stack since these are not destroyed in the thermal oxidiser. The efficiency of condensation was calculated by Focus using a proprietary condenser model.

Concentrations of the substances other than the chlorinated organic compounds were assumed to be the same for the upset condition scenario as in normal conditions, however the exhaust flowrate during upset conditions is lower during loss of natural gas supply than normal operations. Therefore, emissions of these substances are lower during the upset condition where loss of natural gas supply occurs.

Emissions from the DTD Plant stack that were used in dispersion modelling for normal and upset operating conditions (loss of natural gas supply) are provided in Table 6.8. The HCl emission rate during a 15-minute acid gas scrubber failure was set at 40 kg/hr and all other operating conditions and emission rates are as per the normal scenario (not included as a scenario in Table 6.8).

Table 6.8: Estimated Emission Rates from the DTD Plant Stack

Pollutant	Abbrev	Normal Operation Conc. (mg/m^3)[b]	Normal Operation Hourly Emission Rate (kg/hr)	Upset Condition Conc. (mg/m^3)[b]	Upset Condition Hourly Emission Rate (kg/hr)	Upset Condition 15-min[a] Emission Rate (kg/hr)
Oxides of Nitrogen	NO_X	234	7.38	234	6.05	2.04
Sulphur Dioxide	SO_2	104	3.28	104	2.69	0.91
Particulate Matter	PM_{10}	33	1.04	33	0.85	0.29
Carbon Monoxide	CO	44	1.39	44	1.14	0.38
Cadmium	Cd	0.004	1.26×10^{-4}	0.004	1.03×10^{-4}	3.48×10^{-5}
Mercury	Hg	1.16	3.67×10^{-2}	1.16	3.00×10^{-2}	1.01×10^{-2}
Chlorine	Cl_2	8.0	0.25	8.0	0.21	0.07
Hydrogen Chloride	HCl	44	1.39	44	1.14	0.38
Hydrogen Fluoride	HF	44	1.39	44	1.14	0.38
Sulphuric Acid	H_2SO_4	92	2.9	92	2.4	0.8
Dioxins and Furans (TEQ)	Dioxin	5.5×10^{-8}	1.73×10^{-9}	5.5×10^{-8}	1.33×10^{-8}	4.78×10^{-8}
Hexachlorobutadiene	HCBD	0.0014	4.35×10^{-5}	2.1	2.09	8.36
Octachlorostyrene	OCS	0.0002	6.42×10^{-6}	0.017	0.017	0.066
Hexachlorobenzene	HCB	7.7×10^{-5}	2.43×10^{-6}	0.011	0.011	0.043
Tetrachloroethylene	PCE	9.0×10^{-5}	2.84×10^{-6}	0.29	0.286	1.143
Hexachloroethane	HCE	6.2×10^{-5}	1.94×10^{-7}	0.012	0.012	0.046
Polychlorinated Biphenyls	PCB	1.0×10^{-6}	1.61×10^{-7}	1.6×10^{-5}	1.62×10^{-5}	6.43×10^{-5}
Chloroform	$CHCl_3$	1.0×10^{-6}	3.18×10^{-8}	0.0026	2.58×10^{-3}	1.03×10^{-2}
Chloromethane	CM	1.0×10^{-6}	3.18×10^{-8}	0.0003	3.20×10^{-4}	1.28×10^{-3}
1,1-Dichloroethane	1,1-DCA	1.0×10^{-6}	3.18×10^{-8}	0.0024	2.43×10^{-3}	9.72×10^{-3}
1,2-Dichloroethane	EDC	1.0×10^{-6}	3.18×10^{-8}	0.0032	3.18×10^{-3}	1.27×10^{-2}
1,1-Dichloroethylene	1,1-DCE	1.8×10^{-5}	3.18×10^{-8}	0.0018	1.82×10^{-3}	7.26×10^{-3}
cis-1,2-Dichloroethylene	1,2-DCE (cis)	1.0×10^{-6}	5.65×10^{-7}	0.0045	4.50×10^{-3}	1.80×10^{-2}
trans-1,2-Dichloroethylene	1,2-DCE (trans)	1.0×10^{-6}	3.18×10^{-8}	0.0022	2.19×10^{-3}	8.76×10^{-3}
Methylene Chloride	DCM	3.4×10^{-6}	3.18×10^{-8}	0.0020	1.96×10^{-3}	7.82×10^{-3}
Pentachlorobenzene	PER	2.4×10^{-5}	1.07×10^{-7}	0.0005	5.45×10^{-4}	2.18×10^{-3}
1,1,2-Trichloroethane	1,1,2-TCA	2.0×10^{-5}	7.66×10^{-7}	0.080	7.95×10^{-2}	3.18×10^{-1}
Trichloroethylene	TCE	1.0×10^{-6}	6.21×10^{-7}	0.064	6.35×10^{-2}	2.54×10^{-1}
Vinyl Chloride Monomer	VCM	5.1×10^{-6}	3.18×10^{-8}	0.0007	6.98×10^{-4}	2.79×10^{-3}

a. The upset condition (15-minute) emission rate occurs for 15 minutes only, then emergency power is re-established and a controlled shutdown is performed. 15-minute average predicted concentrations are based on this emission rate. Hourly average predicted concentrations for the upset condition, which include the 45-minutes of normal operation preceding the upset condition, are based on emission rates shown in column 6 of Table 6.8.

b. Standard reference conditions: dry, 0°C, 101.3 kPa and corrected to 10% O_2.

6.2 Fugitive Emissions

6.2.1 Contaminated Waste Transport

Transport of the excavated waste from the ESB to the FSB would be by truck. The transport route assumed for the purposes of this assessment is shown in Figure 2.2 and Appendix A.1.2 provides a more detailed description of the proposed operations.

Specifically, the assessment has been performed assuming the use of three 12 tonne capacity tipping trucks and a transport rate of six truckloads/hr assuming a 12 tonne payload, operating 12 hours per day with a 20 to 30 minute turnaround.

The trucks' loads would be covered prior to exit from the buildings. However, for the assessment, it has been assumed that there will be some emissions from the soil in the trucks. Emissions of volatile compounds from an uncovered load have been assessed using emission rate data provided by GHD, and a conservative assumption of a 90% control efficiency even though the loads would be covered or contained.

Table 6.9 provides the emissions that were modelled for the volatile compounds during transport of the contaminated waste from the ESB to the FSB.

Table 6.9: VOC Emissions from Contaminated Waste Transport

Pollutant	Abbreviation	Emission Rate		
		(g/trip) [a]	(kg/hr) [b]	(kg/m²/hr)[c]
Hexachlorobutadiene	HCBD	3.06×10^{-2}	9.17×10^{-5}	2.53×10^{-8}
Octachlorostyrene	OCS	4.76×10^{-5}	1.43×10^{-7}	3.94×10^{-11}
Hexachlorobenzene	HCB	3.72×10^{-4}	1.12×10^{-6}	3.08×10^{-10}
Tetrachloroethylene	PCE	8.21×10^{-3}	2.46×10^{-5}	6.79×10^{-9}
Hexachloroethane	HCE	3.67×10^{-5}	1.10×10^{-7}	3.04×10^{-11}
Polychlorinated Biphenyls	PCB	1.73×10^{-6}	5.20×10^{-9}	1.43×10^{-12}
Chloroform	$CHCl_3$	8.57×10^{-5}	2.57×10^{-7}	7.09×10^{-11}
Chloromethane	CM	1.80×10^{-4}	5.39×10^{-7}	1.49×10^{-10}
1,1-Dichloroethane	1,1-DCA	8.77×10^{-5}	2.63×10^{-7}	7.25×10^{-11}
1,2-Dichloroethane	EDC	4.56×10^{-5}	1.37×10^{-7}	3.77×10^{-11}
1,1-Dichloroethylene	1,1-DCE	1.73×10^{-4}	5.18×10^{-7}	1.43×10^{-10}
cis-1,2-Dichloroethylene	1,2-DCE (cis)	1.23×10^{-3}	3.70×10^{-6}	1.02×10^{-9}
trans-1,2-Dichloroethylene	1,2-DCE (trans)	9.81×10^{-5}	2.94×10^{-7}	8.12×10^{-11}
Methylene Chloride	DCM	9.24×10^{-5}	2.77×10^{-7}	7.64×10^{-11}
Pentachlorobenzene	PER	1.41×10^{-5}	4.23×10^{-8}	1.17×10^{-11}
1,1,2-Trichloroethane	1,1,2-TCA	6.59×10^{-4}	1.98×10^{-6}	5.45×10^{-10}
Trichloroethylene	TCE	1.75×10^{-3}	5.26×10^{-6}	1.45×10^{-9}
Vinyl Chloride Monomer	VCM	2.08×10^{-4}	6.24×10^{-7}	1.72×10^{-10}

a. The emission of each substance emitted by each truck per trip.

b. The emission of each substance per hour (i.e. sum of all trips per hour).

c. The emission rate modelled from the area representing the transport route.

6.2.2 Building Relocation

For the purposes of this assessment, it has been assumed that there will be some emission from the exposed face of the CPWE at the end of each stage while the ESB is being relocated. Prior to demolition of the building, the working face of the excavation area will be covered with the CPWE liner (Hypalon®) and sealed as best as practicable to minimise these emissions. However in order to conservatively quantify the potential risk, an estimate of the emissions that could occur during building relocation has been made. The following working face areas will be exposed during each stage of the works.

- Stage 1/2: face = 44 m x 14 m;
- Stage 2/3: face = 40 m x 14 m and 35 x 14 m;
- Stage 3/4: face = 75 m x 14 m; and
- Stage 4/5: face = 55 m x 14 m and 40 x 14 m.

It has been assumed that a continuous emission, equivalent to 10% of the emission rate of each substance from an exposed face (equivalent in size to the Stage 4/5 face) occurs. This emission is assumed to occur including the time when the shed is covering the face. It is a conservative assumption to account for unforeseen fugitive emissions.

Table 6.10: VOC Emissions from Exposed Working Face during ESB Relocation

Pollutant	Abbreviation	Emission Rate ($kg/m^2/hr$) [a]
Hexachlorobutadiene	HCBD	7.48×10^{-7}
Octachlorostyrene	OCS	1.24×10^{-9}
Hexachlorobenzene	HCB	9.11×10^{-9}
Tetrachloroethylene	PCE	2.13×10^{-7}
Hexachloroethane	HCE	9.56×10^{-10}
Polychlorinated Biphenyls	PCB	4.71×10^{-11}
Chloroform	$CHCl_3$	2.16×10^{-9}
Chloromethane	CM	5.06×10^{-9}
1,1-Dichloroethane	1,1-DCA	2.25×10^{-9}
1,2-Dichloroethane	EDC	1.13×10^{-9}
1,1-Dichloroethylene	1,1-DCE	5.16×10^{-9}
cis-1,2-Dichloroethylene	1,2-DCE (cis)	3.10×10^{-8}
trans-1,2-Dichloroethylene	1,2-DCE (trans)	2.57×10^{-9}
Methylene Chloride	DCM	2.35×10^{-9}
Pentachlorobenzene	PER	3.48×10^{-10}
1,1,2-Trichloroethane	1,1,2-TCA	1.63×10^{-8}
Trichloroethylene	TCE	4.50×10^{-8}
Vinyl Chloride Monomer	VCM	6.63×10^{-9}

a. The continuous emission rate modelled from the area representing an exposed working face at the ESB.

6.2.3 Treated Soil Stockpile

Approximately 23,000 m^3 of treated soil would be stockpiled adjacent to the FSB in the former Propathene Plant area in 20 m wide parallel stockpiles, 5 m high (see Figure 2.2). The remaining soil would be stockpiled in a grassed open area to the east of the FSB. A loader (for example a CAT 950) would be used to manage the Treated Soil Stockpiles.

The stockpiles would be progressively grassed to minimise dust emissions due to wind erosion. However, to account for potential windblown dust impacts, emissions of PM_{10} and TSP matter were estimated for the stockpile, assuming that no emissions controls are in place and that the stockpile is at full capacity. This is a conservative assumption for dust emissions from the stockpile.

The default emission factors for windblown TSP and PM_{10} from overburden provided by the NPI EET Manual for Mining was used to estimate the continuous emission rate from the treated soil stockpile.

The emission rates used in the dispersion modelling for windblown dust from the stockpile were 0.00004 $kg/m^2/hr$ for TSP and 0.00002 $kg/m^2/hr$ for PM_{10}.

6.2.4 Treated Soil Reinstatement Works

Treated soil reinstatement will most likely occur after the completion of the treatment works, on a single campaign basis. Therefore, the contaminated soil haul road would be used.

For the purposes of this assessment, it has been assumed that the treated soil reinstatement occurs on a single campaign basis, but at the same time as the contaminated soil operations. This provides a worst-case assessment for the purpose of assessment.

Emissions for TSP and PM_{10} from a bulldozer (D6 CAT) operating to reinstate treated soil at the car park area have been estimated using the default emission factors in the NPI EET Manual for Mining. Emission rates are based on the silt content and moisture content of the soil. Thiess has advised that the soil for reinstatement is at approximately 12% moisture (in order to achieve the desired compaction) and a default factor of 10% silt was used. Emission rates used in the dispersion modelling were 1.6 kg/hr for TSP and 0.33 kg/hr for PM_{10} due to bulldozer operations.

6.2.5 Vehicles and Machinery Exhaust Emissions

Combustion emissions from trucks transporting contaminated and treated materials and from a loader operating on the treated soil stockpile have been estimated using emission estimation techniques provided in the NPI EET manual for Combustion Engines. These emissions were modelled along the transport routes or work area where the vehicles/machinery would operate.

6.3 Existing Site Emissions

Existing site emissions from the BIP have been included in the dispersion modelling for existing operations and those operations with planning approval.

The following list identifies the sources that have been included in the modelling. The emission inventory for these sources is provided in Appendix C1.1.

- Orica:
  - Groundwater Treatment Plant (GTP) Stack;
  - HCl Burner Vent Stack (Chlorine Plant);
  - Weak Gas Vent Stack (Chlorine Plant);
  - Area remaining after removal of decommissioned cells building near the Chlorine Plant (Old Chlorine plant);
  - Store J Stack (HCB Waste Repackaging Plant); and
  - Store H Stack (HCB Waste Repackaging Plant)[c];
- Qenos:
  - Two Coal Boiler Stacks (Site Utilities);
  - Gas Boiler Stack (Site Utilities);
  - Five Furnace Stacks (Olefines Plant);
  - Two Ground Furnace Stacks (Olefines Plant);
  - Elevated Flare Stack (Olefines Plant); and
  - Ground Flare (Alkatuff Plant).
- Huntsman:
  - Hot Oil Furnace (Surfactants Plant).

[c] Store H will not be a continuous source and its operations may not coincide with the CPWE remediation works, however emissions from Store H are included in the assessment. This assumption provides a conservative approach to potential emissions from the HCB Waste Repackaging Plant.

7 EXISTING AIR QUALITY

7.1 CPWE Monitoring

Air sampling has been done periodically on the CPWE site since 1998. Sampling in October 1998 (URS, 2002) produced the following results:

- Soil gas within the encapsulation was found to contain PCE, trichloroethane, 1,1-DCA, EDC, 1,1-DCE, cis-1,2-dichloroethene, trans-1,2-dichloroethene and chloroform;
- HCB was not detected at any location;
- HCBD was detected at all sampling locations on the site;
- PCE was detected at all sampling locations on the site;
- A range of other volatile chemicals was detected at certain sampling locations on the site;
- VCM was detected at one sampling location; and
- Total petroleum hydrocarbons (TPH) and benzene, toluene, ethylbenzene and xylene (BTEX) compounds were detected in certain locations on the site.

In October 2004 (URS, 2004), air quality sampling was also conducted. These samples measured air emissions from a number of locations on the car park as well as soil gas sampling and ambient air monitoring. The results are summarised as follows:

- The data collected in October 2004 was generally consistent with data collected in the previous air monitoring rounds conducted from 1998 to March 2004;
- The emission rate of PCE and HCBD in a number of individual locations had increased between the sampling events in 1998 and October 2004; and
- Ambient air data collected downwind of the car park site indicated the detection of low concentrations of a number of common urban air contaminants (such as benzene, toluene and xylenes). In addition, one sample located 10 m downwind of the car park reported a concentration of PCE just above the limit of reporting.

The report (URS, 2004) concluded that comparison of the data collected in October 2004 with the data and assumptions used in the *HCB Waste Management Plan Human Health Risk Assessment (Car Park Waste)* (URS, 2002) cited above, found that the conclusions presented within the Car Park Human Health Risk Assessment remained valid and that, therefore, the risks to human health to off-site residents, people involved in recreation, and on- and off-site industrial workers associated with emissions to air from the existing encapsulation were not unacceptable.

The proposed project involves the remediation of the subject site to an extent that will allow for industrial use of the land. The remediation works will remove the existing contaminants that are the source of the abovementioned emissions from the soil. Therefore, the proposal will result in a direct improvement in air quality on and near the site.

7.2 Local Air Quality Monitoring

As part of the GTP project, Orica commissioned URS Australia Pty Ltd (URS) to monitor ambient air at a number of locations in the vicinity of the BIP (URS, 2006). Baseline monitoring (i.e. prior to commissioning of the GTP) was done in September and October 2005, and included ambient monitoring of VOC and dioxin concentrations. Post-commissioning monitoring has yet to be done.

The sampling program included the collection of eight VOC samples that were collected and analysed to US EPA methods for 60 compounds in each sample. The results of the program may be summarised as follows:

- The majority of the VOCs tested were not able to be detected;
- The detected VOCs generally did not exceed the adopted criteria to be protective of human health in the assessment;
- EDC did exceed the adopted criterion at one of the four sampling locations. However, the criterion that was used, the US EPA Region IX criterion, is a conservative screening level criterion and it was further concluded that, at the EDC concentrations reported, risks to workers and at locations further off-site were considered low and acceptable; and
- The single sample dioxin ambient air concentration was comparable to other urban/light industrial locations in Sydney and throughout Australia.

7.3 Regional Air Quality Monitoring

Air quality in the vicinity of the CPWE site is likely to be significantly influenced by existing emission sources in the BIP. It will also be impacted by emissions from the Sydney International Airport, located 2 km to the west-northwest, and emissions from vehicles using the major thoroughfares in the area such as Southern Cross Drive, Wentworth Avenue, Bunnerong Road and Anzac Parade. No relevant ambient air quality monitoring has been done in the immediate vicinity of the BIP, so the assessment of existing air quality at the site and surrounds is based on data collected by the DEC's ambient air quality monitoring network in the Sydney metropolitan region.

An ambient air quality monitoring station is operated by the Australian Nuclear Science and Technology Organisation (ANSTO) at the City of Botany Bay (CoBB) Council's building in Mascot, which is approximately 3 km to the northwest. This monitoring station has been installed to monitor aerosol levels only and does not monitor ambient concentrations of any of the air pollutants that would be emitted by the CPWE. The data collected is therefore not suitable for use in this assessment.

The closest DEC ambient air monitoring station is the Randwick site, which is located in a residential area in the grounds of the Randwick Army Barracks, on the corner of Avoca and Bundock Streets. It was commissioned in 1995 and is located approximately 3 km northeast of the BIP at a similar distance inland from the coast. The following air pollutants are currently measured at Randwick:

- NO, NO_2 and NO_X;
- SO_2;

- O_3; and
- PM_{10}.

A summary of the key statistics for the raw data monitored at the Randwick Air Quality Monitoring site in 2001 is presented in Table 8.2, where values are compared to the background pollutant files that were used for these pollutants.

7.3.1.1 Carbon Monoxide

The *2003 State of the Environment Report* states that levels of CO have fallen over the last two decades as a result of changes to motor vehicle technology. Even in the Sydney CBD, where traffic densities are high, recent measurements indicate that carbon monoxide levels are now generally within the NEPM standard of 10 mg/m^3 (9 ppm) for an 8-hour average.

Elevated CO levels are usually associated with motor vehicle emissions and normally occur in urban air sheds and in localised areas, such as in inadequately ventilated road tunnels and parking areas. The *2003 State of the Environment Report* notes that CO monitoring by the DEC at a number of locations in NSW (including five sites in the Sydney region) has indicated that levels are generally low, and that CO is not a pollutant of regional concern. Hence, there is no relevant baseline concentration used in this study. The Sydney CBD site is the only one where elevated levels of carbon monoxide are detected.

8 ATMOSPHERIC DISPERSION MODELLING

8.1 Modelling Scenarios

Five scenarios have been modelled in the air quality impact assessment as follows:

- The Baseline scenario, which includes the existing sources (see section 6.3) within the BIP without the contribution from the proposed CPWE remediation.
- The Normal scenario, which includes the Baseline scenario plus operations for the proposed CPWE remediation under normal conditions (see section 6.1 and 6.2).
- The Upset Condition (loss of natural gas supply (1 hour average)) scenario, which includes the Baseline Scenario plus the proposed CPWE remediation emissions when the DTD Plant is assumed to have lost natural gas supply and hence the thermal oxidiser burner is extinguished and does not operate for a period of 15 minutes. Emergency power is restored after 15 minutes and a controlled shutdown of the DTD Plant is performed (see section 6.1.3). For the purpose of providing a conservative hourly average predicted GLC, this scenario assumes that normal operation occurs for the first 45 minutes of the hour and then loss of natural gas supply causes upset conditions for 15 minutes before a controlled shutdown is performed.
- The Upset Condition (loss of natural gas supply (15 minute average)) scenario, which is the same scenario as the loss of natural gas supply (1 hour average), except that the emission rates differ to account for the sub-hour averaging period for short term impacts.
- The Upset Condition (acid gas scrubber failure) scenario, which includes the Baseline scenario plus the proposed CPWE remediation emissions when the thermal oxidiser is operating normally, but the acid scrubber fails resulting in increased emissions of gaseous HCl from the DTD Plant stack.

The dispersion modelling results of the Baseline and the Normal scenarios are used in the air quality impact assessment.

The dispersion modelling results for the Normal scenario and Upset Conditions scenarios are used in the HHIA and the Upset Conditions in the PHA.

8.2 Modelling Inputs

8.2.1 Pollutants

Table 8.1 lists the pollutants that were modelled for the assessment.

Table 8.1: Pollutants Modelled for the Assessment

Pollutant	Abbreviation
Sulphur Dioxide	SO_2
Carbon Monoxide	CO
Oxides of Nitrogen	NO_X
Fine Particles	PM_{10}
Cadmium	Cd
Chlorine	Cl_2
Dioxins	Dioxins
Hydrogen Chloride	HCl
Hydrogen Fluoride	HF
Mercury	Hg
Sulphuric Acid	H_2SO_4
Hexachlorobutadiene	HCBD
Octachlorostyrene	OCS
Hexachlorobenzene	HCB
Tetrachloroethylene	PCE
Hexachloroethane	HCE
Chloroform	$CHCl_3$
Chloromethane	CM
1,1-Dichloroethane	1,1-DCA
1,2-Dichloroethane	EDC
1,1-Dichloroethylene	1,1-DCE
cis-1,1-Dichloroethylene	1,2-DCE (cis)
trans-1,1-Dichloroethylene	1,2-DCE (trans)
Methylene Chloride	DCM
Pentachlorobenzene	PER
Polychlorinated biphenyls	PCB
1,1,2-Trichloroethane	1,1,2-TCA
Trichloroethylene	TCE
Total Suspended Particles	TSP
Vinyl Chloride Monomer	VCM

8.2.2 Stack and Emission Data Used In Modelling

A summary of the stack parameters and emissions data used in the modelling is provided in Section 6 Emissions Estimation. This includes emissions from the proposed CPWE remediation works operating under different scenarios and from the existing sources at the BIP.

8.2.3 Terrain Data and Receptors

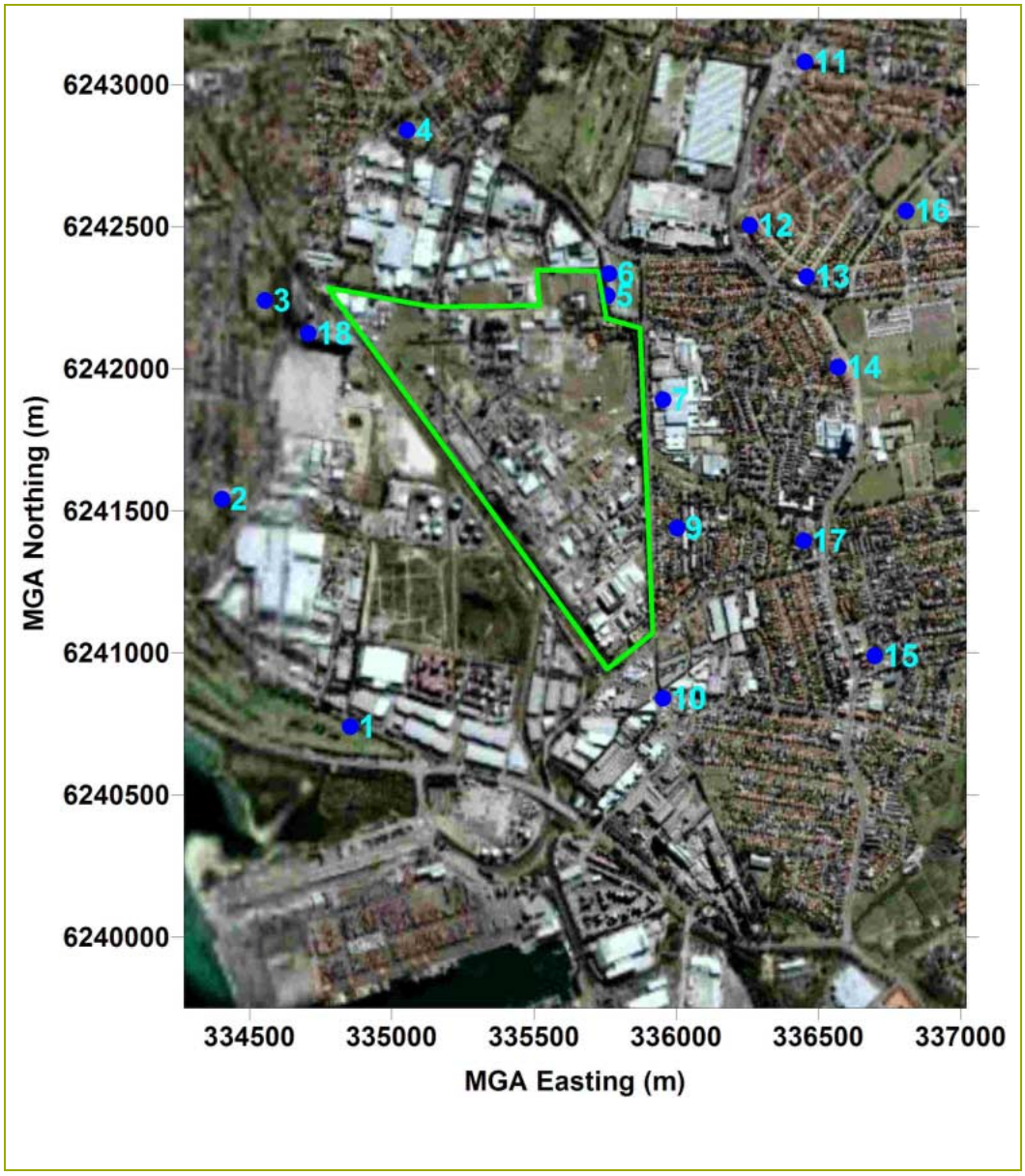
A Cartesian receptor grid with the BIP located at the centre, with a 100 m spacing and extending 13.3 km east-west and 13.1 km north-south, was used in the modelling study.

The following 18 discrete receptor locations were also used to assess predicted pollutant concentrations at nearby sensitive locations:

- Receptor 1: Botany Golf Course (334,854 mE, 6,240,740 mN)
- Receptor 2: Banksmeadow Primary School (334,404 mE, 6,241,541 mN)
- Receptor 3: Garnet Jackson Reserve (334,554 mE, 6,242,240 mN)
- Receptor 4: Pagewood Primary School (335,054 mE, 6,242,840 mN)
- Receptor 5: Botany Athletic Centre Grandstand (335,759 mE, 6,242,258 mN)
- Receptor 6: Botany Athletic Centre Running Track (335,764 mE, 6,242,334 mN)
- Receptor 7: Denison Street north (335,954 mE, 6,241,891 mN)
- Receptor 8: Denison Street north 2 (335,954 mE, 6,241,891 mN)
- Receptor 9: Denison Street south (336,004 mE, 6,241,440 mN)
- Receptor 10: Guides Hall (335,954 mE, 6,240,840 mN)
- Receptor 11: Retirement Village (336,454 mE, 6,243,080 mN)
- Receptor 12: Our Lady of the Annunciation School (336,259 mE, 6,242,505 mN)
- Receptor 13: Marist Brothers High School (336,459 mE, 6,242,325 mN)
- Receptor 14: Childcare Centre (336,569 mE, 6,242,005 mN)
- Receptor 15: St Agnes Primary School (336,699 mE, 6,240,990 mN)
- Receptor 16: South Sydney High School (336,809 mE, 6,242,555 mN)
- Receptor 17: Matraville Primary School (336,449 mE, 6,241,395 mN)
- Receptor 18: Kellogg's (manufacturing plant) (334,707 mE, 6,242,125 mN)

These sensitive receptors were selected as they are locations near the site where children and the elderly are expected to be present for significant periods of time. Ground elevations at these locations were taken from a topographical map of the area. With the exception of Receptor 5 (the Botany Athletic Centre Grandstand) and 8 (the Denison St north 2) the discrete receptors were modelled at ground level. Receptors 5 and 8 were modelled at heights of 4 m and 5 m above ground level, respectively. These heights were estimated as representative of persons sitting in the grandstand (i.e. 4 m) and at work in a top floor office at the Denison St receptor (i.e. 5 m).

A map showing the discrete receptor locations is included as Figure 8.1.



Note: Receptors 7 and 8 are located at the same site but at different heights

Figure 8.1: Receptor Locations used in the Modelling

8.2.4 Meteorological Data

The modelling has been based on meteorological data derived from the combination of observational and prognostic data for 2001, as described in Appendix D.1. The main features of the meteorological dataset are summarised in Appendix E.1.

8.2.5 Building Wakes

The impact of building wake effects on plume dispersion has been included in the modelling for a number of buildings and structures located around the site in the vicinity of the stack discharges. This includes the Olefines cracking furnaces, the Excavation and Feed Soil Buildings, a warehouse located north of the site, and two

cooling towers and the decommissioned cells building near the Chlorine Plant[d]. The heights and locations of these structures were entered into the BPIP (Building Profile Input Program) utility and the wind direction-specific building widths and heights calculated by BPIP for each stack were then entered into the CALPUFF model.

8.2.6 Background Concentrations

8.2.6.1 Nitrogen Dioxide, Particulate Matter, Sulphur Dioxide and Carbon Monoxide

The modelling has included regional background pollutant data for available pollutants, collected at the DEC's Randwick monitoring station, which is located a similar distance inland from the coast, in order to provide a thorough assessment of cumulative impacts. Hourly background NO_2, PM_{10} and SO_2 concentration data files were compiled from data collected at this monitoring station during 2001. This data is considered indicative of current background concentrations of those pollutants for the site. It is consistent with the meteorological year selected for the study.

To fill missing gaps in the raw data obtained from the DEC, gaps of less than three hours were replaced with the concentration recorded in the previous hour. Larger gaps were replaced with concentrations recorded during the same hours on the previous day.

Summaries of the key statistics for the background pollutant data files are presented in Table 8.2.

Table 8.2: Summary of Background Pollutant Data (Randwick, 2001)

Parameter	NO_2		PM_{10}		SO_2	
	Raw Data	Complete Data Set	Raw Data	Complete Data Set	Raw Data	Complete Data Set
Number of Records	7,976	8,760	8,068	8,760	8,275	8,760
Percent Complete	91%	100%	92%	100%	94%	100%
Statistic	**($\mu g/m^3$)**	**($\mu g/m^3$)**	**($\mu g/m^3$)**	**($\mu g/m^3$)**	**($\mu g/m^3$)**	**($\mu g/m^3$)**
Maximum	132.5	132.5	116.1	116.1	104.0	104.0
Minimum	0.0	0.0	0.2	0.2	0.0	0.0
Average	22.2	23.0	18.0	18.5	3.4	3.3
70th Percentile	33.5	35.5	21.4	22.0	3.1	3.1
90th Percentile	52.8	53.2	29.5	30.5	10.3	10.3

The compiled dataset completed one full year of continuous background concentrations that was contemporaneous with the meteorological data that was

[d] The decommissioned cells building near the Chlorine Plant will be removed at the end of 2006. However, since they currently exist a conservative approach has been followed and the wake effects of these structures are included in this assessment. The wake effects of these buildings only affect emissions from existing sources and not the proposed CPWE remediation.

used in the dispersion modelling. At each receptor, the background concentration was added to the corresponding concentration predicted by the modelling to obtain the total hourly average concentration. This is in accordance with the Approved Methods.

As outlined in section 7.3.1.1, carbon monoxide is not a pollutant of regional concern. The Sydney CBD site is the only site where elevated levels of CO are detected. Therefore, background concentrations of CO are not included in the assessment.

8.2.6.2 Other Pollutants

For the other pollutants there is no useful monitoring data available to determine a "typical Sydney" background concentration. It can be assumed that the ambient background concentrations of these pollutants are mainly due to emissions from the BIP and that contributions from other background sources are negligible.

9 MODELLING RESULTS

The highest maximum predicted GLCs (from all predictions at the discrete receptors) are shown for each pollutant for the five modelling scenarios in Table 9.1 to Table 9.5.

The results are presented for the pollutants in categories as outlined by the DEC Approved Methods (DEC, 2005) as follows:

- The first category includes SO_2, CO, NO_2, PM_{10}, HF and TSP;
- The second category includes pollutants specified as toxic air pollutants; and
- The third category includes pollutants modelled that are not specified in the DEC Approved Methods in categories one or two above.

The averaging periods for the predicted concentrations of each pollutant (as shown in the tables below) are as required by the DEC air criteria. In addition, 15-minute averages have been produced for some pollutants, as required for the HHIA.

The DEC guideline values are shown in the tables. Results for those pollutants modelled with background concentrations (i.e. SO_2, NO_2, and PM_{10}) are shown with and without the background concentration.

Emissions of volatile chlorinated organic compounds from the existing car park are not included as the background concentrations or as part of the baseline scenario, since they are assessed as emissions from the proposed remediation works in each scenario. This approach avoids double counting of these emissions.

As mentioned above, these tables present the highest of the maximum predicted concentrations at each receptor. Maximum predicted concentrations for all discrete receptors and maximum predicted on and off-site GLCs are provided in Appendix F.

Maximum predicted 1-hour average concentration contour plots for NO_2, SO_2 and PM_{10} for the Baseline, Normal and Upset Condition (loss of natural gas supply) Scenarios including background concentrations are also presented in Appendix F.

The highest predicted rate of deposition at the discrete receptors for each scenario is presented in Table 9.6 and Table 9.7. These results are used in the HHIA.

Predicted maximum offsite 3-minute average concentrations for HCB, HCBD and PCB are provided in Table 9.8. The ambient design level limits referred to in the HCB WMP and the PCB MP are also shown Table 9.8.

Table 9.1: Maximum Predicted SO_2, NO_2, PM_{10}, CO, HF and TSP GLCs at Discrete Receptors for the Baseline, Normal, and Upset Condition (loss of natural gas supply, 1-hr average) Scenarios

Pollutant	Averaging Period	NSW DEC Guideline	Maximum Predicted GLCs at Discrete Receptors (µg / m³)					
			Baseline		Normal		Upset	
		(µg / m³)	Exc. Back.[a]	Inc. Back.[b]	Exc. Back.[a]	Inc. Back.[b]	Exc. Back.[a]	Inc. Back.[b]
SO_2	10 minute	**712**	98	183	115	183	113	183
	1 hour	**570**	68	128	81	128	79	128
	24 hour	**228**	16	26	16	26	N/A	N/A
	Annual	**60**	1.3	4.7	2.8	6.1	N/A	N/A
NO_2	1 hour	**246**	92	215	225	259	225	259
	Annual	**62**	3.9	27	14	59	N/A	N/A
PM_{10}	1 hour	**N/A**	1.0	116	82	117	76	117
	24 hour	**50**	0.20	36	21	42	N/A	N/A
	Annual	**30**	0.030	18	3.5	22	N/A	N/A
CO	15 minute	**100,000**	21	N/A	92	N/A	92	N/A
	1 hour	**30,000**	16	N/A	70	N/A	70	N/A
	8 hour	**10,000**	5.3	N/A	30	N/A	N/A	N/A
HF	1 hour	**N/A**	0.88	N/A	8.7	N/A	9.0	N/A
	24 hour	**2.9**	0.19	N/A	2.7	N/A	N/A	N/A
	7 days	**1.7**	0.09	N/A	1.1	N/A	N/A	N/A
	30 days	**0.84**	0.035	N/A	0.7	N/A	N/A	N/A
	90 days	**0.5**	0.025	N/A	0.5	N/A	N/A	N/A
TSP	1 hour	**N/A**	N/A	N/A	379	N/A	379	N/A
	Annual	**90**	N/A	N/A	14	N/A	N/A	N/A

a. Excluding background

b. Including background

c. It should be noted that the maximum predictions shown in the table vary spatially and with time. The maximum predictions when background concentrations are included can be at different location to the maximum predictions for the same operating scenario when background is not included.

Table 9.2: Maximum Predicted GLCs at Discrete Receptors for Toxic Air Pollutants for the Baseline, Normal, and Upset Condition (loss of natural gas supply, 1-hr average) Scenarios

Pollutant	Averaging Period	NSW DEC Guideline (µg/m³)	Maximum predicted GLCs at discrete receptors (µg/m³)		
			Baseline	Normal	Upset
EDC	1 hour	**70**	0.17	0.17	0.17
	Annual	**N/A**	0.0069	0.0069	N/A
HCl	1 hour	**140**	2.6	9.5	8.0
VCM	1 hour	**24**	0.27	0.27	0.27
	Annual	**N/A**	0.010	0.01	N/A
Dioxins	1 hour	**2 x 10^{-6}**	2.4×10^{-8}	2.4×10^{-8}	8.6×10^{-8}
	Annual	**N/A**	4.5×10^{-10}	7.3×10^{-10}	N/A
Cd	1 hour	**0.018**	0.00062	0.0036	9.7×10^{-4}
Cl_2	1 hour	**50**	0.013	1.5	1.3
Hg	1 hour	**1.8**	0.0049	0.27	0.30
	Annual	**N/A**	8.9×10^{-5}	0.01	N/A
H_2SO_4	1 hour	**18**	0.93	18	14.4
PCE	1 hour	**3,500**	38	38	38
	Annual	**N/A**	1.1	1.1	N/A
$CHCl_3$	1 hour	**900**	0.24	0.24	0.24
	Annual	**N/A**	0.0050	0.0082	N/A
CM	1 hour	**1,900**	N/A	0.0023	0.004
	Annual	**N/A**	N/A	1.7×10^{-4}	N/A
DCM	1 hour	**3,190**	0.0031	0.0036	0.01
	Annual	**N/A**	5.6×10^{-5}	9.3×10^{-5}	N/A
1,1,2-TCA	1 hour	**1,000**	N/A	0.0053	0.49
	Annual	**N/A**	N/A	2.8×10^{-4}	N/A
TCE	1 hour	**500**	1.1	1.1	1.1
	Annual	**N/A**	0.038	0.04	N/A

Table 9.3: Maximum Predicted GLCs at Discrete Receptors for the Other Modelled Pollutants for the Baseline, Normal, and Upset Condition (loss of natural gas supply, 1-hr average) Scenarios

Pollutant	Averaging Period	Maximum Predicted GLCs at Discrete Receptors ($\mu g/m^3$)		
		Baseline	Normal	Upset
HCBD	1 hour	0.025	0.24	13
	Annual	7.4×10^{-4}	0.01	N/A
OCS	1 hour	N/A	4.02×10^{-4}	0.102
	Annual	N/A	1.64×10^{-5}	N/A
HCB	1 hour	2.0×10^{-4}	2.95×10^{-3}	0.069
	Annual	6.0×10^{-6}	1.26×10^{-4}	N/A
HCE	1 hour	2.7	2.7	2.7
	Annual	0.10	0.10	N/A
DCA	1 hour	N/A	7.86×10^{-4}	0.015
	Annual	N/A	6.44×10^{-5}	N/A
1,1 DCE	1 hour	0.405	0.405	0.040
	Annual	0.0014	0.0014	N/A
1,2 DCE (cis)	1 hour	N/A	0.01	0.033
	Annual	N/A	7.77×10^{-4}	N/A
1,2 DCE (trans)	1 hour	N/A	0.001	0.014
	Annual	N/A	8.17×10^{-5}	N/A
PER	1 hour	N/A	1.13×10^{-4}	3.38×10^{-3}
	Annual	N/A	4.66×10^{-6}	N/A
PCB	1 hour	N/A	1.52×10^{-5}	1.00×10^{-4}
	Annual	N/A	6.01×10^{-7}	N/A

Table 9.4: Maximum Predicted GLCs at Discrete Receptors for the Upset Condition (loss of natural gas supply, 15-minute average) Scenario

Pollutant	Averaging Period	Maximum Predicted GLCs at Discrete Receptors (µg/m^3) Upset Condition (15 minute average)
SO_2	15 minute	96
NO_2	15 minute	297
PM_{10}	15 minute	108
CO	15 minute	92
Cl_2	15 minute	0.6
EDC	15 minute	0.22
HCl	15 minute	5.0
VCM	15 minute	0.36
Dioxins	15 minute	3.9×10^{-7}
Cd	15 minute	9.8×10^{-4}
HF	15 minute	4.3
Hg	15 minute	0.4
H_2S	15 minute	0.01
H_2SO_4	15 minute	12.9
HCBD	15 minute	68
OCS	15 minute	0.5
HCB	15 minute	0.35
PCE	15 minute	50
HCE	15 minute	3.6
$CHCl_3$	15 minute	0.3
CM	15 minute	0.01
DCA	15 minute	0.08
EDC	15 minute	0.22
1,1 DCE	15 minute	0.06
1,2 DCE (cis)	15 minute	0.15
1,2 DCE (trans)	15 minute	0.07
DCM	15 minute	0.07
PER	15 minute	0.02
1,1,2-TCA	15 minute	2.6
TCE	15 minute	2.1
TSP	15 minute	501
PCB	15 minute	5.3×10^{-4}

Table 9.5: Maximum Predicted HCl GLCs at Discrete Receptors for the Upset Condition (Acid Gas Scrubber Failure) Scenario

Pollutant	Averaging Period	Maximum Predicted GLCs at Discrete Receptors (µg/m^3) Upset Condition - Acid Gas Scrubber Failure
HCl	15 minute	327
	1 hour	247

Table 9.6: Maximum Predicted Deposition Rates at Discrete Receptors for the Baseline, Normal, and Upset Condition (loss of natural gas supply, 1-hr average) Scenarios

Pollutant	Averaging Period	Maximum Predicted Deposition Rate at Discrete Receptors (µg/m²/s)		
		Baseline	Normal	Upset
PM_{10}	1 hour	0.25	0.31	0.31
	Annual	0.0095	0.03	0.03
Dioxins	1 hour	8.4×10^{-11}	9.9×10^{-11}	2.4×10^{-10}
	Annual	8.7×10^{-13}	1.1×10^{-12}	2.5×10^{-12}
HCB	1 hour	6.5×10^{-8}	2.2×10^{-6}	1.5×10^{-4}
	Annual	1.4×10^{-9}	4.4×10^{-8}	1.4×10^{-6}
HCBD	1 hour	7.9×10^{-6}	3.9×10^{-4}	0.028
	Annual	1.7×10^{-7}	7.5×10^{-6}	2.7×10^{-4}
HCE	1 hour	0.0020	2.7×10^{-6}	1.6×10^{-4}
	Annual	2.8×10^{-5}	3.9×10^{-8}	2.3×10^{-6}
OCS	1 hour	N/A	4.9×10^{-4}	2.2×10^{-4}
	Annual	N/A	4.5×10^{-6}	2.0×10^{-6}
Hg	1 hour	1.6×10^{-5}	5.1×10^{-4}	4.2×10^{-4}
	Annual	2.2×10^{-7}	4.8×10^{-6}	3.9×10^{-6}
PER	1 hour	N/A	7.9×10^{-8}	7.4×10^{-6}
	Annual	N/A	1.5×10^{-9}	6.9×10^{-8}
PCB	1 hour	N/A	9.4×10^{-9}	2.2×10^{-7}
	Annual	N/A	1.7×10^{-10}	2.2×10^{-9}

Table 9.7: Maximum Predicted Deposition Rates at Discrete Receptors for the Upset Condition (loss of natural gas supply, 15-minute average) Scenario

Pollutant	Averaging Period	Maximum Predicted Deposition Rate at Discrete Receptors (µg/m²/s) Upset (15 minute average)
PM_{10}	15 minute	0.41
Dioxins	15 minute	9.2×10^{-10}
HCB	15 minute	7.6×10^{-4}
HCBD	15 minute	0.15
HCE	15 minute	8.2×10^{-4}
OCS	15 minute	1.2×10^{-3}
Hg	15 minute	2.0×10^{-4}
PER	15 minute	3.9×10^{-5}
PCB	15 minute	1.1×10^{-6}

Table 9.8: Maximum Predicted Offsite GLCs for HCB, HCBD and PCB for the Baseline, Normal and Upset Condition (loss of natural gas supply, 3-minute average) Scenarios

Pollutant	1/30th TWA Concentration (µg/m³)	Averaging Period	Maximum Predicted Offsite GLCs (µg/m³)		
			Baseline	Normal	Upset
HCB	0.833	3-minute	0.0019	0.0076	0.67
HCBD	7.0	3-minute	0.24	0.62	129
PCB	0.033	3-minute	N/A	0.00004	0.001

10 ODOUR ASSESSMENT RESULTS

The modelling results for the compounds that are included in the odour assessment are provided for maximum 1-hour average concentrations for the upset condition (loss of natural gas supply - 1 hour average) scenario. A peak-to-mean ratio of six was applied to each maximum predicted GLC, i.e. at any point, which is generally on the BIP site, in order to produce a short term average concentration that can be compared with nose response time criteria. Using the maximum predicted GLC provides some conservatism about the peak odour concentrations used in this assessment. The resulting peak GLCs are shown in Table 10.1. This ratio applies to tall wake free point sources and is a conservative approximation for volume, area and low stacks.

Table 10.1: Predicted Peak Concentrations of Volatile Chlorinated Organic Compounds

Pollutant	Abbreviation	Maximum 1-Hour GLC (µg/m³)	Peak GLC (µg/m³)
Hexachlorobutadiene	HCBD	32.1	192.3
Octachlorostyrene	OCS	0.25	1.52
Hexachlorobenzene	HCB	0.17	1.0
Tetrachloroethylene	PCE	341	2047
Hexachloroethane	HCE	10	62
Chloroform	CHCl3	1.2	7.1
Chloromethane	CM	0.0070	0.0421
1,1-Dichloroethane	1,1-DCA	0.0378	0.2270
1,2-Dichloroethane	EDC	0.83	4.96
1,1-Dichloroethylene	1,1-DCE	0.20	1.20
cis-1,2-Dichloroethylene	1,2-DCE (cis)	0.0758	0.4547
trans-1,2-Dichloroethylene	1,2-DCE (trans)	0.0344	0.2063
Methylene Chloride	DCM	0.0305	0.1830
Pentachlorobenzene	PER	0.0083	0.0501
Polychlorinated Biphenyls	PCB	0.00025	0.0015
1,1,2-Trichloroethane	1,1,2-TCA	1.2	7.3
Trichloroethylene	TCE	5.6	33.7
Vinyl Chloride Monomer	VCM	1.3	7.9

Odour threshold limits were researched and identified for 14 of the 18 volatile chlorinated organic compounds that were considered in the study. No available literature quoted threshold levels for OCS, HCB, PCB or PER. These compounds have thus been excluded from this analysis, and from the lack of data it can be assumed that these compounds are not particularly odorous. Thresholds for the remaining compounds are presented in Table 10.2.

Although this analysis used the lower threshold values, the upper thresholds are included to indicate the range of values existing in the literature and the uncertainty associated with these thresholds.

Table 10.2: Odour Thresholds for Volatile Chlorinated Organic Compounds

Pollutant	Abbreviation	Lower Odour Threshold (µg/m³)	Upper Odour Threshold (µg/m³)
Hexachlorobutadiene	HCBD	11,000[a]	12,000[b]
Tetrachloroethylene	PCE	6,900[d]	320,000[e, f]
Hexachloroethane	HCE	1,500[g]	10,000[c]
Chloroform	CHCl3	3,000[h]	1,400,000[h]
Chloromethane	CM	21,000[i]	740,000[j]
1,1-Dichloroethane	1,1-DCA	400,000[c]	450,000[k]
1,2-Dichloroethane	EDC	25,000[l, m, n]	450,000[l, m, n]
1,1-Dichloroethylene	1,1-DCE	750,000[o]	2,000,000[p]
cis-1,2-Dichloroethylene	1,2-DCE (cis)	790,000[c]	
trans-1,2-Dichloroethylene	1,2-DCE (trans)	340[q]	67,000[g]
Methylene Chloride	DCM	4,200[r]	1,500,000[r]
1,1,2-Trichloroethane	1,1,2-TCA	45,000[c]	
Trichloroethylene	TCE	1,100[r]	440,000[r]
Vinyl Chloride Monomer	VCM	26,000[r]	7,700,000[o]

a. Agency for Toxic Substances and Disease Registry (ATSDR). *Toxicological Profile for Hexachlorobutadiene*. U.S. Public Health Service, U.S. Department of Health and Human Services, Atlanta, GA. 1994.

b. Ruth JH, *Odor threshold and irritation levels of several chemical substances: a review*. Am Ind Hyg Assoc J, 47: A142-A151, 1986

c. ACGIH (2004) "TLVs and BEIs with other worldwide occupational exposure values 2004 CD-ROM", 2004

d. Agency for Toxic Substances and Disease Registry (ATSDR), *TOX FAQs for Tetrachloroethylene (PERC)*, http://www.atsdr.cdc.gov/tfacts18.html, 1997

e. Association of American Railroads, *Emergency action guide for tetrachloroethylene*. Mar. 1995

f. Hazardous Substances Data Bank (HSDB), *Database record for trichloroethylene*. Last revision date: 08/05/1997

g. Amoore JE, and Hautala E. *Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatilities for 214 chemicals in air and water dilution*. J. Appl. Toxicol. 3(6):272-290. 1983

h. American Industrial Hygiene Association, *Odor thresholds for chemicals with established occupational health standards*, 1989

i. Leonardos, G., Kendall, D., & Barnard, N., *Odor threshold determination of 53 ororant chemicals*. J. Air Pollut. Control Assoc., 19: 91-95, 1969

j. Ontario Ministry of the Environment, *Rationale for the Development of Ontario Air Standards For Methyl Chloride*, June 2006

k. SIPCOT Area Community Environmental Monitors, *Resource Guide*, September 2004

l. May, J., *Odour thresholds of solvents for the judgement of solvent odour in air*, Staub, 26: 385-389, 1966 (in German)

m. Hellmann, T.M. & Small, F.H. *[Characterization of the odour properties of 101 petrochemicals using sensory methods]*. J. Air Pollut. Control Assoc., 24: 979-982, 1974

n. Kleinsvhmidt, E.-G., Von *[Investigations into the relation between odour thresholds of human beings for some substances and their chemical structure.]*, Wiss. Z. Wilhelm-Piech-Univ. Rostock, Naturwiss. Reihe, 32: 54-58, 1983 (in German).

o. International Labour Organization (ILO), CIS International Safety Cards (ICSCs), Appendix 6, 2005

p. Torkelson, T.R. & Rowe, V.K. ed. *Vinylidene chloride*. In: Clayton, G.D. & Clayton, F.E.,Patty's industrial hygiene and toxicology, 3rd ed., New York, John Wiley and Sons, pp. 3545-3550, 1982

q. Spectrum Laboratories, *Chemical Fact Sheet*, http://www.speclab.com/compound/c156605.htm

r. International Programme on Chemical Safety – INTOX database, www.intox.org

The predicted peak GLCs were divided by the lower odour thresholds to give an approximation of the odour concentration (pseudo odour units). These odour concentrations are presented in Table 10.3.

Table 10.3: Predicted Odour Concentrations of Volatile Chlorinated Organic Compounds

Pollutant	Abbreviation	Odour Concentration (Max GLC / Min Threshold)
Hexachlorobutadiene	HCBD	0.017
Tetrachloroethylene	PCE	0.297
Hexachloroethane	HCE	0.042
Chloroform	CHCl3	0.0024
Chloromethane	CM	2.0×10^{-06}
1,1-Dichloroethane	1,1-DCA	5.7×10^{-07}
1,2-Dichloroethane	EDC	2.0×10^{-04}
1,1-Dichloroethylene	1,1-DCE	1.6×10^{-06}
cis-1,1-Dichloroethylene	1,2-DCE (cis)	5.8×10^{-07}
trans-1,1-Dichloroethylene	1,2-DCE (trans)	6.1×10^{-04}
Methylene Chloride	DCM	4.4×10^{-05}
1,1,2-Trichloroethane	1,1,2-TCA	1.1×10^{-06}
Trichloroethylene	TCE	6.6×10^{-03}
Vinyl Chloride Monomer	VCM	1.3×10^{-03}
Sum		**0.37**

To estimate odour concentration of a mixture of odorants by summing the individual 'chemical odour units' as above is subject to some uncertainty. However, research by Cometto-Muñiz *et al.* (2001) found that:

> *For both trigeminal endpoints (i.e., eye irritation and nasal pungency), the results showed that stimuli of relatively low detectability did show complete sensory agonism, whereas stimuli of relatively high detectability fell short of complete sensory agonism when compared with the detectability of the single substances.*
>
> (Cometto-Muñiz *et al.*, (2001))

In other words, at low concentrations (near or below odour threshold), the individual odorants appear to be additive in terms of odour strength. However, at somewhat higher concentrations, the resultant is less than additive. For the current results, simple addition should provide a reasonable approximation.

The summed odour concentration resulting from this approach is 0.37 ou, which is well below the odour threshold. Combined with other conservative elements in the analysis, such as the assessment of the upset condition (loss of natural gas supply - 1 hour average) scenario and application to maximum GLCs, the result indicates that off-site odours from these emissions are unlikely to be detectable at any time. In addition, for the most of these compounds the odour threshold is well above the health/Occupational Health and Safety (OHS) exposure limits, i.e. if an odour exists then it is likely that the health exposure limits have been exceeded. Compliance with the OHS/air quality limits would mean that odour is not likely to be an issue.

11 IMPACT ASSESSMENT

11.1 Air Quality

An air quality impact assessment, including a comprehensive atmospheric dispersion modelling study has been performed for the proposed CPWE remediation project.

The dispersion modelling study used the CALPUFF dispersion model and included the proposed emissions from the CPWE, along with existing emissions sources located within the BIP. Regional background levels of criteria pollutants such as NO_2, PM_{10} and SO_2 were also included based on data collected by the DEC at its Randwick monitoring site, located approximately 3 km northeast of the BIP.

The modelling study involved an iterative process, whereby the modelling results have been assessed against DEC air quality assessment criteria for the normal operation of the proposed CPWE remediation project. Where original model runs identified potential breaches of air quality criteria, the emission source parameters were amended and the model interrogated to determine source parameters that would result in acceptable air quality at the discrete receptors.

Based on the emissions and modelling parameters outlined in Sections 6 and 8 of this assessment, the DEC air quality assessment criteria will be easily met for most of the pollutants that were assessed.

The exceptions are discussed below.

- Nitrogen Dioxide: The long-term (annual average) NO_2 assessment criterion is predicted to be met at the discrete receptors for the normal operating scenario. The maximum predicted annual average NO_2 concentration at the discrete receptors (including background concentration and the contribution from other existing sources at the BIP) was 95% of the DEC guideline. However, the short term (1-hour average) was predicted to be 105% of the guideline, when including background NO_2. Iterative modelling has shown that the maximum prediction for the hourly average that causes a breach of the guideline is influenced more by other sources on the BIP and background NO_2. Considering that this assessment has been performed based on conservative assumptions, the predicted impacts are considered to be over-predicted. Hence it is assumed that emission rates used in this study (see section 6) would provide a reasonable maximum permissible rate that is protective of air quality.

- Hydrogen fluoride (HF): The original dispersion model was run using the stack concentration limit to determine the mass flux at the stack. The predicted GLCs exceeded the relevant DEC guidelines for HF. Therefore the modelling was analysed to determine the required emission rates to meet the air quality criteria. The emission rate provided in this study is therefore maximum permissible rate that is predicted to meet the criteria. The stack concentration limit was assumed in the absence of any historical data to predict a stack concentration. Because there is no significant fluoride source in the CPWE and based on the results of stack testing on the Allied Feeds site, fluoride emissions are not predicted to be an issue.

- Sulphuric acid (H_2SO_4): The dispersion model was run using a high side stack concentration based on the results of the treatability trials and testing. The predicted GLCs exceeded the relevant DEC guidelines for H_2SO_4 so the modelling was analysed to determine the required emission rates to meet the air quality criteria. The emission rate provided in this study is therefore a maximum permissible rate that is predicted to meet the criteria. Modelling using average parameters indicated that the concentration limit is achievable. However there is some uncertainty related to the amount of sulphur liberated from the soil, the partitioning between SO_2 and SO_3 in the thermal oxidiser and conversion to H_2SO_4 in the scrubber. This issue will be evaluated during commissioning trials and further emission controls installed, if required and to the extent practicable, to minimise emissions.

- Mercury and Total Metals: There is uncertainty regarding compliance with Hg stack concentrations and GLCs. This is also reflected in predicted aggregate metal stack concentrations and GLCs, solely because aggregate metals includes Hg. The Hg is associated with bottom ash from coal-fired boilers and represents a concentrated residue from naturally occurring inorganic Hg. The uncertainty arises mainly because the amount of Hg actually removed during processing in the rotary dryer varies with soil treatment temperature (about 50% at 350°C and about 100% at 450°C), and the extent to which the Hg would be captured in the ECS is unquantifiable. Little is known about partitioning of Hg between its forms (particle bound, elemental and oxidised) in the ECS, though the presence of carbon (from ash in the soil) and chlorine (from contaminants) tends to reduce the amount of Hg in the stack. In the absence of definitive data the modelling was undertaken using average soil concentrations and "worst case" removal efficiencies (100% removal in the rotary dryer and 0% removal in the ECS). Although the predicted stack concentrations are exceeded by a factor of five in the worst case, the resultant GLCs are still acceptable by a factor of six when compared against the ambient air criteria for inorganic Hg, which is the form that any Hg emitted from the plant would exist. The extent to which Hg can be controlled will be evaluated during commissioning trials, and further emission controls installed, if required and to the extent practicable, to minimise emissions.

Ambient design level limits referred to in the HCB WMP and the PCB MP are predicted to be met.

Two abnormal operating scenarios have been identified. These scenarios assess short-term abnormal events. The modelling results for these scenarios have been assessed in the HHIA and the PHA for this project (see relevant chapters of the EA). In addition, where DEC air quality impact assessment criteria do not exist for pollutants in this study, the modelling results have been assessed in the HHIA.

Based on the results of the modelling study as described above, under normal operating conditions, the maximum emissions from the proposed CPWE remediation are not predicted to have a significant impact on air quality in the surrounding area. It is also noted that this assessment has been based on the minimum performance specifications and they therefore represent potential maximum impacts.

In addition, the proposed remediation operations would only exist for a temporary period until the CPWE remediation works are completed. When remediation is

completed, emissions from the works will no longer exist and any volatilisation of chlorinated organic compounds from the existing CPWE will have been removed.

11.2 Odour

Eighteen volatile chlorinated organic substances were modelled for the CPWE remediation works and the resulting peak GLCs were compared to odour threshold values from literature.

This analysis could not find any odour threshold values for four of the compounds and these were excluded from this study on the basis that it can be assumed that these excluded compounds are not odorous (since no odour threshold data for them exists) and therefore do not contribute to the overall odour impacts.

Of the other fourteen chlorinated organic compounds, PCE is predicted to be the most likely to cause odour, accounting for 80% of the total impact. However, it should be noted that the predicted odour concentration from PCE is very low at 0.30 ou compared to the relevant DEC odour guideline of 2 ou.

The cumulative effect of all 18 volatile chlorinated organic compounds can be estimated as having a maximum impact of 0.37 ou, which is well within the NSW DEC guideline.

11.3 Dust

Dust emissions from the construction phases of the project would not be expected to result in offsite nuisance impacts. The construction periods for dust generating activities are relatively short, access roads are sealed and the site is compact. Dust mitigation measures would be specified in the Construction Environment Management Plan (CEMP) for the CPWE remediation project to minimise the potential for any emissions from construction activities.

During operations, dust emissions from activities in the ESB and FSB will be contained inside those buildings, which will operate so that air flows inwards through louvres and exhausts via the ECS. Wheel-generated dust from truck and machinery movements outside of the buildings would not be expected to cause nuisance and these would be controlled by water sprays, if necessary.

12 MITIGATION MEASURES

12.1 During Construction

A description of construction plant is provided in Appendix A.1.2. It should be noted that the construction phases of the project will be conducted over a short timeframe and it is not expected that any significant impacts will be experienced during the time that construction activities take place.

However, the following mitigation measures should be observed during the construction phase of the ESB/FSB buildings and the DTD Plant for the CPWE remediation works, in order to minimise impacts as much as possible.

- Access to the CPWE site will be via existing sealed roadways only;
- Water shall be used to suppress particles potentially generated during the erection of boundary fences, barriers and screens;
- Land clearing activities will be controlled using water suppression, if necessary;
- Areas of disturbed soils will be minimised during the construction period;
- Water may be used to suppress dust emissions during dry windy periods (as required);
- The height from which dust generating material is dropped will be minimised;
- Loaded trucks carrying contaminated materials shall be covered at all times;
- The cutting/grinding of materials on site shall be kept to a minimum. Where cutting or grinding is necessary equipment and techniques to minimise dust will be used;
- Earthworks will be kept damp or avoided if possible, especially during dry weather;
- Soil mounds will be treated with surface binding agents or sealed by seeding or surfacing with vegetation or covered with secured tarpaulins;
- Soil mounds will be damped as necessary;
- Potentially dusty materials will be handled as little as possible;
- Heavily used areas will be paved;
- Paved areas will be swept when necessary using a vacuum sweeper;
- Wheels of all site plant and vehicles will be cleaned so that mud is not spread on surrounding roads;
- Exhaust emissions will not discharge straight at the ground;
- Construction plant and vehicles will be well maintained and regularly serviced. Visible smoke from plant should be avoided. Defective plant will not be used;
- Engines will be switched off when vehicles are not in use and refuelling areas will be away from areas of public access;
- Loading and unloading will take place within the site;

- All waste will be removed from site and disposed to an appropriately licensed waste facility; and
- A CEMP would also be prepared for the construction phase, specifically addressing measures to be implemented to minimise off-site dust emissions.

12.2 During Operation

Mitigation measures for air quality have been considered in the design of the proposed remediation works. These measures include the complete enclosure of excavation activities and contaminated material handling activities in the ESB and FSB. Both of these buildings operate so that air flows inwards through louvres and out of the buildings through the ECSs, which include dust filters and activated carbon adsorption beds.

Emissions from the DTD Plant are treated by a series of emissions control equipment prior to release to atmosphere. This includes a:

- Cyclone – gases from the rotary kiln pass through a hot cyclone to remove large particulate matter.
- Thermal oxidiser – the gas exiting the cyclone will be directed to a thermal oxidiser to destroy volatile chlorinated organic compounds.
- Quench – the gas exiting the thermal oxidiser is partially quenched in a refractory lined evaporative cooler to prepare the emissions for the baghouse, but to avoid condensing acid gases.
- Baghouse – a pulse jet baghouse is used to capture particulate matter and metals. A particulate matter emission concentration of < 30 mg/Nm^3 corrected to 11% oxygen is expected to be achieved. If required activated carbon may also be blown into the baghouse to coat the fabric filters and assist with removal of Hg that is present in the feed soil. This need for the control technology will not be known with certainty until commissioning trial have been completed, but provision will be made for the necessary hardware.
- ID fan – an induced draft (ID) fan is used as the prime mover to pull gases through the system and exhaust it to the scrubber.
- Acid Gas Scrubber – the gas exiting the ID fan is directed to a packed scrubber, which neutralises acid gases (i.e. HCl and SO_2).
- Stack- The scrubber gas exhausts to the stack.

These control measures for the DTD Plant have been further detailed in Appendix A.1.2.

The thermal oxidiser (being the major piece of emission control equipment) will be designed to meet the requirements of best practice in terms of destruction efficiency and air pollutant emissions. Operation and control of the gas treatment system would be managed through monitoring of various key operating parameters, linked to alarm and control actions.

13 MONITORING

A monitoring program would be designed for each of the ESB, FSB and DTD Plant ECSs and stacks. The monitoring programs would include:

- Monitoring of the ESB, FSB and DTD Plant and ECS components, flow pressures and temperature;
- Continuous monitoring of the ESB and FSB ECS for parameters such as relative humidity, pressure and VOCs;
- Continuous monitoring of the DTD Plant stack for moisture, oxygen, NO_X and CO. Carbon monoxide provides feedback on the efficiency of combustion in the thermal oxidiser; and
- Periodic discrete sampling of the ESB, FSB and DTD Plant stacks for a range of combustion pollutants and / or contaminants.

The stacks would be fitted with sampling port(s) in accordance with the Australian Standard and safe access provided for stack sampling.

An ambient monitoring program may also be conducted to ensure that fugitive emissions are controlled and unacceptable impacts are not experienced off-site.

14 RESIDUAL IMPACTS

No residual air quality impacts are expected from the proposed CPWE remediation works, provided that emissions are kept below those used in this assessment. The Plant will be designed to ensure that emissions are below the emission rates in this assessment, since the dispersion modelling input rates are based on conservative assumptions in order to provide a conservative assessment.

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Appendix A

Project Background & Proposed Development

A.1 PROPOSED DEVELOPMENT

A.1.1 Project Background

The proposed project relates to land within the Botany Industrial Park (BIP) known as the Car Park Waste Encapsulation (CPWE).

The land comprising the BIP has been used for industrial purposes since the early 1940s and was operated by ICI Australia Operations Pty Ltd (ICI, now Orica Australia Pty Ltd, Orica) until 1996 when Orica established the BIP.

Commencing in the 1960s, chlorinated solvents such as tetrachloroethene (PCE - commonly used as dry cleaning fluid) and carbon tetrachloride (CTC – an industrial solvent and formerly used for manufacturing refrigerants) were produced at the BIP in the 'Solvents Plant'. During this manufacturing process, a number of waste by-products were produced, including hexachlorobutadiene (HCBD), PCE, hexachlorobenzene (HCB) and octachlorostyrene (OCS). The waste by-product was commonly known as 'Heavy Ends'.

Prior to 1979, the Heavy Ends from the Solvents Plant were drummed and stored on a bed of boiler ash. Drum corrosion led to contamination of the ash bed and underlying sandy soil. Orica (then ICI) undertook investigations into the treatment and storage of the contaminated ash and soil. At the time there was no suitable technology available to treat this material, therefore, it was managed by encapsulation – that is, containing the soil within a synthetic liner (Hypalon®) and burying it awaiting the development of a suitable remediation technology. In 1980, the contaminated material was excavated and transferred to the subject site located in the north east of the BIP. Approximately 45,000 m^3 of excavated material was encapsulated and the surface capped with bitumen. The area has subsequently been referred to as the CPWE.

The CPWE has been managed and monitored for a number of years. Recent monitoring results indicate that contamination of surrounding soil has occurred. The precise cause of this is unknown although hypotheses which have been considered include:

- Some contaminated fill could have been placed outside the encapsulation;
- Potential penetration of the encapsulation liner via tree roots;
- Potential vapour permeation through the liner; and
- Possible chemical degradation of the liner.

Studies have identified low concentrations of HCBD in groundwater in close proximity to the CPWE. Low concentrations of HCBD are also present in air emissions in the vicinity of the CPWE. Studies have confirmed that the identified contamination does not pose an unacceptable risk to human health or the environment.

Although conditions indicate that there is not a risk, they do show that the conditions are not improving at the CPWE. Additionally, Orica's strategy for the BIP involves remediation of contamination legacies to enable ongoing industrial use of

the land. Accordingly, given that suitable proven technology is now available, Orica proposes to undertake the remediation of the CPWE site.

Orica has been through an extensive process of identifying appropriate remediation options for the CPWE and has concluded that Directly-heated Thermal Desorption (DTD) technology would be the most appropriate method of remediation of the site.

A.1.2 Project Description

A.1.2.1 Excavation Soil Building

Excavation at the CPWE will be done within an enclosure in the form of a large shed, known as the Excavation Soil Building (ESB). The ESB will be constructed in 1, 2, 3, 4 or 5 stages, depending on the outcome of detailed design studies and costings. Each stage will involve the construction of the ESB to enclose the active working face, excavation of the area covered by the ESB, then dismantling of the building and subsequent re-construction over the next area to be excavated. The sequence of excavation could be either from the Qenos Pty Ltd (Qenos) car park and progressing to the east then south, or from the Corish Circle entry progressing to the north then west.

Figure 2.2 presents a likely site layout plan for the five-stage scenario. This option is expected to have the maximum impact in terms of contaminant emissions, and has therefore been used as the basis for this assessment. The building dimensions for each stage are expected to be as follows:

- Stage 1: ESB = 55 m x 65 m, 5 m tall;
- Stage 2: ESB = 55 m x 60 m, 5 m tall;
- Stage 3: ESB = 55 m x 60 m, 5 m tall;
- Stage 4: ESB = 70 m x 40 m, 5 m tall;
- Stage 5: ESB = 70 m x 55 m, 5 m tall.

The five stages will include four weeks for construction and two weeks demolition of the building, per stage. Assuming some overlap of the construction and operation activities, the construction period is expected to have a total duration of 26 weeks.

A.1.2.2 ESB Construction Equipment

During both construction and demolition of the building per stage, which will also include footing construction and shoring works (if needed), a number of plant items will be required, with the likely plant make up to include the following:

- 20 tonne Excavator x 1;
- 5 tonne excavator x 1;
- Drill rig to bore footings x 1;
- Concrete pump x 1 (possibly 2);

- Concrete trucks x 1 to 2 at a time;
- Various trucks up to semi-trailer size making deliveries (1 at a time usually);
- All terrain fork lift x 1;
- Shoring Rig (Driven sheets or vibrating) x 1;
- 20 tonne slew crane x 1
- 100 tonne slew crane x 1
- 25 tonne Franna Crane x 1;
- Scissor lift x 2
- Cherry Picker x 1; and
- Miscellaneous hand tools such as angle grinders and drills.

Personnel would include one operator per plant item, with one additional person required per crane and two additional people required per drilling and shoring rigs. Additionally, there will be a manager and leading hand, plus a number of general labourers (approximately 10) working in the construction and demolition for such activities as the erection/removal of structural members, roofing, steel reinforcement, concreting, etc.

A.1.2.3 ESB Operation

The plant operating in the ESB will include one 20 tonne excavator, one loader (CAT 950 or equivalent) and one grizzly screen, all operating for 12 hours per day (7 am to 7 pm). Personnel would include one operator for the excavator, one operator for the loader, a manager and general hand. It has also been assumed that three bogie drive tip trucks, each with a dedicated operator, will be used to transport the soil to the Feed Soil Building (FSB).

The ESB will have an entry and exit airlock (which could be the same one) plus a truck decontamination area, including an automated wheel wash at the exit. There would also be decontamination sheds for the ESB plant operators.

A.1.2.4 ESB Emissions

The ESB will be vented through an emission control system (ECS) comprised of dust filters and carbon beds. The ECS will vent to atmosphere from a stack located within the Qenos car park, and has been notionally sized at 90,000 m^3/hr for the five-stage scenario. The final design ventilation rate will be determined principally by health and safety considerations associated with emissions from the diesel-powered equipment operating within the building. In the case of the 1, 2 or 3 building scenarios, the ESB would be partitioned internally to match the capacity of the ECS.

It is anticipated that workers in the ESB will be required to wear self-contained breathing apparatus (SCBA), although possibly not inside the trucks depending on details of the loading arrangement.

For the purposes of this assessment, it has been assumed that there will be some emission from the exposed face of the CPWE at the end of each stage while the ESB is being relocated. Prior to demolition of the building, the working face of the excavation area will be covered with the Hypalon liner and sealed as best as possible to minimise these emissions. If the liner cannot be reused, then alternatives such as covering the face with High Density Polyethylene (HDPE) or by some other appropriate means would be used to control the emissions. This will be addressed during the detailed design. However in order to determine the potential risk, an estimate of the emissions that could occur during building relocation has been made and assessed. The following working face areas will be exposed during each stage of the works.

- Stage 1/2: face = 44 m x 14 m;
- Stage 2/3: face = 40 m x 14 m and 35 x 14 m;
- Stage 3/4: face = 75 m x 14 m;
- Stage 4/5: face = 55 m x 14 m and 40 x 14 m.

For the assessment, it has been assumed that there will be some emissions from the excavation face (equivalent in size to the Stage 4/5 face) during relocation of the FSB. Emissions from an uncovered face have been assessed as a continuous uncontrolled emission, and a 90% control efficiency assumed, due to the face being covered, which is a very conservative assumption.

A.1.2.5 Waste Transport to Feed Soil Building

Transport of the excavated waste from the ESB to the FSB would be done using three 12 tonne capacity tipping trucks. Semi-trailers are not preferred because of tight turns on the site and access constraints within the buildings.

The assumed treatment rate for the DTD Plant is 35 tonnes per hour, or 840 tonnes per day. The matching transport rate is six truckloads/hr assuming a 12 tonne payload, operating 12 hours per day with a 20 to 30 minute turnaround. The truck's load would be covered or contained prior to exit from the excavation and feed soil buildings. The external surfaces of the trucks would also be decontaminated before exiting both the ESB and FSB.

For the assessment, it has been assumed that there will be some emissions from the soil in the trucks. Emissions from an uncovered load have been assessed, and a 90% control efficiency assumed, due to the loads being covered.

The transport route assumed for the purposes of this assessment is shown in Figure 2.2. It involves a two-way transport route, predominantly using existing roads. This option is not suited to back-loading clean soil because of the problem of transporting it over contaminated areas (through the ESB), hence this option would require reinstatement of the clean soil to occur after all the excavation works have been fully completed. However, for the purpose of assessment, it is assumed that

the reinstatement operations occur simultaneously with contaminated soil transport, which will result in a conservative impact assessment.

A.1.2.6 Feed Soil Building

This assessment has been performed based on the assumption that the FSB is to be located in the north east corner of the former Propathene Plant area (see Figure 2.2).

Activities to be performed inside the FSB include soil pre-treatment and loading into the DTD Plant. Pre-treatment activities include screening and crushing. Crushing would be performed on a campaign basis, as required.

The FSB would be operated so that air flow is inwards. Air from inside the building would be passed through an ECS prior to discharge to atmosphere through a 30 m high stack. It has been assumed for the assessment that this system would have a capacity of 60,000 m^3/hr but would operate at 40,000 m^3/hr when the DTD Plant is operating. Due to the nature of the compounds present in the feed soil and the fact that they are heavier than air, it is anticipated that workers will be required to wear SCBA inside the FSB.

The FSB will be fitted with an entry and exit airlock (which could be the same one), and a truck decontamination area including an automated wheel wash at the exit. There would also be decontamination sheds for the FSB and DTD Plant operators.

A.1.2.7 FSB Construction

It should also be noted that for the construction of the FSB, the same plant will be required as for the ESB above. Additionally, as the initial stage of the ESB will more than likely coincide with the construction of the FSB, then a number of plant items may be doubled up, pending final programming. Items of plant and personnel that are likely to be doubled up include the All Terrain Fork Lift, 20 tonne Excavator, 5 tonne Excavator, all cranes, Scissor lift, Cherry Picker and miscellaneous hand tools and general labourers.

Construction of the FSB is likely to extend for approximately 9 to 12 weeks, depending upon final design, slab requirements (if any) and construction/commissioning of the emission control system. A similar length of time would be expected for the deconstruction due to the decontamination of the structure.

A.1.2.8 FSB Operation

The building would have an entry and exit airlock (which could be the same one) plus an automated wheel wash on the exit. It is anticipated that SCBA will be required in the building.

The plant operating in the ESB would include one loader (for example a CAT 950) operating 24 hours per day and one loader and a power screen operating 12 hours per day (7 am to 7 pm), which is a conservative assumption. Personnel would

include one operator for each plant item (except the screen), plus a manager and general hand.

A.1.2.9 FSB Emissions

Emissions from the FSB would be from the ECS comprising dust filters and carbon beds. The ECS has been notionally sized at 60,000 m^3/hr and operating 24 hours a day, 7 days a week (40,000 m^3/hr when the DTD plant is operating). The rate will be determined principally by Occupational Health and Safety (OHS) considerations for oxides of nitrogen (NO_X) and carbon monoxide (CO) emissions from plant within the building. The ECS would be located south of the FSB from assessment purposes and would have a guyed stack. The location is flexible.

A.1.2.10 Directly-Heated Thermal Desorption

A schematic diagram of the DTD system is shown in Figure A.1. The system includes a feed hopper, weigh belt conveyor, rotary dryer, cyclone, thermal oxidiser, quench, baghouse, fan, acid gas (or packed) scrubber and stack. As detailed design has not been completed, brief descriptions of each of the key unit operations in the process are presented below.

- Rotary dryer – The rotary dryer would be about 10 m long with a 2.5 m inside shell diameter. It would be equipped with a natural gas fired burner and a combustion air blower. The rotary dryer would be constructed of a high temperature alloy shell with internal lifters. The nominal waste feed rate to the rotary dryer would be around 30 tonnes per hour at average feed material moisture content of 12.5% by weight. The rotary dryer would be operated to achieve a treated soil temperature of 350 to 450°C depending on the results of commissioning trials. The residence time of the material in the drum would be approximately 10 to 20 minutes.

- Cyclone – gases from the rotary kiln would pass through a hot cyclone or multiclones to remove large particulate matter.

- Thermal oxidiser – the gas exiting the cyclone would be directed to a thermal oxidiser operating in the exit gas temperature of up to approximately 1,000°C. The thermal oxidiser would be equipped with a natural gas fired burner operated at approximately 50 GJ/hr.

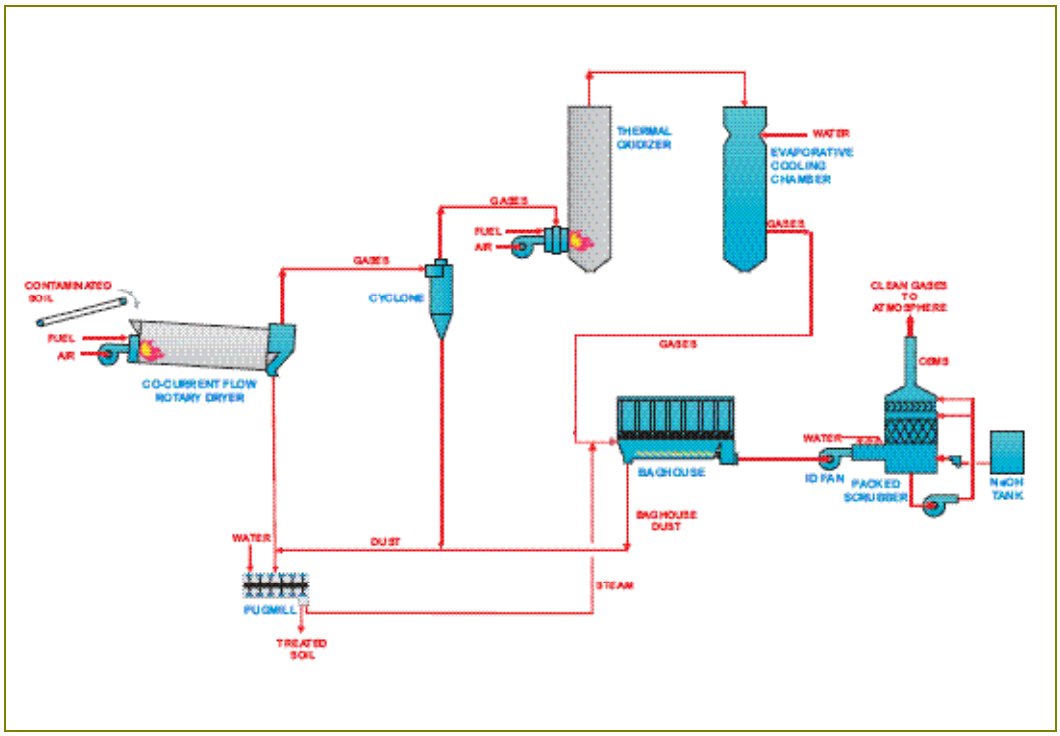
- Quench – the gas exiting the thermal oxidiser would be partially quenched in a refractory lined evaporative cooler. Process water is injected at the top of the evaporative cooler and atomised with compressed air to make small droplets. As the water droplets evaporate, the gas is cooled to a temperature of approximately 190°C. This temperature must be controlled to stay below the maximum temperature rating on the baghouse bags (~230°C) but above the temperature at which condensation of acid gases could occur (~150°C).

- Baghouse – a pulse jet baghouse would be used to capture particulate matter and metals. The design of the baghouse would take matters of high moisture and acid gases into consideration and provide for suitable materials of construction and insulation as required.

- Induced Draft (ID) fan – an ID fan would be used as the prime mover to pull gases through the system and exhaust it to the scrubber. The capacity of the ID fan would be approximately 1,800 m^3/min at 5 kPa at a temperature of 190°C.

- Acid Gas Scrubber (including pipe quench) – the gas exiting the ID fan would be directed to a packed scrubber. The scrubber would be packed with approximately 2 m of 5-cm Tellerette packing. A sodium hydroxide solution is injected into the scrubber sump to neutralise acid gases (hydrogen chloride and sulphur dioxide). A recirculation pump recycles scrubber water from the sump to the top of the packing.

- Stack - The scrubber gas exhausts to the stack, which would be fitted with a silencer at the stack tip.



Source: Thiess

Figure A.1: DTD Schematic Diagram

A.1.2.11 Treated Soil Stockpile

Approximately 23,000 m^3 of treated soil would be stockpiled adjacent to the FSB in the former Propathene Plant area in 20 m wide parallel stockpiles, 5 m high (to give a 2:1 batter) (see Figure 2.2). This stockpile arrangement has an added benefit in terms of mitigating explosion risks from nearby Orica operations. The remaining soil would be stockpiled in a grassed open area to the east of the FSB. A loader (for example a CAT 950) would be used to manage the treated soil stockpiles.

As noted above, it is proposed that the clean soil would be stockpiled until the excavation of the CPWE is complete, then approximately 30,000 m^3 of the soil would be returned to the car park so that the front of the CPWE site is reinstated to the same level as Corish Circle and the back (Qenos car park) is left at the level of the Qenos administration building. The remaining 20,000 m^3 of soil would remain in stockpiles (on-site) for future reuse on other areas of BIP.

The stockpiles would be progressively grassed to minimise dust emissions due to wind erosion.

Construction of the stockpiles described above would require some ground works (to trim old foundations), construction of perimeter drains and bunds and grassing or covering of stockpiles to manage dust and sediment.

A.1.2.12 Transport of Treated Soil

For the purposes of this assessment, it has been assumed that the treated soil reinstatement occurs on a single campaign basis, however, at the same time as the contaminated soil operations. This provides a worst-case assessment for the purpose of assessment. The following equipment is required for reuse of clean soil in the CPWE excavation:

- Three bogie drive tippers, operating 10 hours per day each with 30 tonne (20 m^3 in-situ) per hour productivity; and
- A CAT D6 dozer, a 10 tonne smooth-drum self-propelled roller and water cart for compaction.

Appendix B
Regulatory Requirements

B.1 REGULATORY REQUIREMENTS

B.1.1 Action for Air –Actions for Industrial Emissions

Action for Air: The NSW Government's 25-Year Air Quality Management Plan provides the strategic framework for improving air quality in the Greater Metropolitan Regions of NSW. The Action Plan includes a range of strategies including transport, education and regulatory initiatives as well as actions to reduce household and industrial emissions. The specific objectives applicable to the BIP relate to the promotion of cleaner business and reducing industrial emissions. Actions included in the Action for Air to address these objectives, which have implications for the proposed activities, are:

Action 4.1 - Implement revised Clean Air Regulation 1997: This Regulation set never-to-be-exceeded emission concentration limits for air pollutants. On the 26 August 2005 the Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities and Plant) Regulation 2005, was released. The objective of this Regulation is to repeal the Clean Air (Plant and Equipment) Regulation 1997 and to transfer its provisions, with modifications, to the Protection of the Environment Operations (Clean Air) Regulation 2002. The modifications involve the classification (by age) of different activities and plant (both for premises accommodating licensed activities and plant and those not requiring a licence) and the establishment of emission standards whose level of stringency vary between the various classes of activities and plant.

Action 4.2 - Implement load based licensing: This system sets annual load limits for pollutant emissions in EPL's. The licence fees are to be used to provide financial incentives for licensees to achieve discharges below the required minimum performance. Load limits are 'not applicable' in Orica's EPL No. 2148.

Action 4.5 - Develop a framework to control NO_X emissions in the Greater Metropolitan Region (GMR): The intention of this Action was for the NSW DEC to implement its NO_X policy for the GMR by capping total emissions and setting up a scheme for trading within the cap by the 1999/2000 financial year. This trading scheme has not yet been implemented. In the interim, the DEC requires that new plant (replacement or greenfield) will not cause extra exceedances of air quality goals for NO_2 or ozone in local or adjacent areas.

B.1.2 EPL No.2148 - Concentration Emission Limits

EPL No. 2148 sets concentration emission limits for seven air emission points. These points are listed below;

- Point 3 - the vent from the hypochlorite backing tower;
- Point 4 - the vent duct from the absorption tail tower;
- Point 7 -the emergency chlorine vent;
- Point 8 - the SSU vent stack;
- Point 9 - the stack serving the GTP;

- Point 23 – the stack serving the HCl storage tank; and
- Point 25 – the stack serving the mercury vapour extraction system.

The maximum emission concentration limits for these points are shown in Table B.1.

Table B.1: Concentration Limit Conditions – EPL No.2148

Licence Point	Pollutant	Units of measure	100 percentile concentration limit
Point 3	Chlorine	mg/m^3	200
Point 4	Hydrogen Chloride	mg/m^3	30
Point 7	-	-	-
Point 8	1,2-Dichloroethane	ppm	128
	Volatile Organic Compounds	ppm	150
	Vinyl Chloride	ppm	41
Point 9 [a]	1,2-Dichloroethane [b]	mg/m^3	8
	Chlorine	mg/m^3	30
	Nitrogen Oxides	mg/m^3	400
	Volatile Organic Compounds [b]	mg/m^3	10
	Hydrogen Sulphide	mg/m^3	2
	Dioxins and Furans [c]	ng/m^3	0.1
	Hydrogen Chloride	mg/m^3	30
	Sulphur Dioxide	mg/m^3	100
	Vinyl Chloride	mg/m^3	10
	Solid Particles	ppm	20
	Carbon Monoxide	mg/m^3	100
Point 23	Hydrogen Chloride	mg/m^3	30
Point 25	Mercury	$\mu g/m^3$	30

a. These air pollutant concentration limits apply to the stack emissions prior to the addition of any re-heat air.

b. Expressed as total organic carbon. This should be determined by summing all individual components after being analysed by FTIR.

c. Polychlorinated-dibenzo-p-dioxins (PCDD) and polychlorinated-dibenzofurans (PCDF) as 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD) equivalent calculated in accordance with the procedures included in Part 9, Clause 19 of the Clean Air (Plant and Equipment) Regulation 1997.

B.1.3 Emission Standards for Thermal Oxidation Plant

Table B.2: DTD Plant Stack Emission Standards and Regulations

Pollutant	Units	Stack Emission Concentration [a]						
		Lednaz ITD Consent	Allied Feeds DTD Consent	Orica GTP Operating Limits [b]	POEO (Clean Air) Reg 2002 [c]	2000/76/EC [d]		
						Daily Average	Half Hourly Average (100%)	Half Hourly Average (97%)
Sulphuric acid mist (H_2SO_4) or sulphur trioxide (SO_3), or both (as SO_3)	mg/m^3	-	90	-	100	-	-	-
Sulphur dioxide	mg/m^3	-	-	100	-	50	200	50
Chlorine (Cl_2)	mg/m^3	200	180	30	200	-	-	-
Hydrogen chloride (HCl)	mg/m^3	100	90	30	100	10	60	10
Any fluorine compound (HF)	mg/m^3	-	45	-	50	1	4	2
Nitrogen dioxide (NO_X) or nitric oxide (NO) or both	mg/m^3	150	450	400	350	200	400	200
Hazardous substances (Sb, As, Cd, Pb, Hg, Be, Cr, Co, Mn, Ni, Se, Sn, V)	mg/m^3	-	0.5	-	1	-	-	-
Cadmium	mg/m^3	-	0.1	-	0.2	-	-	-
Mercury	mg/m^3	-	0.1	-	0.2	0.05	-	-
Hazardous substances (Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V)	mg/m^3	-	-	-	-	0.5	-	-
Cadmium& Thallium	mg/m^3	-	-	-	-	0.05	-	-
Solid particles	mg/m^3	30	25	20	50	10	30	10
Dioxins and furans (ITEQ)	ng/m^3	0.1	0.1	0.1	0.1	-	-	-
Total VOCs	ppm_v	10	9	-	-	-	-	-
	mg/m^3	-	-	10	20	-	-	-
Carbon monoxide	ppm_v	100	90	-	-	-	-	-
	mg/m^3	-	-	100	125	-	-	-
Gaseous and vaporous organic substances, as total organic carbon	mg/m^3	-	-	-	-	10	20	10

a. Stack reference conditions are dry, 273 K, 101.3 kPa, 11% O_2.

b. POEO Act Licence No. 2148 condition for the Groundwater Treatment Plant.

c. Protection of the Environment Operations (Clean Air) Regulation 2002, which replaces CAPER: Clean Air (Plant & Equipment) Regulation 1997, as set out by Protection of the Environment Operations (Clean Air) Amendment (Industrial and Commercial Activities and Plant) Regulation 2005.

d. Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste.

e. Metals values are collected over a sample period of a minimum of 30 minutes and a maximum of 8 hours.

B.1.4 Pollutants Described in NEPM for Ambient Air Quality

B.1.4.1 Oxides of Nitrogen

The oxides of nitrogen are formed by the direct combination of oxygen and nitrogen during a variety of thermal processes. They include nitrogen dioxide (NO_2), nitric oxide (NO) and nitrous oxide (N_2O). Of these compounds, it is NO_2 which is of most significance in terms of potential human health effects and it is this compound that is the focus of ambient air quality guidelines and standards. NO emitted into the air, however, reacts with oxygen in the atmosphere to form NO_2, hence emission limits normally relate to total NO_X emissions expressed as NO_2.

NO_2 is a reddish-brown gas with an acrid odour detectable at 0.12 ppm. It is highly soluble in water, forming nitric acid. Human activities that are sources of NO_2 include operation of internal combustion engines (motor vehicles being the major source of NO_2 in the urban environment) and thermal power generating stations. Natural sources of NO_2 include the biological cycling of nitrogen and thermal processes in the atmosphere, for example lightning.

B.1.4.2 Sulphur Dioxide

Sulphur dioxide (SO_2) is a colourless, pungent, irritating and reactive gas, which is soluble in water. SO_2 and its reaction products (sulphurous and sulphuric acids and sulphate particles) are generally removed from the atmosphere by rain, and by direct uptake at plant, soil and water surfaces.

Natural sources of SO_2 are volcanic and geothermal activity. Bacterial and algal processes can produce organic sulphur compounds that are readily converted to SO_2. The main human activities that are sources of SO_2 include power generation from the burning of coal, oil or gas containing significant amounts of sulphur, the roasting or smelting of mineral ores containing sulphur, oil refining, and industrial plants that burn large quantities of fuels with a high sulphur content. In urban areas, motor vehicles contribute about 10% of ambient SO_2 levels.

B.1.4.3 Particulate Matter

Suspended particulate matter is dust or aerosol that stays suspended in the atmosphere for significant periods. In general terms, suspended particulate matter has a diameter up to about 10 to 20 microns (µm) although some particulate matter up to about 50 µm can be collected with high volume sampling. There is, however, no sharp dividing line between suspended and deposited particulate matter, which rapidly drops out of the air.

Inhalable particulate matter refers to the portion of total suspended particulate matter (TSP) that penetrates the upper respiratory tract and deposits in the fine airways of the lung. The indicator PM_{10} refers to that fraction of TSP with an aerodynamic diameter smaller than 10 µm. These particles have been recognised as being of greatest concern in terms of potential human health impacts because of their ability to reach the lower regions of the respiratory tract. Recent research,

however, has indicated that particles with a diameter less than 2.5 µm ($PM_{2.5}$) penetrate further into the lung and can enter the alveoli, posing a greater risk.

In the *Action for Air*, the NSW EPA adopted the regional ambient air quality goals for PM_{10} (particulate matter less than 10 microns in diameter). The 24-hour average goal adopted by the NSW EPA is the same as that set in the NEPM for Ambient Air Quality. The NSW EPA has also maintained an annual guideline for TSP of 90 µg/m^3, which is designed to protect against amenity loss. The advisory reporting standards for $PM_{2.5}$ set by the NEPC in the Variation to the Ambient Air Quality NEPM are also presented.

Deposited particulate matter is dust that, because of its aerodynamic diameter and density, falls from the air. In general terms, deposited particulate matter has a diameter greater than about 20 µm. However there is no sharp dividing line between these particles and the smaller particles of suspended matter that fall more slowly out of the air. Due to the size of the particulate matter, most of this material would not enter the body. Hence the effects of deposited particulate matter are primarily nuisance, and may only affect health via annoyance reactions. This larger fraction of particulate matter would only be emitted from the site during construction activities.

The dust deposition rate is measured as the amount of dust deposited on a horizontal surface as a result of gravitational settling over a specified time period. The units for this parameter are grams per square metre per month (g/m^2/month).

B.1.4.4 Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless gas produced by the incomplete combustion of carbon in fuels. Major CO sources include transportation activities, as well as incinerators and industrial sources. When CO enters the bloodstream it reduces the delivery of oxygen to organs and tissues.

B.1.4.5 Ozone

Photochemical smog is produced by the interaction of strong sunlight with the precursor pollutants of NO_X and non-methane hydrocarbons (NMHCs). The chemical reaction produces ozone (O_3), nitrogen dioxide, peroxyacetyl nitrate and aldehydes. Aerosols are also formed, which result in visibility degradation in the form of orange-brown hazes.

Ozone is often used as the indicator pollutant for monitoring photochemical smog. While ozone in the upper atmosphere is beneficial to life by shielding the earth from ultraviolet radiation from the sun, high concentrations of ozone at ground level are a major health and environmental concern. At elevated concentrations, ozone causes health problems by damaging lung tissue and reducing lung function.

The meteorological conditions required for photochemical smog formation are extended periods of light winds (several hours to several days) accompanied by strong sunlight. The reaction occurs over several hours and is dependent on both the meteorology and precursor pollutant concentrations. The highest O_3 concentrations are generally observed in the late afternoon during summer.

Appendix C
Emissions

C1 EMISSIONS

C1.1 Existing Emissions from BIP

Table C.1: Parameters used in Dispersion Modelling for Existing and Approved Orica Emission Sources at the BIP

Owner		Orica	Orica		Orica	Orica	
Plant		GTP	Chlorine Plant		Old Chlorine Plant	HCB Waste Repackaging Plant	
Emission Source	Units	Stack	HCl Burner Vent Stack	Weak Gas Vent Stack	Decommissioned H, MK & B Cells area	Store J Stack	Store H Stack
Source ID	-	OGTP	OCP1	OCP2	H, MK & B Cells	Store J	Store H
Stack Location (MGA)	(mE, mN)	[335,504 6,241,590]	[335,639 6,241,190]	[335,624 6,241,230]	[335,688 6,241,238]	[335,154 6,241,890]	[335,669 6,241,740]
Ground Elevation	(m)	12.4	11.6	11.9	12.0	12.0	15.3
Stack Height above Ground Level	(m)	34	25	15		10	15
Diameter	(m)	1.80	0.2	0.3	*Area Source*	0.44	0.15
Exit Velocity	(m/s)	19.90	1.4	14		14.6	15
Exit Temp	(°C)	105	25	30		20	20
Exit Temp	(K)	378	298	303		293	293
Moisture Content	(vol%)	12	3				
Oxygen Content	(%wet)	14.0					
Oxygen Content	(%dry)	11.0					
Gas Flowrate (0°C, 1 atm, wet)	(m^3/s)	36.6					
Gas Flowrate (0°C, 1 atm, dry gas)	(Nm^3/s)	32.6	0.04	1.08		2.2	0.28
Operating Hours	(hrs/year)	8,760	8,760	8,760		8,760	8,760

Table C.2: Parameters used in Dispersion Modelling for Existing Qenos Emission Sources at the BIP

Owner / Plant / Emission Source	Units	Qenos Olefines						
		Furnace #1	Furnace #2	Furnace #3	Furnace #4	Furnace #5	Ground Furnace 1	Ground Furnace 2
Source ID	-	QOCF1	QOCF2	QOCF3	QOCF4	QOCF5	QOGF1	QOGF2
Stack Location (MGA)	(mE, mN)	[335,264 6,242,165]	[335,284 6,242,165]	[335,264 6,242,167]	[335,284 6,242,167]	[335,304 6,242,167]	[335,014 6,242,135]	[335,004 6,242,115]
Ground Elevation	(m)	14.2	14.3	14.2	14.4	14.5	12.7	12.5
Stack Height above Ground Level	(m)	35	35	35	35	35	5	6
Diameter	(m)	1.25	1.25	1.25	1.25	1.25	*Volume Source* 6 m sigma y 3 m sigma z	*Volume Source* 6 m sigma y 3 m sigma z
Exit Velocity	(m/s)	17.2	17.2	17.2	17.2	17.2		
Exit Temp	(°C)	184	184	184	184	184		
Exit Temp	(K)	457	457	457	457	457	-	-
Moisture Content	(vol%)	22.2	22.2	22.2	22.2	22.2		
Oxygen Content	(%wet)							
Oxygen Content	(%dry)							
Gas Flowrate (0°C, 1 atm, wet)	(m^3/s)							
Gas Flowrate (0°C, 1 atm, dry gas)	(Nm^3/s)	9.8	9.8	9.8	9.8	9.8	0.11	0.11
Operating Hours	(hrs/year)	8,760	8,760	8,760	8,760	8,760	8,760	8,760

Table C.3: Parameters used in Dispersion Modelling for Existing Qenos and Huntsman Emission Sources at the BIP

Owner		Qenos			Qenos	Qenos	Huntsman
Plant		Site Utilities			Alkatuff	Olefines	Surfactants
Emission Source	Units	Coal Boiler Stack 1	Coal Boiler Stack 2	Gas Boiler Stack	Ground Flare 1	Elevated Flare	Hot Oil Furnace
Source ID	-	QCB1	QCB2	QGB	QAGF	QOEF	H1
Stack Location (MGA)	(mE, mN)	[335,304 6,241,643]	[335,301 6,241,650]	[335,307 6,241,655]	[335,004 6,242,065]	[334,994 6,242,130]	[335,739 6,241,430]
Ground Elevation	(m)	10.4	10.4	10.5	12.5	12.5	14.6
Stack Height above Ground Level	(m)	73	73	47.5	5	72	12
Diameter	(m)	1.37	1.37	1.75	*Volume Source* 6 m sigma y 3 m sigma z		0.30
Exit Velocity	(m/s)	17.7	17.7	6.1		20	15
Exit Temp	(°C)	138	145	152			150
Exit Temp	(K)	411	418	425	-		423
Moisture Content	(vol%)	2.3	3.8	11.5			
Oxygen Content	(%wet)	12.6	13.5	7.2			
Oxygen Content	(%dry)						
Gas Flowrate (0°C, 1 atm, wet)	(m^3/s)						
Gas Flowrate (0°C, 1 atm, dry gas)	(Nm^3/s)	16.9	16.4	8.3	4.9	0.11	1.0
Operating Hours	(hrs/year)	8,760	8,760	8,760	8,760	8,760	8,760

Table C.4: Emissions used in Dispersion Modelling for Existing and Approved Orica Emission Sources at the BIP

Owner		Orica	Orica		Orica	Orica	
Plant		GTP	Chlorine Plant		Old Chlorine Plant	HCB Waste Repackaging Plant	
Emission Source	Units	Stack	HCl Burner Vent Stack	Weak Gas Vent Stack	Decommissioned H, MK & B Cells area	Store J Stack	Store H Stack
Carbon Monoxide (CO)	(kg/hr)	0.12					
Cadmium (Cd)	(kg/hr)						
Chlorine (Cl_2)	(kg/hr)	0.006	$5.0x10^{-5}$	$1.2x10^{-4}$			
Chloroform ($CHCl_3$)	(kg/hr)						0.011
1,2-Dichloroethane (EDC)	(kg/hr)	0.027					0.008
1,1-Dichloroethylene (1,1-DCE)	(kg/hr)						0.002
Dioxins (TEQ)	(kg/hr)	$6.4x10^{-9}$					
Fine Particles (PM_{10})	(kg/hr)	0.34					
Hexachlorobenzene (HCB)	(kg/hr)					$1.4x10^{-5}$	$1.8x10^{-6}$
Hexachlorobutadiene (HCBD)	(kg/hr)					$1.8x10^{-3}$	$2.2x10^{-4}$
Hexachloroethane (HCE)	(kg/hr)					0.08	0.09
Hydrogen Chloride (HCl)	(kg/hr)	0.06	$7.0x10^{-5}$				
Hydrogen Fluoride (HF)	(kg/hr)						
Oxides of Nitrogen (NO_X)	(kg/hr)	9.1					
Mercury (Hg)	(kg/hr)				$3.43x10^{-3}$		
Methylene Chloride (DCM)	(kg/hr)						
Sulphur Dioxide (SO_2)	(kg/hr)	0.39					
Sulphuric Acid (H_2SO_4)	(kg/hr)						
Tetrachloroethylene (PCE)	(kg/hr)					2.7	0.3
Trichloroethylene (TCE)	(kg/hr)						0.05
Vinyl Chloride Monomer (VCM)	(kg/hr)	0.005					0.012