FINAL REPORT

AIR QUALITY IMPACT ASSESSMENT FOR ORICA VILLAWOOD REMEDIATION PROJECT

Thiess Services Pty Ltd

Job No: 3672

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A PEL Company

PROJECT TITLE:	**AIR QUALITY IMPACT ASSESSMENT FOR ORICA VILLAWOOD REMEDIATION PROJECT**
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EXECUTIVE SUMMARY

PAEHolmes has been commissioned by Thiess Services Pty Ltd (Thiess) on behalf of Orica Australia Pty Ltd (Orica) to prepare an air quality impact assessment for the remediation of the former chemical manufacturing facility located at 2 Christina Road, Villawood NSW. Thiess 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 Air Health Risk Assessment (AHRA) and Preliminary Hazard Analysis (PHA) for the project.

The site covers an area of approximately 12.6 hectares (ha) and was initially part of a larger chemical complex owned by the Commonwealth of Australia and used for the manufacturing of munitions, including trinitrotoluene (TNT), in 1941. The site was subsequently purchased by Taubmans in 1946, who manufactured a range of chemicals including chlorobenzene and DDT until the southern portion of the site was purchased by ICI ANZ Pty Limited (ICI) in 1953. ICI (and later Orica) continued to manufacture a wide range of agricultural and pharmaceutical chemicals until the site was closed in 2000.

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 DTD process is an ex-situ remedial treatment method. The contaminated material must first be excavated before being treated in the DTD plant. Excavated materials requiring treatment will be transported from the Remediation Area to a Feed Soil Building (FSB), where they will be readied for treatment in the adjoining DTD plant. The FSB will be equipped with an Emission Control System (ECS) to control and regulate emissions from the material handling processes prior to 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), evaporative cooler, 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.

After treatment, the material will be validated and temporarily stockpiled adjacent to the FSB. Once treatment of each of the Remediation Areas has been completed and the areas have been suitably validated, the treated material will be reused as backfill material at the Site.

Information provided to PAEHolmes 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 proposed remediation project.

Conservatively estimated emission rates were used as input data for atmospheric dispersion modelling. The AUSPLUME model was chosen to perform dispersion modelling for this assessment. AUSPLUME v.6.0 or later is an approved dispersion model for use in most simple, near-field applications in NSW, where coastal effects and complex terrain are of no significant concern, such as the conditions in the project area.

Cumulative impacts of criteria air pollutants have been assessed using air quality monitoring data sourced from the DECCW monitoring network. Emissions of the other pollutants that were assessed in this study are assumed to be negligible in the surrounding environment as these pollutants are not common and there are no known operating sources of them nearby.

The atmospheric dispersion modelling results have been assessed against New South Wales (NSW) Department of Environment, Climate Change and Water (DECCW) air quality assessment criteria to provide an air quality impact assessment for the proposed remediation project.

The modelling study involved an iterative process. Where original model runs identified potential issues for air quality, the proposed approach was changed and source parameters such as stack heights and emission rates were amended accordingly and the model was re-run to determine source parameters that would result in acceptable air quality.

Based on the results of the modelling study the emissions from the proposed remediation are not predicted to have a significant impact on air quality in the surrounding area.

In addition, the proposed remediation project would only exist for approximately one year until the remediation works are completed, with excavation and treatment activities taking about 6 months. When remediation is complete, emissions from the works will no longer exist and the contaminants in the treated soil will have been essentially destroyed by the DTD plant.

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 DECCW 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, the existing network of sealed access roads will be used for internal transport where possible and the site is compact. Dust mitigation measures would be specified in the Construction Environment Management Plan (CEMP) for the remediation project to minimise the potential for any emissions from construction activities.

During operations, dust emissions from activities in the FSB will be contained inside those buildings, which will operate so that airflow is inwards through louvers 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 ECS and stacks to manage air emissions. An ambient monitoring program may also be conducted, if required, to confirm that fugitive emissions are controlled and unacceptable impacts are not experienced off-site.

No residual air quality impacts are expected from the proposed remediation works, provided that emission rates 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

PAEHolmes has been commissioned by Thiess Services Pty Ltd (Thiess) on behalf of Orica Australia Pty Ltd (Orica) to prepare an air quality impact assessment for the remediation of the former chemical manufacturing facility located at 2 Christina Road, Villawood NSW.

The air quality impact assessment is based on project information and data provided by Thiess, AECOM Australia Pty Ltd (AECOM[a]), 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 PAEHolmes 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 proposed remediation project.

Thiess has also prepared the Environmental Assessment (EA) for the Project **(Thiess, 2010)** and this air quality impact assessment has informed the EA.

AECOM was commissioned by Orica to develop a Remedial Action Plan (RAP) for the site **(AECOM, 2010)**. The RAP has been prepared to meet the requirements of Remediation Order No. 23019, Area 3200 issued by the NSW Environment Protection Authority (EPA[b]) on 2 November 2005.

A Remedial Technology Assessment (RTA) was completed for the remediation of the contaminated soils identified at the site **(HLA, 2006)**. Based on the findings of the RTA and further evaluation, ex-situ Directly-Heated Thermal Desorption (DTD) was selected as the preferred remediation technology (further details are outlined in the RAP).

This air quality impact assessment covers the preferred remediation approach, i.e. ex-situ DTD.

PAEHolmes has also provided results of air quality modelling for use in the air health risk assessment (AHRA) provided by GHD **(GHD, 2010)**, and in the preliminary hazard analysis (PHA) provided by Sherpa Consulting (Sherpa) **(Sherpa, 2010)**.

a Previously known as HLA-Envirosciences Pty Ltd and ENSR Australia Pty Ltd

b NSW EPA is part of the NSW Department of Environment, Climate Change and Water (DECCW)

2 PROJECT DESCRIPTION

2.1 The Site

The site covers an area of approximately 12.6 hectares (ha) and is located at 2 Christina Road, Villawood in the Local Government Authority of Bankstown City Council. It was initially part of a larger chemical complex owned by the Commonwealth of Australia and used for the manufacturing of munitions, including trinitrotoluene (TNT), in 1941. The site was subsequently purchased by Taubmans in 1946, who manufactured a range of chemicals including chlorobenzene and DDT until the southern portion of the site was purchased by ICI ANZ Pty Limited (ICI) in 1953. ICI (and later Orica) continued to manufacture a wide range of agricultural and pharmaceutical chemicals until the site was closed in 2000 **(AECOM, 2010)**.

Figure 2.1 shows the contaminated land areas within the site and its location within the surrounding area.

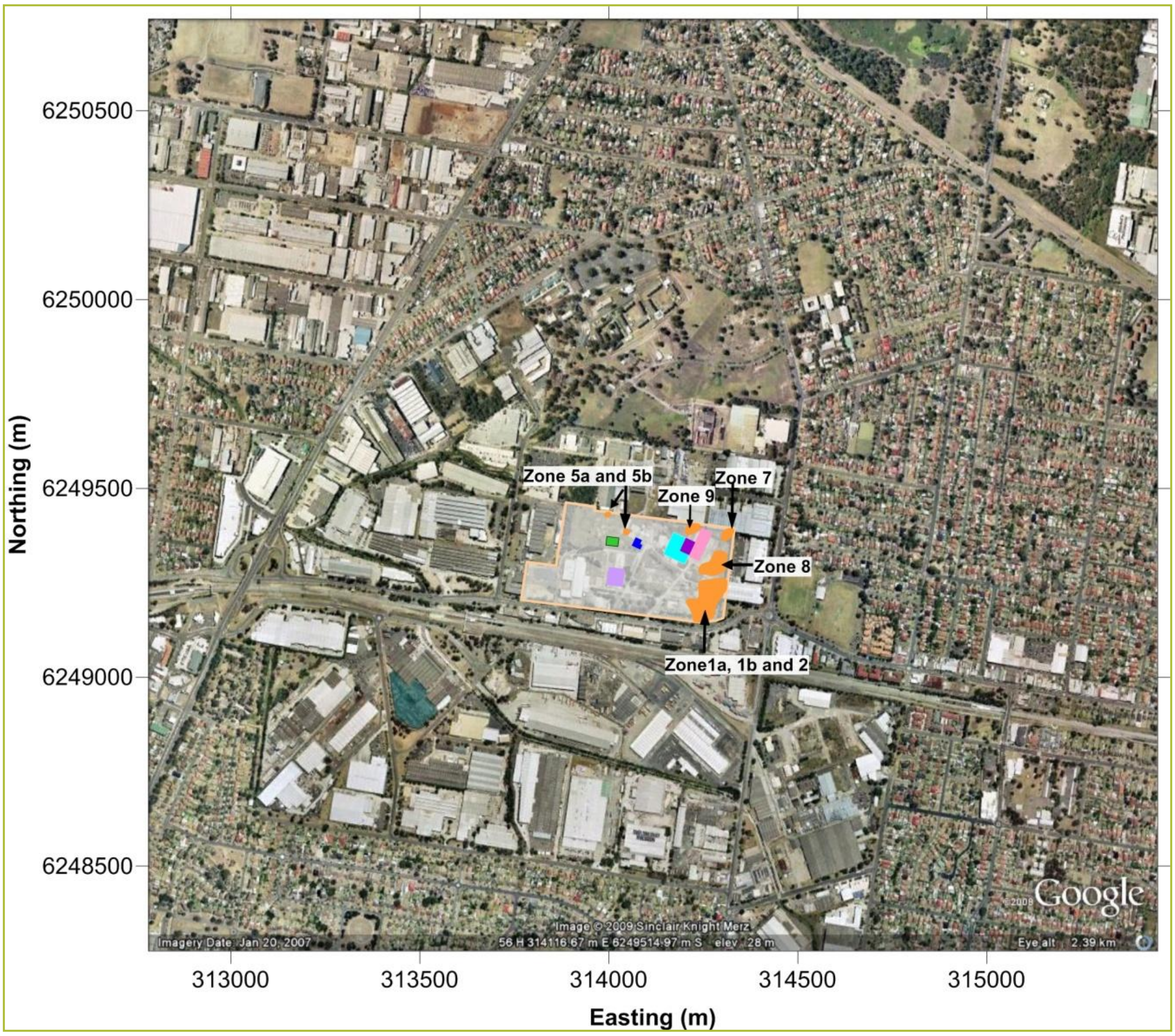


Figure 2.1: Site location and contaminated land areas

2.2 Project Overview

The following information is presented in the RAP to provide a general overview of the proposed Project. Further detailed outline of the Excavation Works, Materials Handling and Treatment Operations are also provided in the RAP **(AECOM, 2010)**.

The DTD process is an ex-situ remedial treatment method, and as such, excavation of the Remediation Areas will be required prior to treatment. The excavated materials will be assessed upon excavation and sampled for classification. Excavated materials requiring treatment will be transported from the Remediation Area to a Feed Soil Building (FSB), where they will be readied for treatment in the adjoining DTD plant. The FSB will be equipped with an Emission Control System (ECS) to control and regulate emissions from the material handling processes prior to treatment. After treatment, the material will be validated and temporarily stockpiled adjacent to the FSB (refer to **Figure 2.2**). Once treatment of each of the Remediation Areas has been completed and the areas have been suitably validated, the treated material will be reused as backfill material at the Site.

Specific information on the individual plant, site facilities and treatment processes are outlined in the appropriate sections of the RAP. However, the proposed remedial works will involve the following general operations:

- Preliminary activities including project planning and licensing;
- Site establishment, including:
  - Set-up of site offices, fencing, decontamination stations, environmental control measures, Water Treatment Plant (WTP) and other associated facilities;
  - Set-up of various safety zones and Remediation Areas to be excavated (the sequencing is yet to be determined);
  - Installation of DTD plant and equipment;
  - Construction of the FSB and associated ECS and the sealed hardstand adjacent to the FSB (as required); and
  - Construction of internal haul roads (as required).
- Progressive excavation of contaminated soils from the first Remediation Area;
- Proof of Performance (PoP) testing period for the DTD plant and associated ECS for the FSB;
- Screening of oversize excavated materials (as required);
- Transport of the excavated materials from the Remediation Area to:
  - The FSB if the initial testing finds that the excavated materials require remedial treatment; or
  - A second soil stockpile if initial testing indicates that the excavated materials are suitable for reuse without remedial treatment; or
  - An off-site licensed waste facility where excavated materials are considered unsuitable for remedial treatment, but are suitable for disposal/recycling at such a facility.
- Treatment of soils within the DTD plant;
- Progressive validation of the treated soils and placement in temporary stockpile areas;

- Progressive validation of the Remediation Areas (against the Remediation Goals) after the excavation and removal of the contaminated materials;
- Dismantling and reestablishment of Remediation Area for each stage of excavation works;
- Backfilling of the validated Remediation Areas after completion of the excavation and remedial treatment works;
- Final reinstatement and finishing of the Remediation Areas; and
- All necessary OH&S, environmental protection works and monitoring.

The proposed remediation works also includes a stockpile of contaminated materials that was moved from a nearby site at Chester Hill and soils that are currently stored in a secure storage facility (SSF) at the site.

The remediation activities are expected to take approximately 50 weeks including site establishment, pre-treatment, treatment, validation, reinstatement and demobilisation. A detailed project schedule has been provided by Thiess and is also presented in Appendix F to the AHRA **(GHD, 2010)**.

The location of excavation areas, stockpiles and project infrastructure referred to by the project schedule are shown in **Figure 2.2**.

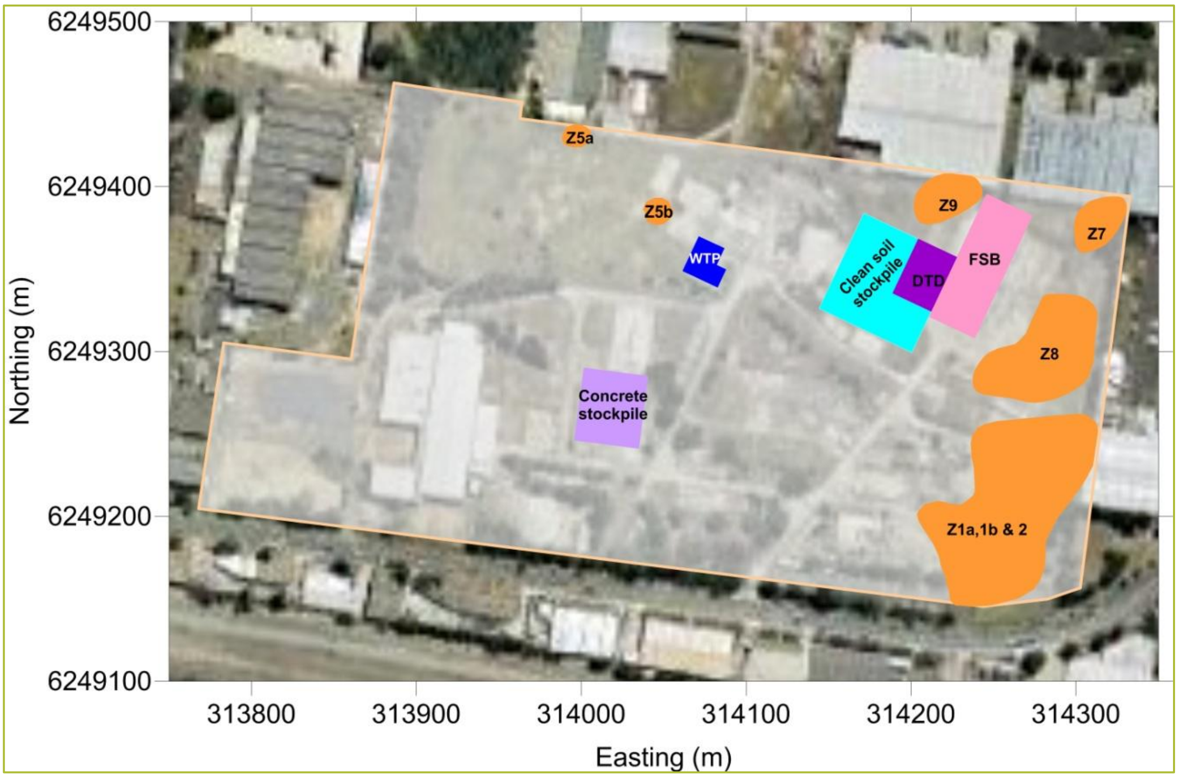


Figure 2.2: Location of excavation areas, stockpiles and project infrastructure

2.3 Identification of Air Emission Sources

The assessment of emissions to air has been based on options for remediation activities that are expected to have the greatest potential for air quality impacts, in order to provide a conservative assessment.

There are a range of emissions that have been assessed for the proposed remediation works. These are summarised in **Table 2.1**.

Table 2.1: Emissions Identified for Assessment

Source	Emissions			
	Dust from contaminated soil	Organic compound vapours	Fuel combustion products	Dust from treated or clean soil
Excavation: Exposed face of contaminated soil	✓	✓		
FSB: Contaminated soil stockpile (inside) Emission control system stack		✓ ✓		
DTD plant: Stack		✓	✓	
Treated soil stockpile: Loading Windblown emissions				✓ ✓
Treated soil reinstatement: Earthworks				✓
Concrete stockpile: Breaking and handling				✓

3 REGULATORY REQUIREMENTS

3.1 Existing Licence Requirements

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) 2149, issued by the New South Wales (NSW) Department of Environment, Climate Change and Water (DECCW) under the POEO Act, which regulates activities at the site.

There are currently no concentration limits or annual load limits for discharges to air specified in the EPL. Upon approval of the Development Application for the project, a separate application would be required to request a Variation to EPL 2149 from DECCW, in order to regulate the stack emissions proposed as part of the remediation project.

EPL 2149 already contains general Conditions to minimise or prevent emissions of dust and potentially offensive odour during operations at the site.

3.2 Air Quality Impact Assessment Criteria

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.

The *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* ("the Approved Methods") **(DEC, 2005)** 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 DECCW impact assessment criteria set for those pollutants relevant to the activities proposed for the Villawood remediation project are shown in **Table 3.1** to **Table 3.4**.

Table 3.1: NSW DECCW Assessment Criteria for SO_2, NO_2, PM_{10}, TSP, CO and HF

Pollutant	Concentration (ppm)	Concentration (µg/m³)	Averaging Period
Sulfur dioxide (SO_2)	0.25	712	10 minutes
	0.20	570	1 hour
	0.08	228	24 hours
	0.02	60	Annual
Nitrogen dioxide (NO_2)	0.12	246	1 hour
	0.03	62	Annual
Particulate matter (PM_{10})	-	50	24 hour
	-	30	Annual
Total suspended particulates (TSP)	-	90	Annual
Carbon monoxide (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 (DEC, 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 3.2: NSW DECCW 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 (DEC, 2005)

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

Table 3.3: NSW DECCW Assessment Criteria for Toxic Air Pollutants

Pollutant	Concentration (ppm)	Concentration (mg/m^3)	Averaging Period
1,2-Dichloroethane (EDC)	0.018	0.07	1 hour
Chloroform	0.18	0.9	1 hour
Carbon tetrachloride (CCl4)	0.0018	0.012	1 hour
Trichloroethylene (TCE)	0.09	0.5	1 hour
Chlorobenzene	0.023	0.1	1 hour
Benzene	0.009	0.029	1 hour
Toluene	0.09	0.36	1 hour
Ethylbenzene	1.8	0.8	1 hour
Xylenes	0.04	0.19	1 hour
Mercury (organic) (Hg)	-	0.00018	1 hour
Mercury (inorganic) (Hg)	-	0.0018	1 hour
Hydrogen Chloride (HCl)	0.09	0.14	1 hour
Polycyclic aromatic hydrocarbon (as benzo[a]pyrene)	-	0.0004	1 hour
1,2-Dichloroethylene	3.7	14.4	1 hour
1,1,1-trichloroethane	2.3	12.5	1 hour
Vinyl Chloride (VCM)	0.009	0.024	1 hour
Dioxins and Furans	N/A	2.0E-09	1 hour

Source: Table 7.2a and Table 7.2b (DEC, 2005).

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

Table 3.4: 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 (DEC, 2005)

The Approved Methods does not provide 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 Approved Methods does not provide air quality impact assessment criteria for some pollutants of concern that are included in this study, such as hexachlorobenzene (HCB), tetrachloroethene (PCE), 1,4-dichlorobenzene, 1,2,3-trichloropropane, Bis(2-chloroethyl)ether, lindane, dieldrin, DDX, endosulfan II, naphthalene, 1,1-dichlorethane (11 DCA), 1,1-dichlorethylene (11 DCE).

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

3.3 Odour Impact Assessment Criteria

In November 2006, DEC (now DECCW) released two documents, i.e. *Technical framework* and *Technical notes* for the *Assessment and Management of Odour from Stationary Sources in NSW* **(DEC, 2006a) (DEC, 2006b)**. These documents outline the DECCW'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 Villawood Remediation Project were assessed as part of this study using comprehensive dispersion modelling assessment. However, due to the complexity of determining odour thresholds for the 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.

3.4 Scheduled Wastes

3.4.1 Environmentally Hazardous Chemicals Act

There are a number of international agreements relating to chemicals management. Australia is a signatory to the Stockholm Convention on Persistent Organic Pollutants and is bound to take particular care with activities involving persistent organic pollutants (POPs) including PCBs, certain organochlorine compounds (e.g. DDT, dieldrin, BHCs, lindane) and dioxins. This Convention is implemented in Australia under the *National Implementation Plan* (July 2006) and the *National Strategy for the Management of Scheduled Wastes* which is given effect in NSW through three chemical control orders (CCO's) under the *Environmentally Hazardous Chemicals Act* (EHC Act) 1985, which allows DECCW to regulate activities of chemicals or groups of chemicals of environmental concern. These requirements are set out in CCOs and may require a licence or prohibit certain activities. The activities may include storing, transporting or treating chemicals and/or their wastes.

3.4.2 Licences

In addition to environment protection licences there are also provisions for DECCW to declare and make orders for the investigation and remediation of sites that DECCW considers are likely to be contaminated with chemicals and that may pose a significant risk of harm to human health or the environment. These declarations of contaminated sites are made under the Contaminated Land Management Act 1997.

The Villawood Remediation Project is proposed to meet requirements of Remediation Order No. 23019, Area 3200 issued by the NSW EPA on 2 November 2005.

3.4.3 Technology Assessments

Technologies for treating or destroying those chemicals listed under the National Strategy are assessed in accordance with the National Protocols for Approval/Licensing of Trials of Technologies for the Treatment/Disposal of Schedule X Wastes 1994 and/or National Protocol for Approval/Licensing of Commercial-Scale Facilities for the Treatment/Disposal of Schedule X Wastes 1994. These protocols were developed as part of the National Strategy for the Management of Scheduled Waste.

A technology assessment is generally carried out as part of a licensing process for a specific premise or mobile treatment plant.

It should be noted that while DECCW may approve use of a treatment technology at a specific site this should not be viewed as a generic approval of that technology. Approvals are always site specific and may require some public consultation.

3.4.4 Approvals relating to Scheduled Wastes

Section 2.0 of the RAP **(AECOM, 2010)** details the Approvals process with respect to the Villawood Remediation Project and Scheduled Wastes, in further detail.

In summary, the requirements of DECCW with respect to destruction of Scheduled Waste is to ensure that the proposed control measures for the Project minimise its contribution to emissions of scheduled wastes, particularly those chemicals regulated by international agreements, such as the Stockholm Convention on Persistent Organic Pollutants, which Australia is signatory too.

The Villawood Remediation Project proposes to remove the contaminated soils from the site and destroy the contaminated compounds via the DTD technology and its pollution control system. This aim is consistent with the Stockholm Convention on Persistent Organic Pollutants, which aims to protect human health and the environment from the effects of persistent organic pollutants (POPs) with a range of control measures to reduce and, where feasible, eliminate POPs releases, including emissions of unintentionally produced POPs such as dioxins. The Convention also aims to ensure the sound management of stockpiles and wastes that contain POPs.

4 STUDY APPROACH

4.1 Air Quality

An inventory of emissions has been compiled for the Project, based on information provided by AECOM (in the RAP), Thiess (the proposed schedule of works and technical data for the remediation technology), and GHD (emissions calculations for volatile organic emissions from excavation and handling of contaminated soils). PAEHolmes provided the emissions for dust from non-contaminated sources for the proposed works.

The emissions inventory includes details for stack conditions (eg. 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 AUSPLUME dispersion model was selected for this work as it is an accepted dispersion model for use in NSW and the local topography and meteorological conditions are appropriate for its use. The modelling assesses the dispersion of air pollutants over a 2.8km x 2.8km Cartesian domain at 100 m grid spacing using meteorological data recorded at the nearby Bankstown Airport meteorological station.

The atmospheric dispersion modelling results have been assessed against relevant air quality assessment criteria to provide impact assessment for the proposed remediation project. The modelling study involved an iterative process. Where original assessment identified that the approach may lead to breaches of air quality criteria, the source parameters and/or remediation approach such as stack heights or excavation rates were revised and the model was re-run to determine source parameters that would result acceptable air quality whilst providing a practical approach to the proposed remediation.

The dispersion modelling for this study is outlined further in section 8 of this report.

4.2 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 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 at the Project site 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 16 potentially odorous organic compounds (i.e. chlorinated organic compounds) modelled in this study. For 10 of these compounds, an appropriate odour threshold was researched in the available literature. It can be assumed that from the lack of data, the six compounds that do not have readily available odour threshold data are not particularly odorous. The maximum predicted GLC from modelling 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.

4.3 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 operations or new development itself;
- Air emissions from any plant and equipment already operating at the site; 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. 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 the 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.

For this assessment, background pollutant concentrations for criteria pollutants, i.e. NO_2, SO_2, PM_{10} and CO are required. There is currently no plant and equipment already operating at the site. The other Contaminants of Concern to the study are not common pollutants in the airshed and hence the existing concentrations of these pollutants can be assumed to be negligible.

In the case of the Villawood Remediation Project, the nearest appropriate DECCW ambient monitoring site is located in Chullora. The Chullora air quality monitoring site is located in the grounds of the Southern Sydney TAFE, Worth St, Chullora. It is situated in the centre of the Sydney basin in a mixed residential and commercial area and is approximately 6 km to the east of the Villawood site.

The modelling has included regional background pollutant data collected at the DECCW's Chullora monitoring site in order to provide an assessment of cumulative impacts. Maximum hourly background concentrations were used from data monitored at this site in 2008 (for PM_{10} due to several dust storms in 2009) and 2009 (for NO_2, SO_2 and CO).

For the other pollutants ambient concentrations have been assumed to be negligible.

5 EMISSIONS TO AIR

5.1 Sources of Emissions

As outlined in Section 2.3, the following emission sources from the proposed remediation works have been identified for assessment:

- The stack venting treated air from the ECS on the FSB;
- The stack emitting treated air from the pollution control system of the DTD plant;
- Fugitive organic emissions and dust from excavation and handling of contaminated soil; and
- Fugitive dust emissions from activities involved in the project such as treated soil stockpiles, earth movement works on clean soil, and concrete breaking and handling activities.

Thiess have advised that the excavation works would occur between the hours of 7am and 5pm for 6 days a week. However, we have assessed impacts for 7 days a week to be conservative and assess for the complete set of annual meteorological conditions.

It is assumed that up to 500m^3 of contaminated material could be moved in a day. There will be one 25 tonne excavator operating at the site for purposes of excavation, so only one excavation area would be open to the atmosphere at any given time. Therefore, organic emissions would only be concurrent from one open excavation area as well as the DTD stack and the FSB ECS stack. For the air quality assessment, we have compared the maximum predicted ground level concentrations for organic emissions for all open contaminated areas for all meteorological conditions in the annual dataset and presented the highest predicted concentrations at each receptor point on the modelled domain to provide the worst case assessment for organic emissions from open sources.

The FSB and the DTD will operate 24 hours a day, 6 days a week, however we have assessed impacts for operations 7 days a week

There are also activities associated with clean soil, treated soil and concrete that may result in emissions of non-contaminated dust (i.e. without organic pollutants), which have been assessed in terms of air quality impacts for TSP, PM_{10} and dust deposition.

Based on the remediation schedule (see Appendix F **(GHD, 2010)**) several source locations were identified and used as model inputs. All earth movement activities have been modelled as volume sources and emissions from DTD plant and FSB have been modelled as stack sources. The locations of these sources are presented in **Figure 5.1**.

Figure 5.1: Source locations (in air dispersion model)

5.2 Estimated Emissions

5.2.1 Dust Emissions

There is potential for dust to be generated from mechanical activities such as excavation, loading and unloading, transport of materials and wind erosion. The contribution of TSP (Total Suspended Particles) emissions from the project activities and wind erosion has been estimated and are presented in **Table 5.1**. The table provides only the dust generating activities and the corresponding dust emission rate. The full project schedule can be found in Appendix F of the AHRA **(GHD, 2010).**

The rate at which dust is estimated to be generated by the activities outlined in **Table 5.1** are provided in Chapters 11.9.2 and 13.2.4.3 of AP-42 **(USEPA, 1985)** and are provided below:

Excavator operation:

$$E_{TSP} = k \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

Dozers operation:

$$E_{TSP} = \frac{2.6 \times s^{1.2}}{M^{1.3}}\ kg/hour$$

Loader operation:

$$E_{TSP} = \frac{0.58}{M^{1.2}}\ kg/tonne$$

Where:
K = 0.74
U = wind speed (m/s)
M = moisture content (%)

Annual average wind speed used in the equation for excavator emissions was 3.07 m/s (derived from meteorological dataset for Bankstown Airport (2008)) and soil moisture content was 12% as advised by Thiess. Further information on soil properties is available in Appendix B of the AHRA **(GHD, 2010).**

A control factor of 70% was applied to the dust emissions shown in Table 5.1, as advised by Thiess, to account for dust mitigation such as water sprays. This control factor is based on observation of the effectiveness of typical dust management measures, particularly wetting down of excavation surfaces and stockpiles on the Rhodes Peninsula projects over the last decade.

Dust modelling has been conducted to predict concentrations of TSP and PM_{10} as well as dust deposition. The particle size and mass distribution used in the modelling is shown below:

- < 2.5 µm (4.7% of total mass);
- 2.5 to 10 µm (34.4% of total mass); and
- > 10 µm (60.9% of total mass).

5.2.2 Volatile Emissions

GHD has estimated the volatile organic emissions from the excavation and handling activities of contaminated soils, the FSB ECS, and the pollution control system of the DTD plant.

The emission estimation techniques and the equations used are based on a variant of the Johnson & Ettinger volatilisation model **(Johnson & Ettinger, 1991)**, which are further detailed in the AHRA **(GHD, 2010)** for these volatile organic emissions.

Estimated organic emissions used in this assessment are presented in **Table 5.2**.

Table 5.1: Estimated TSP emission for each activity

Week	Equipment/Activity	Emission factor	Unit	TSP Emission (kg)
1	25t excavator	4.46E-05	kg/tonne	0.08
	padfoot roller	2.13E-01	kg/hour	8.51
	bulldozer	2.13E-01	kg/hour	8.51
11, 12, 13	25t excavator	4.46E-05	kg/tonne	0.40
	25t excavator	4.46E-05	kg/tonne	0.40
14, 15, 16	25t excavator	4.46E-05	kg/tonne	0.72
	25t excavator	4.46E-05	kg/tonne	0.05
	25t excavator	4.46E-05	kg/tonne	0.05
	25t excavator	4.46E-05	kg/tonne	0.02
	25t excavator	4.46E-05	kg/tonne	0.02
17, 18	25t excavator	4.46E-05	kg/tonne	0.40
	25t excavator	4.46E-05	kg/tonne	0.05
19	25t excavator	4.46E-05	kg/tonne	0.20
	25t excavator	4.46E-05	kg/tonne	0.02
	25t excavator	4.46E-05	kg/tonne	0.02
20	Loader	8.82E-03	kg/tonne	29.77
	padfoot roller	2.13E-01	kg/hour	
	Bulldozer	2.13E-01	kg/hour	
	Loader	8.82E-03	kg/tonne	29.77
	padfoot roller	2.13E-01	kg/hour	
	Bulldozer	2.13E-01	kg/hour	
11 to 17	25t excavator	4.46E-05	kg/tonne	1.56
	screen	2.70E-03	kg/tonne	94.77
	loader	8.82E-03	kg/tonne	309.63
	padfoot roller	2.13E-01	kg/hour	
20	25t excavator	4.46E-05	kg/tonne	0.08
	25t excavator	4.46E-05	kg/tonne	0.04
	25t excavator	4.46E-05	kg/tonne	0.08
21, 22	25t excavator	2.94E-02	kg/tonne	66.16
	25t excavator	8.82E-03	kg/tonne	36.84
23	25t excavator	4.46E-05	kg/tonne	0.06
	25t excavator	4.46E-05	kg/tonne	0.21
	25t excavator	4.46E-05	kg/tonne	0.07
24	25t excavator	4.46E-05	kg/tonne	0.06
	25t excavator	4.46E-05	kg/tonne	0.21
	25t excavator	4.46E-05	kg/tonne	0.07
	25t excavator	4.46E-05	kg/tonne	0.07
25, 26	25t excavator	4.46E-05	kg/tonne	0.11
27	25t excavator	4.46E-05	kg/tonne	0.06
	25t excavator	4.46E-05	kg/tonne	0.06
	25t excavator	4.46E-05	kg/tonne	0.06
	25t excavator	4.46E-05	kg/tonne	0.01
48, 49	crusher	1.25E-02	kg/tonne	180.00
	Loader	2.94E-02	kg/tonne	423.42
	25t excavator	1.49E-04	kg/tonne	0.01
	25t excavator	1.49E-04	kg/tonne	0.08

Week	Equipment/Activity	Emission factor	Unit	TSP Emission (kg)
	Loader	2.94E-02	kg/tonne	7.94
	Wind erosion	0.4 kg/ha/hr	kg/hour	
			kg/hour	
	Loader	2.94E-02	kg/tonne	7.94
	padfoot roller	2.13E-01	kg/hour	
	Bulldozer	2.13E-01	kg/hour	
13 to 38	Loader	2.94E-02	kg/tonne	1296.73
1-50	Wind erosion	0.4	kg/ha/hour	1051.20
Annual TSP Emission Rate (kg/annum)				**3,556.56**

Table 5.2: Estimated volatile emissions (g/s), as modelled

Chemical	S1	S8	S9	S12	S16	S26	S25	ECS	DTD
Hexachlorobenzene	2.56E-05	3.41E-05	3.41E-05	3.55E-05	2.25E-05	1.93E-05	2.56E-05	1.02E-06	1.85E-06
1,2-dichloroethane (EDC)	0.00E+00	6.89E-04	6.89E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.83E-04	4.86E-06
Chloroform	0.00E+00	8.64E-04	8.64E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.19E-04	8.47E-07
Carbon tetrachloride	0.00E+00	3.87E-03	3.87E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E-03	2.28E-06
TCE	0.00E+00	2.03E-02	2.03E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.42E-03	1.44E-05
PCE	5.37E-03	4.45E-03	4.45E-03	6.39E-03	5.06E-03	4.74E-03	5.37E-03	2.61E-04	6.22E-07
Chlorobenzene	1.28E-02	1.43E-02	1.43E-02	1.67E-02	1.16E-02	1.04E-02	1.28E-02	1.33E-03	1.39E-05
Benzene	2.14E-04	2.25E-04	2.25E-04	2.73E-04	1.96E-04	1.77E-04	2.14E-04	1.00E-05	5.25E-08
Toluene	2.96E-03	3.11E-03	3.11E-03	3.78E-03	2.70E-03	2.44E-03	2.96E-03	1.38E-04	8.65E-07
Xylenes	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E-04	9.72E-07
1,4-Dichlorobenzene	3.81E-04	4.37E-04	4.37E-04	5.01E-04	3.44E-04	3.05E-04	3.81E-04	4.63E-04	8.17E-06
1,2,3-trichloropropane	2.44E-05	2.96E-05	2.96E-05	3.27E-05	2.18E-05	1.91E-05	2.44E-05	1.05E-06	3.31E-08
BHC (lindane)	2.61E-04	3.48E-04	3.48E-04	3.63E-04	2.30E-04	1.97E-04	2.61E-04	8.01E-06	4.09E-05
Dieldrin	8.95E-06	1.19E-05	1.19E-05	1.24E-05	7.87E-06	6.75E-06	8.95E-06	3.10E-07	2.82E-06
DDX	2.12E-04	2.83E-04	2.83E-04	2.94E-04	1.86E-04	1.59E-04	2.12E-04	7.39E-06	6.55E-04
endosulfan II	3.07E-05	4.10E-05	4.10E-05	4.26E-05	2.70E-05	2.31E-05	3.07E-05	1.20E-06	9.17E-05
mercury (total organic)	3.17E-05	3.61E-05	3.61E-05	4.16E-05	2.87E-05	2.55E-05	3.17E-05	1.44E-06	4.18E-03
Naphthalene	2.76E-06	3.55E-06	3.55E-06	3.78E-06	2.44E-06	2.11E-06	2.76E-06	1.13E-07	1.07E-08
Benzo(a)pyrene – TEQ	3.87E-08	5.18E-08	5.18E-08	5.39E-08	3.41E-08	2.92E-08	3.87E-08	1.09E-09	4.86E-08
1,1-Dichloroethane (11DCA)	0.00E+00	2.42E-04	2.42E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.26E-05	1.82E-07
1,1-Dichloroethylene (11DCE)	0.00E+00	2.70E-04	2.70E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.41E-05	9.82E-08
cis-1,2-Dichloroethylene (12DCE)	0.00E+00	5.85E-04	5.85E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E-04	5.44E-07
1,1,1-Trichloroethane (111TCA)	0.00E+00	4.62E-03	4.62E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.28E-03	2.30E-06
Vinyl Chloride	6.45E-03	5.28E-03	5.28E-03	7.64E-03	6.08E-03	5.70E-03	6.45E-03	2.81E-04	3.31E-07

5.2.3 Other Emissions from DTD

Thiess has provided emissions data for pollutants (other than the organic vapours) from the DTD plant. **Table 5.3** outlines these emission rates for the DTD. The emission rates are conservative because they are 100 percentile concentrations that would not be exceeded under normal operating conditions.

Note that mercury emissions from the DTD plant that were applied in the modelling, as presented in **Table 5.2,** are based on processing the hot spot soils containing the highest concentrations of mercury. The modelled concentration rate for mercury was 258 µg/m³ and the ground level concentrations presented in this assessment are based on that emission rate. However, the proponent will blend the high concentration soils prior to processing, and this would ensure that an in-stack concentration limit for mercury would not exceed 200 µg/m³, as presented in **Table 5.3**.

Table 5.3: Stack Emissions for pollutants related to DTD operation

Pollutant	Stack concentration (mg/m³)	Emission rate (g/s)
Sulphuric acid mist (H_2SO_4), sulphur trioxide (SO_3), or both (as SO_3)	100	1.62
Chlorine	200	3.24
Hydrogen chloride (HCl)	100	1.62
Any fluorine compound (HF)	50	0.81
Nitrogen dioxide (NO_2) or nitric oxide (NO), or both as NO_2	350	5.67
Hazardous subs. Types 1 and 2	1	1.62E-02
Cadmium	0.2	3.24E-03
Mercury	0.2	3.24E-03
Solid particles	50	0.81
Dioxins and furans at 11% O_2	0.0001	1.62E-09
Carbon monoxide	125	2.02

5.3 Stack Parameters

The DTD plant includes a range of treatment technology and pollution control equipment before the air is exhausted via a stack to atmosphere. The design of the DTD treatment plant proposed for the Project is outlined in detail in the RAP **(AECOM, 2010)**. Because the remediation project has not been tendered, a conservative approach was taken in the modelling that would allow either of two locally available DTD plants to be used for the project. Thus the modelling applied the lower stack height in combination with the larger gas flow and lower gas temperature to ensure the maximum glcs are presented in the analysis.

The FSB also includes an ECS, which consists of parallel trains of lead and lag, coarse and fine dust filters and carbon beds.

Each treatment process for air emissions eventually releases to atmosphere via stacks. The stack parameters used in the modelling are provided in **Table 5.4**.

Table 5.4: Stack parameters used in dispersion modelling

Stack Parameters	Units	DTD	FSB ECS
Stack Location (MGA)	(mE, mN)	[314209.7, 6249344]	[314224, 6249396]
Ground Elevation	(m)	33	35
Stack Height above Ground Level	(m)	14.9 (30)[1]	21.5
Diameter	(m)	1.2	1.3
Exit Velocity	(m/s)	18.3	15
Exit Temp	(°C)	60	20

1. The predicted GLCs for the majority of pollutants in this study are shown for 14.9m high stack. Where pollutants showed an exceedance with a 14.9m stack, they were remodelled with a 30m stack height.

Initial modelling was performed with a 14.9m DTD stack height (to provide the most conservative assessment of air quality impacts). This is the lowest stack height of locally available DTD plants. Predictions for some pollutants in this study showed exceedance of the air quality criteria for a 14.9m high DTD stack. Where this occurred the stack was remodelled at 30m height above ground level. Clearly the stack cannot be different heights for different pollutants, therefore the 30m height would be required, unless the values for emissions of those exceeding pollutants can be proven to be lower/less conservative than the values used in this assessment. Further dispersion modelling would be required to assess potential impacts for lower emissions of these pollutants if it is determined that lower emissions data are valid and a lower stack than 30m is to be proposed.

6 EXISTING ENVIRONMENT

6.1 Meteorology

Table 6.1 presents the temperature, wind speed and rainfall data from the Bankstown Airport Station (**Bureau of Meteorology, 2010**). Temperature and wind speed data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures.

Table 6.1: Climate statistics for Bankstown Airport

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Mean maximum temperature (°C)	26.4	26.3	25.2	22.9	20	17.6	17	18.3	20.5	22.5	24	25.7	22.2
Mean minimum temperature (°C)	18.8	19	17.5	14.1	10.9	8.6	7.1	8.1	10.3	13.1	15.3	17.5	13.4
Rainfall													
Mean rainfall (mm)	95	114	114	105	101	121	69	77	61	71	80	73	1082
Mean number of rain days	11.2	11.5	12.3	10.9	11.1	11.2	9.2	9.2	9.3	10.7	11.4	10.5	128.5
9 am conditions													
Mean 9am temperature (°C)	22.4	22.3	21.1	18.2	14.6	11.9	10.7	12.5	15.6	18.4	19.9	21.6	17.4
Mean 9am wind speed (km/h)	14.4	13.8	12.9	12.9	12.6	13.4	13.2	14.3	15.4	16.3	16	14.8	14.2
3 pm conditions													
Mean 3pm temperature (°C)	24.8	24.8	23.9	21.7	19	16.6	16.1	17.2	19	20.7	22.1	23.9	20.8
Mean 3pm wind speed (km/h)	24.1	23	21	19.3	17.1	17.8	18.1	20.7	23.1	24.6	25.3	25.2	21.6

The annual average maximum and minimum temperatures experienced at Bankstown are 22.2°C and 13.4°C respectively. On average January is the hottest month with an average maximum temperature of 26.4°C. July is the coldest month, with average minimum temperature of 7.1°C. Rainfall data collected at Bankstown show that June is the wettest month, with an average rainfall of 121 mm.

6.2 Existing Air Quality

The DECCW's air quality criteria refer to pollutant levels which include the contribution from specific projects and existing sources. To fully assess impacts against all the relevant air quality criteria, it is necessary to have information or estimates on existing pollutant concentrations in the area in which the Project is likely to contribute to these levels. This section discusses monitoring data available in the study area.

DECCW measures NO_2, PM_{10}, SO_2 and CO concentrations at Chullora, approximately 6 km east of the proposed location. **Table 6.2** presents the measured available pollutant concentrations for the 2008 and 2009 monitoring periods **(DECCW, 2008)** (**DECCW, 2009)**. Due to several dust storms in 2009 monitoring period, PM_{10} monitoring data for 2009 monitoring period are not suitable to use in cumulative assessment. Therefore PM_{10} monitoring data for 2008 period have been used in this assessment. Analysis of extreme weather conditions for 2008 shows that higher wind speeds (>90 km/hour) were observed on 26th June and 1st July 2008, resulting relatively higher 24-hour average PM_{10} concentrations. Data for these two days have been excluded in estimating background concentration of 24-hour average PM_{10}.

Table 6.2: Background concentration at Chullora monitoring station

Pollutant	Averaging Period	Unit	DECCW Criteria	Background Concentration
Sulfur dioxide (SO_2)	10 minutes	µg/m³	**712**	118.6
	1 hour	µg/m³	**570**	82.9
	24 hour	µg/m³	**228**	13.0
	Annual	µg/m³	**60**	2.3
Nitrogen dioxide (NO_2)	1 hour	µg/m³	**246**	106.8
	Annual	µg/m³	**62**	23.9
Particulate Matter (PM_{10})[1]	24 hour	µg/m³	**50**	39.1
	Annual	µg/m³	**30**	19.5
Carbon monoxide (CO)	15 minute	mg/m³	**100**	5.4
	1 hour	mg/m³	**30**	3.8
	8 hours	mg/m³	**10**	2.6

[1]Background concentration shown for 2008. Data for 2009 is not suitable due to severe dust storm events

Data converted from pphm to µg/m³ for NO_2 and SO_2 and ppm to mg/m³ for CO

7 AIR DISPERSION MODELLING

7.1 Dispersion Model Used

The AUSPLUME model was chosen to perform dispersion modelling for this assessment. AUSPLUME v.6.0 or later is the approved dispersion model for use in most simple, near-field applications in NSW, where coastal effects and complex terrain are of no concern. AUSPLUME is a Gaussian plume model, based on the assumption that cross-sections through elevated plumes from point sources of pollution have a Gaussian (or normal) distribution of concentration. AUSPLUME is also a steady-state model, which assumes the atmosphere is in a state of uniform flow, and wind velocity is a function of height alone and does not vary with direction. The mathematical basis of AUSPLUME is the Victorian EPA's Plume Calculation Procedure **(EPA Victoria 1985)**, which itself is an extension of the ISC model of Bowers et al. (1979).

7.2 Meteorology

7.2.1 Wind speed

Since no onsite data is available, a long term meteorological data analysis has been carried out to select the modelling year. **Figure 7.1** presents a comparison of average wind speed of six consecutive years (2004 – 2009) with the long term average wind speed. It can be observed from **Figure 7.1** that average wind speed data for calendar year 2008 fitted best with long term average wind speed. Other years shows relatively higher wind speed in several months. This may result in relatively lower predicted concentration at sensitive receptor locations. Therefore meteorological data for 2008 calendar year has been selected for this study as a conservative approach.

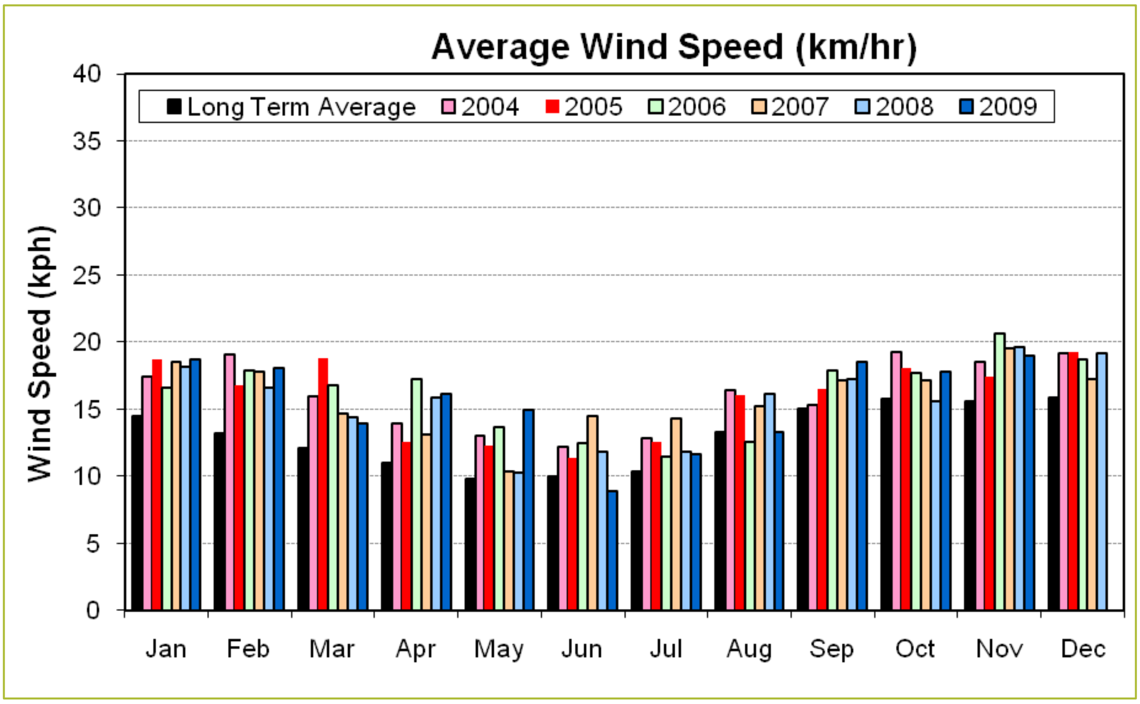


Figure 7.1: Long term average wind speed analysis

The frequency distribution of hourly averaged wind speed values is shown in **Figure 7.2**. Light wind speeds (up to 2 m/s) are relatively frequent and occur approximately 33% of the time. Strong winds (greater than 6 m/s) occur approximately 14% of the time.

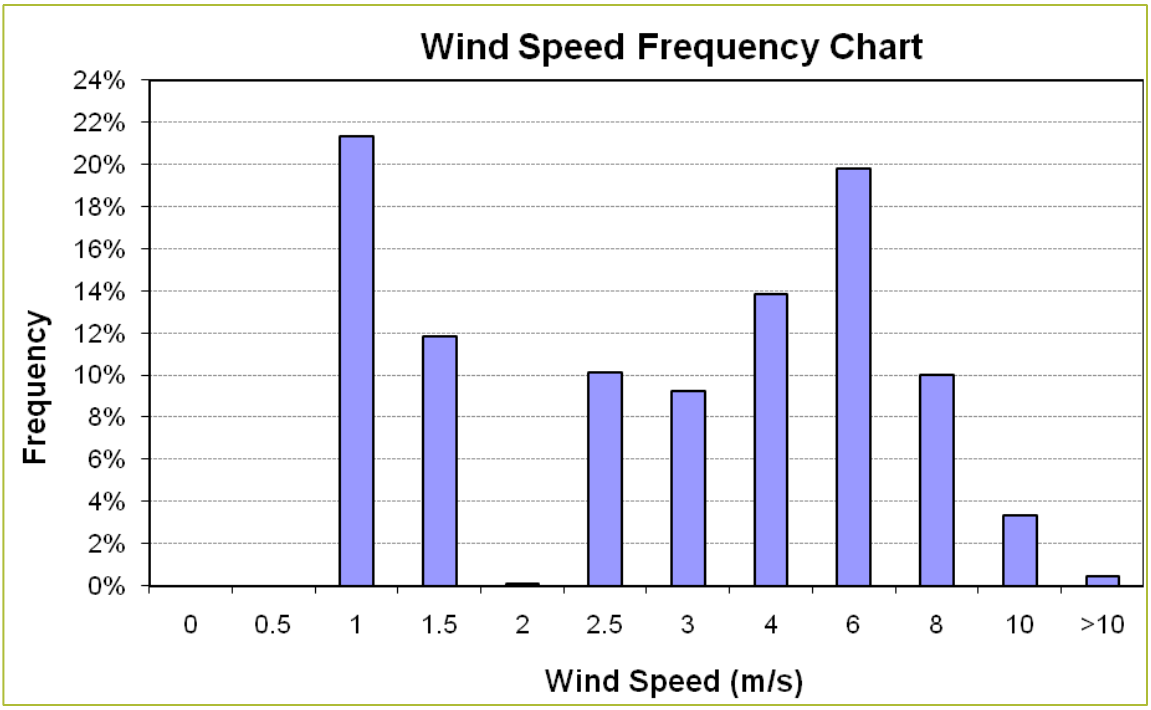


Figure 7.2: Wind Speed Distribution for 2008

7.2.2 Wind direction

Wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points – N, NNE, NE, etc. The bar at the top of each wind rose diagram represents winds blowing from the north (i.e. northerly winds), and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the widths of the bar sections correspond to wind speed categories, the narrowest representing the lightest winds. Thus it is possible to visualize how often winds of a certain direction and strength occur over a long period, either for all hours of the day, or for particular periods during the day.

The diurnal wind roses are shown in **Figure 7.3**. On annual basis winds from south and west are predominant. In autumn winds are predominantly from west. In summer winds from south and east-southeast and in winter winds from west are most common. In spring winds from north are predominant.

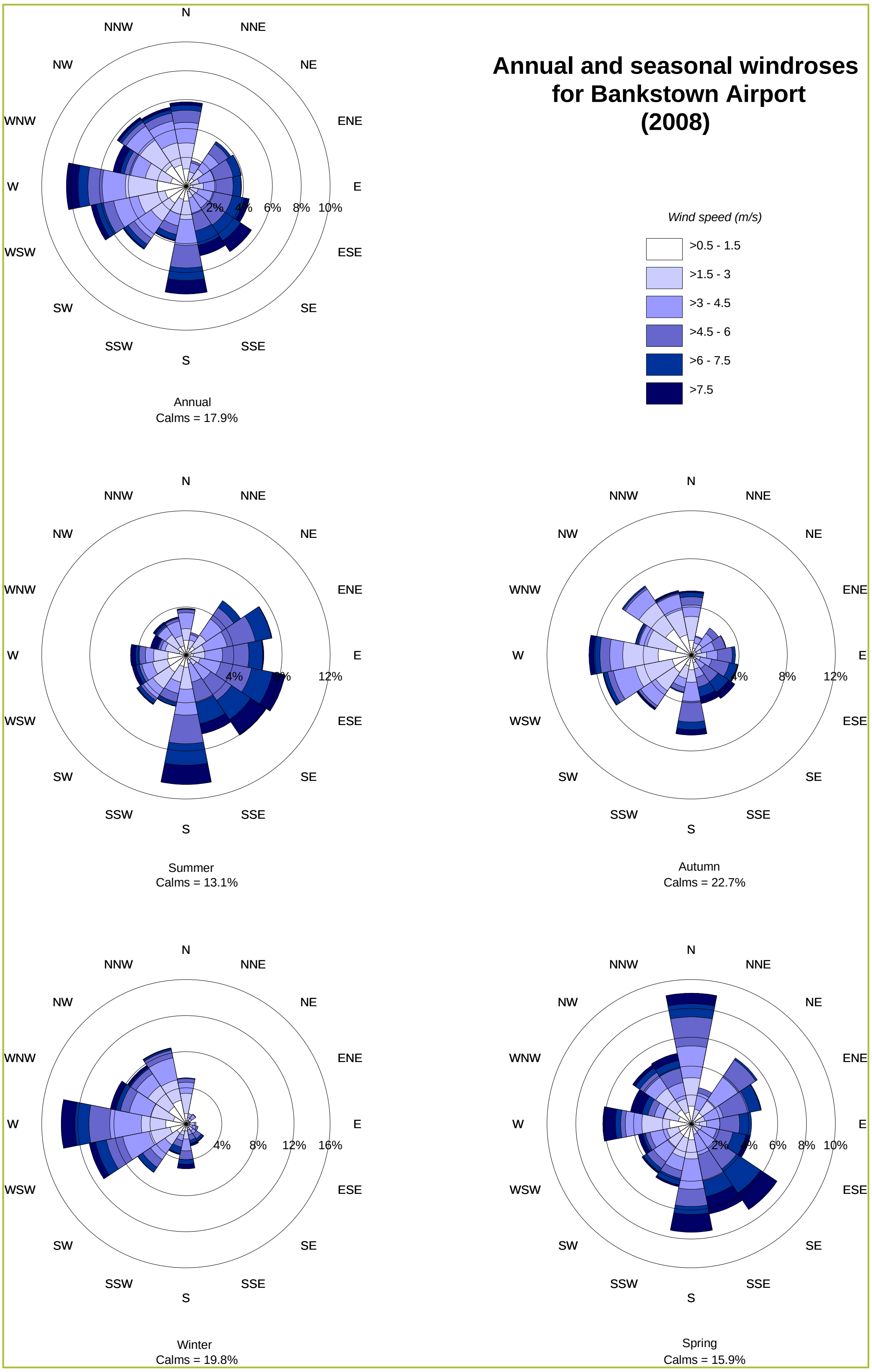


Figure 7.3: Annual and seasonal wind roses (Bankstown Airport, 2008)

7.2.3 Atmospheric Stability

Atmospheric turbulence is an important factor in plume dispersion. Turbulence acts to increase the cross-sectional area of the plume due to random motions, thus diluting or diffusing a plume. As turbulence increases, the rate of plume dilution or diffusion increases. Weak turbulence limits plume diffusion and is a critical factor in causing high plume concentrations downwind of a source, particularly when combined with very low wind speeds.

Turbulence is related to the vertical temperature gradient, the condition of which determines what is known as stability, or thermal stability. For traditional dispersion modelling using Gaussian plume models, categories of atmospheric stability are used in conjunction with other meteorological data to describe atmospheric conditions and thus dispersion.

The most well-known stability classification is the Pasquill-Gifford scheme, which denotes stability classes from A to F. Class A is described as highly unstable and occurs in association with strong surface heating and light winds, leading to intense convective turbulence and much enhanced plume dilution.

At the other extreme, class F denotes very stable conditions associated with strong temperature inversions and light winds, which commonly occur under clear skies at night and in the early morning. Under these conditions plumes can remain relatively undiluted for considerable distances downwind.

Intermediate stability classes grade from moderately unstable (B), through neutral (D) to slightly stable (E). Whilst classes A and F are strongly associated with clear skies, class D is linked to windy and/or cloudy weather, and short periods around sunset and sunrise when surface heating or cooling is small.

As a general rule, unstable (or convective) conditions dominate during the daytime and stable flows are dominant at night. This diurnal pattern is most pronounced when there is relatively little cloud cover and light to moderate winds.

The frequency distribution of estimated stability classes in the meteorological file is presented in **Figure 7.4**. The data show a total of 46% of hours with either E or F stability class.

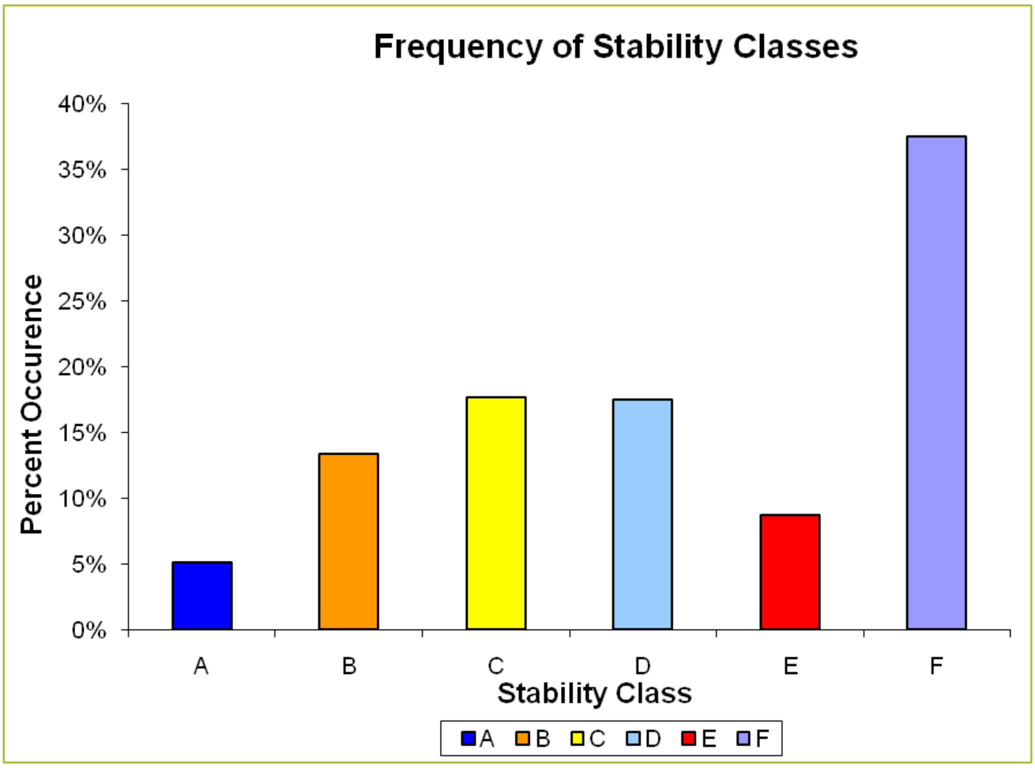


Figure 7.4: Frequency distribution of stability classes

8 AIR QUALITY ASSESSMENT

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

- Category 1 includes the criteria air pollutants, i.e. SO_2, CO, NO_2, PM_{10}, HF and TSP;
- Category 2 includes pollutants specified as toxic air pollutants; and
- Category 3 includes pollutants that were modelled but are not specified in the Approved Methods in categories one or two above.

8.1 Category 1 Pollutants

The assessment criteria for Category 1 pollutants are applicable at the nearest existing or likely off-site sensitive receptors (**DEC, 2005**). **Figure 8.1** shows the location of surrounding offsite sensitive receptors. Predicted incremental concentrations due to the proposed Project at offsite sensitive receptor locations are presented in **Table 8.1**. Contour plots for the project increment for Category 1 pollutants are presented in **Appendix A**. Cumulative impact of the criteria pollutants are presented in the following sections.

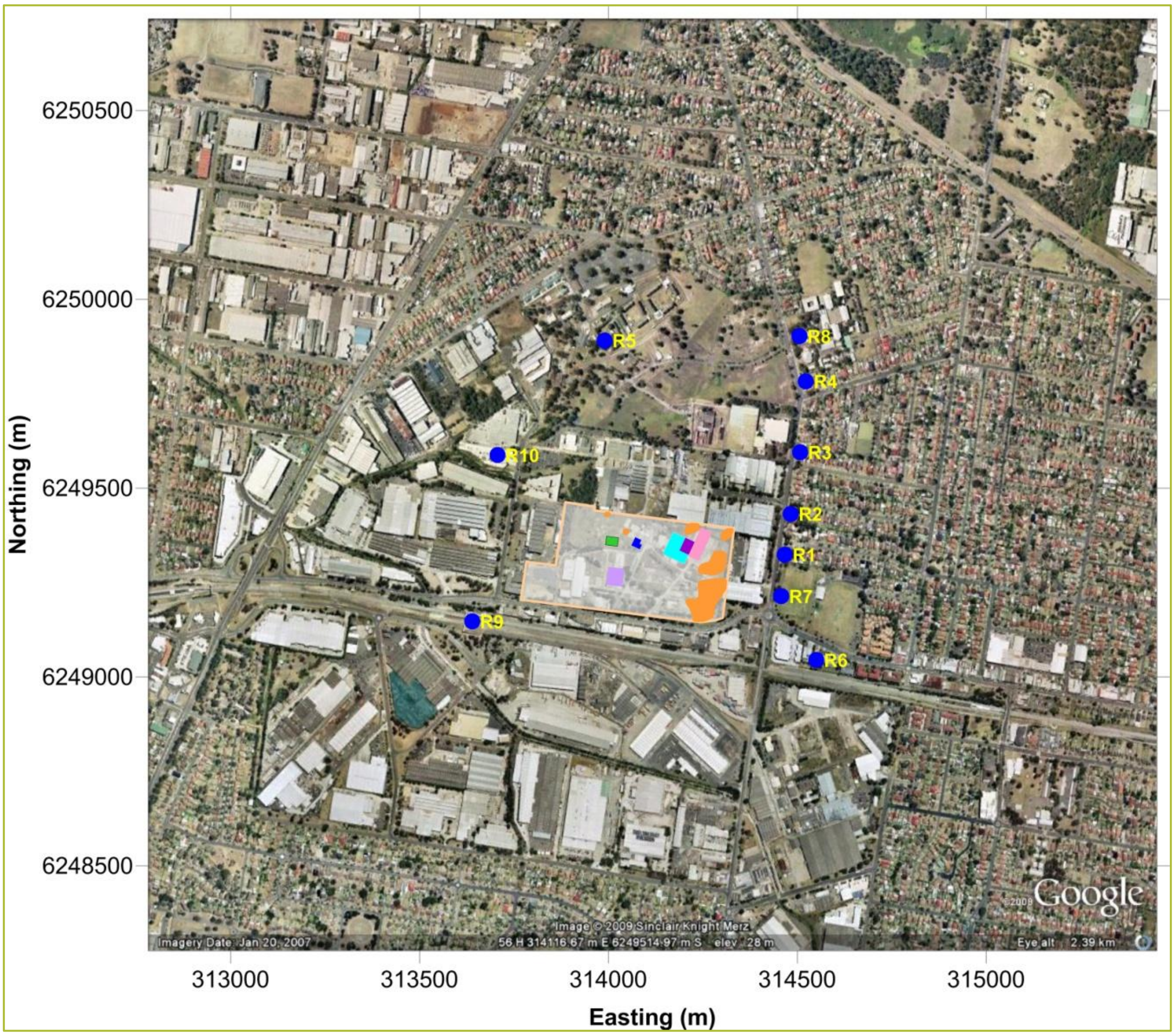


Figure 8.1: Location of surrounding sensitive receptors

Table 8.1: Predicted concentration of Category 1 pollutants at surrounding sensitive receptors from the Project

ID				R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Pollutant	Averaging Period	Unit	DECCW Criteria	Residence at Miller Road	Residence at Miller Road	Residence at Miller Road	Residence at Miller Road	Villawood Detention Centre	Residence at Waldron Road	Abbott Park	Wentworthville Evening College	Leightonfield Train Station	A La Turko Food Industries
SO_2	10 minutes	µg/m³	**712**	140	162	118	55	53	64	91	31	22	31
	1-hour	µg/m³	**570**	98	113	83	39	37	45	64	22	16	22
	24-hours	µg/m³	**228**	37	40	28	8.8	11	11	22	5.4	3.8	7.7
	Annual	µg/m³	**60**	2.7	2.7	1.8	0.91	0.95	1.1	2.0	0.68	0.50	0.72
NO_2	1-hour	µg/m³	**246**	118	100	92	77	68	89	131	57	55	61
	Annual	µg/m³	**62**	4.0	4.0	3.0	2.1	2.4	2.5	3.5	1.7	1.6	2.1
CO	15 minutes	mg/m³	**100**	0.16	0.19	0.14	0.06	0.06	0.07	0.10	0.04	0.03	0.04
	1-hour	mg/m³	**30**	0.12	0.14	0.10	0.05	0.05	0.06	0.08	0.03	0.02	0.03
	8-hour	mg/m³	**10**	0.07	0.07	0.05	0.02	0.02	0.02	0.05	0.01	0.01	0.02
HF[1]	24-hours	µg/m³	**2.9**	1.3	1.5	1.4	1.3	1.5	0.97	1.0	1.4	0.72	1.1
	7 days	µg/m³	**1.7**	0.74	0.86	0.54	0.44	0.57	0.53	0.59	0.43	0.40	0.62
	30 days	µg/m³	**0.84**	0.44	0.39	0.29	0.22	0.31	0.51	0.49	0.23	0.25	0.33
	90 days	µg/m³	**0.5**	0.34	0.39	0.33	0.23	0.26	0.31	0.31	0.20	0.18	0.24
PM_{10}[1]	24-hour	µg/m³	**50**	5.9	4.6	4.1	2.3	2.2	3.7	6.2	2.0	1.3	1.9
	Annual	µg/m³	**30**	1.2	0.91	0.54	0.33	0.28	0.52	1.1	0.27	0.19	0.23
TSP[1]	Annual	µg/m³	**90**	1.2	0.79	0.35	0.16	0.10	0.33	1.1	0.12	0.09	0.10
Dust deposition	Annual	g/m²/month	**2**	0.10	0.06	0.02	0.01	0.01	0.02	0.08	0.01	0.01	0.02

[1]HF, PM_{10} and TSP results are based on a 30m stack assumption.

Preliminary assessment with initial proposed DTD plant stack parameters (shown in **Table 5.4**) predicted exceedance of HF and PM_{10} criteria at surrounding offsite sensitive receptors shown in **Figure 8.1**. Based on further communication with Thiess the stack height for the DTD plant was increased from 14.9 m to 30 m to test the potential impact at surrounding offsite sensitive receptors for these pollutants with a 30 m stack.

Predicted concentrations for HF, PM_{10} and TSP presented in **Table 8.1** are based on stack height of 30 m. Other stack parameters were held constant in this study.

If further assessment confirms that the concentrations of HF, PM_{10} and TSP in the DTD plant exhaust, are lower than the values used in this assessment, then it may be possible that the DTD plant could use a 14.9 m stack for the remediation. However, a modelling assessment would be required to assess potential impacts of these pollutants at a lower stack concentration if it were proposed to use a lower DTD plant stack height than 30m.

8.1.1 Sulfur dioxide (SO_2)

Table 8.2 presents the predicted maximum SO_2 concentrations (project increment and cumulative) for the offsite sensitive receptors **(Figure 8.1)**. These results show that predicted concentrations comply with DECCW criteria for SO_2 for all averaging periods.

Table 8.2: Maximum predicted ground level SO_2 concentrations at any offsite sensitive receptors (µg/m³)

Averaging Period	DECCW Criteria	Background	Project Increment	Cumulative Impact
10 minutes	**712**	119	162	281
1-hour	**570**	83	113	196
24-hours	**228**	13	40	53
Annual	**60**	2.3	2.7	5.0

8.1.2 Nitrogen dioxide (NO_2)

Table 8.3 presents predicted maximum NO_2 concentrations (project increment and cumulative) at any offsite sensitive receptors **(Figure 8.1)**. These results show that predicted concentrations comply with DECCW criteria for NO_2 for both 1-hour and annual averaging period.

Table 8.3: Maximum predicted ground level NO_2 concentrations at any offsite sensitive receptors (µg/m³)

Averaging Period	DECCW Criteria	Background	Project Increment	Cumulative Impact
1-hour	**246**	107	131	237
Annual	**62**	24	4.0	28

8.1.3 Carbon monoxide (CO)

Table 8.4 presents predicted maximum CO concentrations (Project increment and Cumulative) at any offsite sensitive receptors **(Figure 8.1)**. These results show that predicted concentrations comply with DECCW criteria for CO for all averaging period.

Table 8.4: Maximum predicted ground level CO concentrations at any offsite sensitive receptors (µg/m³)

Averaging Period	DECCW Criteria	Background	Project Increment	Cumulative Impact
15 minutes	**100,000**	119	162	280
1-hour	**30,000**	83	113	196
24-hours	**10,000**	13	40	53

8.1.4 Hydrogen Fluoride (HF)

Since no background data are available, cumulative assessment has not been conducted for HF. However, it can be assumed that the ambient HF concentration will be minimal. Based on this assumption and results presented in **Table 8.1** it can be concluded that the project will comply with DECCW criteria for HF for all averaging periods.

8.1.5 Particulate Matter

Table 8.5 presents predicted maximum PM_{10} and TSP concentrations (project increment and cumulative) at offsite sensitive receptors **(Figure 8.1)**. These results show that predicted concentrations comply with DECCW criteria for both PM_{10} and TSP.

Table 8.5: Maximum predicted ground level PM_{10} concentrations at any offsite sensitive receptors (µg/m³)

Parameter	Averaging Period	DECCW Criteria	Background	Project Increment	Cumulative Impact
PM_{10}	24-hour	**50**	39	6.2	45.3
	Annual	**30**	20	1.2	21
TSP	Annual	**90**	49.9[1]	1.1	51

[1]Background TSP concentrations are calculated from background PM_{10} concentration assuming 39% of TSP is PM_{10}

8.2 Category 2 Pollutants

The impact assessment criteria for individual toxic air pollutants are applicable at and beyond the boundary of the facility. The incremental impact (99.9th percentile, Level 2 assessment) for each pollutant due to the proposed operations at any offsite locations are presented in **Table 8.6.** Contour plots for the project increment for Category 2 pollutants are presented in **Appendix B**.

It is noted that soil sampling data provided by Thiess indicates several mercury hotspots in Zone 7 and none of the other zones indicated the presence of mercury. As a conservative approach it has been assumed that all of the mercury emissions from the proposed Project will be organic mercury. Model predictions for a 14.9 m stack show exceedance of DECCW criteria for organic mercury at offsite locations. Further modelling was conducted with a 30 m stack and offsite mercury concentrations due to the Project are presented in **Table 8.6**.

Mercury emissions from the excavation activities in zone 7 have also been modelled separately to find the maximum soil mercury concentrations that could be excavated while the DTD stack is operating. The results of that assessment indicate that predicted cumulative impacts (i.e. emissions from DTD plant, FSB ECS and excavation activities) would comply with DECCW criteria for organic mercury if soil mercury concentrations are at or below 25 mg/kg.

Further modelling would be required to establish the maximum concentration of mercury in soil that could be excavated without full engineering controls if the DTD plant was not operating or not processing mercury contaminated soil. In the case that the concentration of mercury in soil was above that which may be safely excavated without full engineering controls, an excavation building with ECS similar to the FSB) would be used to control emissions during excavation.

In terms of complying with the DTD plant mercury stack emission limit and subject to the outcome of commissioning trials, the mercury contaminated soil would either be blended with other contaminated soil (not containing mercury);,or if the stack standard could not be met it would be stabilised and landfilled.

Table 8.6 shows that the predicted offsite ground level concentrations comply with DECCW criteria for each pollutant (except 'mercury' and 'dioxins and furans' when the DTD plant stack height is 14.9 m). However, if the proposed DTD plant stack height is increased to 30 m, then both mercury and dioxins and furans would also comply with DECCW criteria.

In future, if further soil analysis for zone 7 is conducted and mercury concentrations in the soil are proven to be lower than the indicated "hotspot" concentrations, then it is possible that the DTD plant could use a 14.9 m stack for the remediation. However, a model run would be required to assess potential mercury impacts at a lower feed soil concentration if it were proposed to use a lower stack than 30m.

Table 8.6: Predicted maximum offsite concentrations for toxic air pollutants (listed in DECCW guideline)

Pollutants	Unit	DECCW Criteria	Maximum Offsite concentration
CCl_4	mg/m³	0.012	0.007
Chlorobenzene	mg/m³	0.1	0.034
Mercury (organic)	mg/m³	0.00018	3.0E-05
Benzene	mg/m³	0.029	5.5E-04
PAH	mg/m³	0.0004	1.0E-07
Chloroform	mg/m³	0.9	0.0016
EDC	mg/m³	0.07	0.0013
TCE	mg/m³	0.5	0.036
Toluene	mg/m³	0.36	0.008
Xylene	mg/m³	0.19	1.7E-05
1 2 DCE	mg/m³	14.4	0.001
1 1 1 TCA	mg/m³	12.5	0.0085
Vinyl Chloride	mg/m³	0.024	0.017
HCl	mg/m³	0.14	0.12
Dioxins and Furans	mg/m³	2.0E-09	1.9E-09

8.3 Category 3 Pollutants

These pollutants do not have defined DECCW criteria for air quality assessment. Therefore, assessment of these pollutants has been conducted using the guideline for toxic air pollutants (Level 2 Assessment). The predicted 99.9th percentile offsite concentrations for these pollutants are listed in **Table 8.7.** Contour plots for the project increment for Category 3 pollutants are presented in **Appendix C**.

Note that all pollutants that were assessed in this study and do not have applicable air quality assessment criteria, have been assessed by GHD in the AHRA **(GHD, 2010)**.

Table 8.7: Predicted maximum offsite concentrations for toxic air pollutants (not listed in DECCW guideline)

Pollutants	Unit	Maximum Offsite concentration
DDX	mg/m³	5.50E-04
Napthalene	mg/m³	7.0E-06
PCE	mg/m³	0.015
Endosulfan	mg/m³	8.0E-05
Dichlorobenzene	mg/m³	0.001
Dieldrin	mg/m³	2.4E-05
HCB	mg/m³	6.5E-05
Trichlorobenzene	mg/m³	6.5E-05
BHC	mg/m³	6.5E-04
1,1 DCA	mg/m³	4.4E-04
1,1 DCE	mg/m³	5.0E-04

9 ODOUR ASSESSMENT

The modelling results for the compounds that are included in the odour assessment are provided for maximum 1-hour average concentrations. A peak-to-mean ratio of six was applied to each maximum predicted GLC, i.e. at any point, which is generally on the Project 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 9.1**. This ratio applies to tall wake free point sources and is a conservative approximation for volume, area and low stacks.

Table 9.1: Predicted Peak Concentrations of Volatile Chlorinated Organic Compounds

Pollutant	Maximum 1-Hour GLC (mg/m³)	Peak GLC (µg/m³)	Mean Odour Threshold (mg/m³)	Odour Concentration (Max GLC / Mean Threshold)
Carbon Tetrachloride	3.54E-02	2.12E-01	1380.5	1.54E-04
Chlorobenzene	1.31E-01	7.84E-01	6.6	1.19E-01
Napthalene	3.00E-05	1.80E-04	2.1	8.65E-05
Benzene	2.08E-03	1.25E-02	106.6	1.17E-04
PCE	5.36E-02	3.22E-01	32.0	1.01E-02
Chloroform	7.90E-03	4.74E-02	1582.2	3.00E-05
Dichlorobenzene	4.00E-03	2.40E-02	45.4	5.29E-04
TCE	1.86E-01	1.11E+00	25.0	1.51E-03
Toluene	2.86E-02	1.72E-01	0.5	4.02E-03
Xylene	1.80E-05	1.08E-04	317.7	3.51E-03
Total				**0.14**

There were 16 chlorinated organic compounds that were included in this study (the other volatile compounds are expected to have no odour potential, eg. Hg). Odour threshold limits were researched and identified for 10 of the 16 volatile chlorinated compounds that were considered in the study. No available literature quoted threshold levels for HCB, PCB, 111-TCA, 11-DCE, 12-DCA or trichloropropane. 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. The predicted peak GLCs were divided by the mean odour thresholds to give an approximation of the odour concentration (pseudo odour units).

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, for a mixture of odorants 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 odour strength is less than the sum. For the current results, simple addition should provide a reasonable approximation.

The total odour concentration resulting from this approach is 0.14 ou, which is well below the odour threshold. When average odour threshold values are applied to maximum predicted GLCs, the results indicate that off-site odours from these emissions are unlikely to be detectable. In addition, the odour threshold for most of these compounds is well above the health/Occupational Health and Safety (OHS) exposure limits, meaning compliance with the OHS/air quality limits would mean that odour is not likely to be an issue.

10 MITIGATION MEASURES

10.1 During Construction

The construction phase 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 FSB and the DTD plant, in order to minimise impacts as much as possible.

- Access to the site will be via existing sealed roadways wherever possible;
- Water will be used to suppress particles potentially generated during the erection of boundary fences, barriers and screens;
- Dust from 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, unless the time taken to cover the trucks would exceed the travel time to transport the material from the excavation face to the FSB enclosure;
- 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, especially during dry weather;
- Soil stockpiles will be damped as necessary to control dust;
- Soil stockpiles that will be inactive for extensive periods will be treated with surface binding agents or sealed by seeding or surfacing with vegetation or covered with secured tarpaulins as appropriate to control dust;
- Potentially dusty materials will be handled as little as possible;
- Traffic movements will use the network of existing pavements where possible;
- 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 Construction Environment Management Plan would be prepared for the construction phase, specifically addressing measures to be implemented to minimise off-site dust emissions.

10.2 During Operation

Emissions management and mitigation measures for fugitive emissions (including odour) and point sources have been considered in the design of the proposed remediation works.

The FSB is proposed to be completely enclosed and will operate so that air flows inwards through louvres and out of the building through the ECS. The ECS includes dust filters and activated carbon adsorption beds to control organic vapour emissions. Therefore, handling of contaminated material in the FSB will not generate significant emissions to atmosphere.

The proposed excavation of contaminated zones will include sampling and validation of contaminant concentrations in soil. Contaminated zones would be excavated with reference to the soil sampling validation data to ensure that excavation rates do not cause volatile organic emissions that result in unacceptable air quality and/or health risks. For example, where there is a known contaminated hotspot, iterative dispersion modelling has been used to determine the maximum excavation rate for respective contaminated soil concentrations. When the validation data confirms the in-situ pollutant soil concentrations, a maximum excavation rate can be derived that would meet the air quality and health risk criteria based on modelling. If higher than expected soil concentrations are encountered, then the excavation rate for the delineated area for those soil validation results, can be slowed significantly to manage volatile organic vapour emissions (this principle is also effective for reducing odour, if it is encountered). In extreme cases, the excavation area could be enclosed in a temporary structure and captured air from within the temporary structure could be vented to the FSB where it would be treated by the FSB ECS.

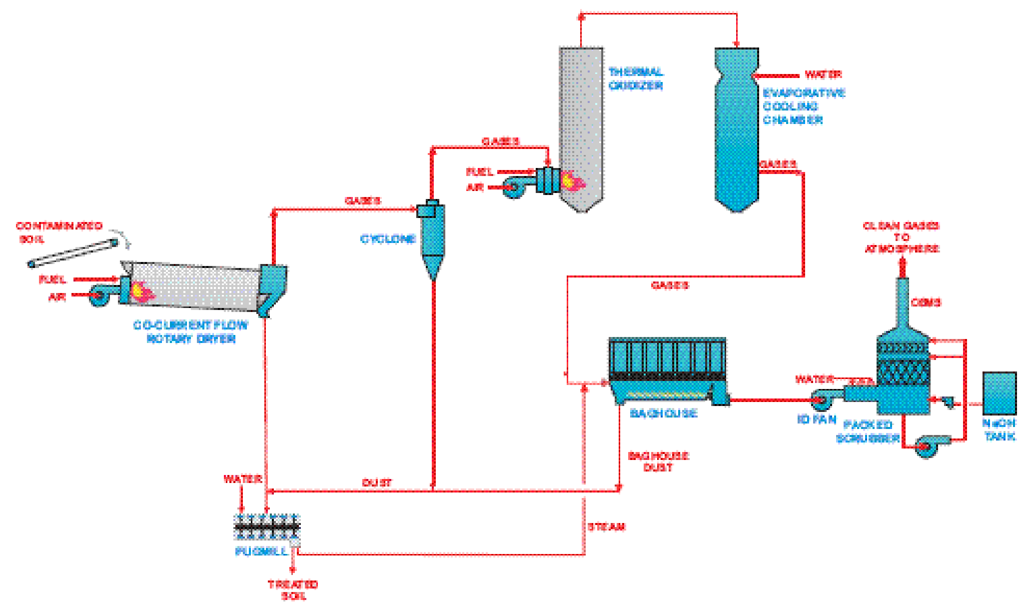
Emissions from the DTD plant are treated by a series of emissions control equipment prior to release to atmosphere. This includes a:

- 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 organic compounds.
- Evaporative cooler – the gas exiting the thermal oxidiser is partially quenched in a partly refractory lined evaporative cooler to minimize dioxin reformation and prepare the emissions for the baghouse, and the gas is maintained above the temperature required to condense 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 become known once commissioning

trials have been completed, and the mercury hotspot on the site has been evaluated, however 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 pipe quench and packed scrubber, which neutralises acid gases (i.e. HCl and SO_2).
- Stack- The scrubber gas exhausts to the stack.

Figure 10.1 shows the DTD plant emission control equipment as a schematic diagram.



Source: Thiess

Figure 10.1: DTD schematic diagram

The thermal oxidiser (being the major piece of emission control equipment) will be designed to meet the requirements of best practice technology 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.

11 MONITORING

A monitoring program would be designed for the FSB and DTD Plant stacks to include measurement of the exhaust gas temperature, flow rate, oxygen concentration (DTD Plant only) and moisture content in order to enable the calculation of pollutant emission rates corrected to dry conditions at specified O_2 contents as per agreed standards.

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, if required, to ensure that fugitive emissions are controlled and unacceptable impacts are not experienced off-site.

12 CONCLUSIONS

No residual air quality impacts are expected from the proposed remediation works, provided that emission rates are kept below those used in this assessment. The plant will be designed and the remediation activities managed 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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