CLYDE TERMINAL CONVERSION PROJECT

APPENDIX C

AIR QUALITY IMPACT ASSESSMENT

Clyde Terminal Conversion Project
The Shell Company of Australia Ltd
06-Nov-2013

Air Quality Impact Assessment

Clyde Terminal Conversion Environmental Impact Statement

Air Quality Impact Assessment

Clyde Terminal Conversion Environmental Impact Statement

Client: The Shell Company of Australia Ltd

ABN: 46004610459

Prepared by

AECOM Australia Pty Ltd
17 Warabrook Boulevard, Warabrook NSW 2304, PO Box 73, Hunter Region MC NSW 2310, Australia
T +61 2 4911 4900 F +61 2 4911 4999 www.aecom.com
ABN 20 093 846 925

06-Nov-2013

Job No.: 60236231

AECOM in Australia and New Zealand is certified to the latest version of ISO9001, ISO14001, AS/NZS4801 and OHSAS18001.

Quality Information

Document Air Quality Impact Assessment

Ref 60236231

Date 06-Nov-2013

Prepared by Adam Plant and Kristen Clarke

Reviewed by David Rollings

Revision History

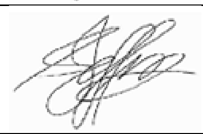
Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	29-Sep-2012	Draft for internal review	Renae Gifford Principal Scientist	
B	17-May-2013	Draft for client review	Ruth Baker Associate Director - Environment	
C	23-Aug-2013	Final Report for Regulatory Review	Scott Jeffries Associate Director - Environment	
D	06-Nov-2013	Final Report	Scott Jeffries Associate Director - Environment	

Table of Contents

List of Tables

List of Figures

Executive Summary

AECOM Australia Pty Ltd (AECOM) was commissioned by the Shell Company of Australia Ltd (Shell) to undertake an Air Quality Impact Assessment (AQIA) for the Clyde Terminal Conversion Project (the Project). The Project involves conversion of the Clyde Terminal for use solely as a finished fuels storage terminal. The AQIA was prepared as part of an Environmental Impact Statement (EIS) in accordance with Part 4 of the *Environmental Planning and Assessment Act 1979 (NSW)* (EP&A Act) to assess the potential air quality impacts associated with the Project.

The assessment investigated levels of volatile organic compounds (VOCs) from the proposed operations, as total VOCs and benzene. Historical complaint data suggest that odour is not a major issue of concern for the Clyde Terminal. Since refining operations ceased at the Clyde Terminal in late 2012 the total VOC emissions from the Clyde Terminal - the primary source of odour at the Project Area - are expected to have been reduced by greater than 80%. As a result odour is not expected to be a pollutant of concern for the Project and was excluded from the assessment.

Ground level concentrations of VOCs resulting from the operation of the Project were estimated using the CALPUFF dispersion model. Pollutant emission rates for benzene and total VOCs were estimated using the TANKS emissions estimation model and the physical properties and throughput volumes of the proposed storage tanks. The proposed demolition / construction components of the Project were also discussed and mitigation measures proposed.

The potential impacts of the Project on air quality were determined through comparison of the modelling results against the impact assessment criteria published in the NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005).

Predicted ground level concentrations of benzene were found to be well below the EPA criterion; predicted to be 2.3% of the criterion. The modelling results for total VOCs were apportioned in accordance with the composition of typical VOCs found in unleaded gasoline, jet fuel and automotive gas oil (diesel). Analysis revealed that all VOCs were within the applicable EPA criteria. A maximum percentage contribution to the EPA criteria of 24% (Cumene for Jet Fuel) was predicted, while most impacts were expected to have a contribution of less than 1%. These values were based on the maximum total VOC concentration predicted within the Project Area boundary and, as such, concentrations at the nearest receptor would be expected to be lower than the concentrations provided.

A comparison of the annual emission rates calculated from the TANKS model against the annual emission rates from the facility for each of the previous four annual return periods showed a significant reduction in emissions from the Clyde Terminal following the implementation of the proposed Project works. The Project's predicted total VOC and benzene emission rates represent an 85% and 99% reduction respectively from the maximum annual total emission rate of previous years. The comparison also confirmed that the annual loads of total VOC and benzene predicted using the TANKS model for the Project met the Clyde Terminal's EPL load limits with 3% and <1% of the allowable load limits respectively.

As the conservative predicted impacts are well below the required EPA criteria, there is no need for further mitigation at the Project Area at this time. Additional air monitoring beyond the sites current environment protection license requirements is therefore not proposed. The requirements for a construction environmental management plan and an operational environmental management plan were discussed.

This AQIA predicts that the Project is compliant with the EPA air emission assessment criteria without any additional mitigation measures.

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was commissioned by the Shell Company of Australia Ltd (Shell) to undertake an Air Quality Impact Assessment (AQIA) for the Clyde Terminal Conversion Project (the Project). The Project involves conversion of the Clyde Terminal for use solely as a finished fuel storage terminal. The Shell Clyde Terminal is located at the confluence of Parramatta and Ducks Rivers in Rosehill, New South Wales (NSW) approximately 16 km west of Sydney's central business district (see **Figure 1**). The Terminal, which receives fuel from Shell's Gore Bay Terminal via 19 km of underground pipeline, is bounded to the north by Parramatta River, to the south and east by Duck River, and to the west by industrial complexes. The Project Area falls wholly within the Parramatta Local Government Area and is zoned *IN3 Heavy Industrial* under the Parramatta Local Environment Plan 2011 (Parramatta LEP 2011).

This AQIA was prepared as part of an Environmental Impact Statement (EIS) in accordance with Part 4 of the *Environmental Planning and Assessment Act 1979 (NSW)* (EP&A Act) to assess the potential air quality impacts associated with the conversion of the Clyde Terminal into a finished fuel storage terminal.

The Project coincides with a significant reduction in potential emission sources onsite as the refining processes that have historically been the likely major contributor to the Project Area's emissions have been removed, with fuel storage remaining as the primary operation and potential source of pollutants. A review of the previously reported emissions from the then Clyde Refinery and those proposed under the operation of fully converted Clyde Terminal is provided, and the potential impacts of the Project on the local air quality are quantified.

1.1 Scope of the Assessment

This AQIA estimates ground level pollutant concentrations associated with the Project. This AQIA discusses the demolition/construction works and quantitatively considers the operation of the Project. The assessment investigated levels of volatile organic compounds (VOCs) from the proposed operations, as total VOCs and benzene.

As discussed in **Section 3.0,** historical complaint data suggest that odour is not a major issue of concern for the Clyde Terminal, the refining processes onsite have ceased and the total VOC emissions from the site - the primary source of site odour - are expected to reduce by greater than 80%. As a result odour is not expected to be a pollutant of concern for the Project and was excluded from the assessment.

Operational pollutant emission rates were estimated using the physical tank properties and predicted throughput volumes as input into the TANKS emissions estimation model. Pollutant emissions from operation of the proposed Project were assessed quantitatively using the CALPUFF dispersion model. Sensitive receptors in the vicinity of the Project Area were identified and pollutant concentrations at sensitive receptor locations estimated.

The potential impacts of the Project were determined through comparison with ambient pollutant concentrations and the impact assessment criteria published in the NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005), hereafter referred to as the *EPA Approved Methods*. A review of the previously reported emissions from the former Clyde Refinery and those proposed under the fully converted Clyde Terminal is also provided.

The demolition / construction works would be undertaken with standard construction equipment and the emissions would be managed using best practice construction management and mitigation processes. As such, while demolition / construction works associated with the proposed Project have the potential to generate pollution, the potential emissions were not quantitatively assessed.

Mitigation measures for demolition / construction works and operation of the proposed Project were proposed.

1.2 Regulatory Consultation

The methodology for the assessment was developed in consultation with the EPA. On 25 September 2012, AECOM and Shell representatives met with EPA staff at the EPA Goulburn Street Office. The meeting was undertaken to discuss the proposed methodology for the air quality assessment to be included in the EIS and to gain any feedback from the EPA with respect to the methodology or other parts of the assessment. From this discussion measures were taken to develop the methodology in a manner consistent with the EPA's feedback.

The method for which to assess potential odour impacts has been discussed with the EPA. AECOM were advised that odour should be addressed in the assessment. However, a qualitative assessment may be suitable if appropriate and justifiable reasons for the exclusion of modelling odour impacts are provided. This discussion is provided in **Section 3.0**.

AECOM

LOCATION OF CLYDE SHELL TERMINAL

Clyde Terminal Conversion Project
Environmental Impact Statement

FIGURE 1

2.0 Project Description

A full description of the existing facility and proposed modifications is provided in the EIS. The following sections summarise the key components of the Project relevant to the AQIA.

2.1 Project Overview

The Clyde Terminal currently receives finished product from Gore Bay Terminal. These products are distributed to the Sydney Airport, Newcastle, and other NSW destinations via pipelines and haul trucks from the Parramatta Terminal. The retention of a vast majority of these facilities is crucial in ensuring the distribution of fuels within regional NSW and metropolitan Sydney. The conversion of Shell's Clyde Terminal to enable the receipt, storage, product dosing and distribution of fuel products, including finished petroleum products, would be progressive. This would include the demolition of redundant tanks and existing processing units as well as tank reallocation into final fuel grades. The Project would not involve petroleum production.

The distribution of finished petroleum products except for bitumen, Fuel Oil Blending Component and LPG would remain unchanged. Bitumen was distributed from Clyde Terminal by truck. This is no longer stored so is not distributed. LPG was a by-product of the refining process which has ceased so no LPG will be distributed from Clyde, however, Butane will be trucked into the site for use in ongoing operations. Fuel Oil Blending Component was also a by-product of the refining process which has ceased and, as such, no fuel oil blending component is now produced. All other finished petroleum product distribution is by pipeline – to the adjacent Parramatta Terminal truck loading gantry, to Sydney Airport, to Silverwater Terminal and to Newcastle via a third party operated pipeline.

The proposed Project would comprise:

- Demolition of redundant tanks and other infrastructure; and
- Upgrades and improvements to site infrastructure.

The key components of the conversion of the Project Area would comprise:

- Demolition of the existing Clyde Terminal processing units and other redundant infrastructure at the Project Area. Existing storage tanks to be retained would be reallocated into final grades of finished petroleum products. Storage tanks surplus to the ongoing operation of the Clyde Terminal would be demolished. This would reduce the capacity and quantity of storage for petroleum fuels at the Clyde Terminal from 638 ML to 264 ML of fuels; and
- Conversion of part of the existing Clyde Terminal assets to more efficiently receive, store, dose and distribute solely imported finished petroleum products. These products would continue to be supplied from the Clyde Terminal to Shell's existing nearby Parramatta Terminal , and directly via existing pipelines from the Clyde Terminal to Sydney Airport and Newcastle.

The proposed Project would also include:

- Geodesmic domes would be installed over Jet fuel storage Tanks 34, 35 and 42, located in Tankfarm B2. These geodesmic domes would be designed so as to retain the majority of potential odours and emissions emitted from these Jet fuel storage tanks;
- Upgrades to tank instrumentation and tank control systems to enable remote and automated control;
- Upgrades to tank bunds where necessary;
- Reduction of the gas storage capacity of the Clyde Terminal from 10,851 cubic metres (m^3) to 1,550 m^3 metres to accommodate the continued receipt (by road tanker) and storage of Butane. Butane would continue to be dosed with winter grades of Gasoline;
- Upgrades to the electrical supply, control and safeguarding systems;
- Increased automation of terminal systems;
- Installation of equipment to provide improved product quality segregation;
- Revised drainage and water treatment to suit reduced operations;

- Changes to the current fire system to provide articulated foam deployment and fire response for the converted Clyde Terminal arrangement;
- Revised internal facility pumping and piping arrangements;
- Associated works to increase the efficiency and effectiveness of the Clyde Terminal and to facilitate safe and efficient operations, such as lighting, safety shutdown systems, control room facilities and amenity upgrades; and
- An overall reduction in the operational footprint of the Clyde Terminal.

The Project would only involve minimal excavation activities, including grading works surrounding existing tankfarms, and foundation works for new substations and firewater tanks and the removal of some existing foundations. No other sub-surface disturbance is anticipated as part of the Project.

The Clyde Terminal would remain operational as a receipt (from the Gore Bay Terminal), storage, product dosing and distribution facility for finished petroleum products during the proposed works. Once the Project is executed and implemented, the Clyde Terminal would continue to receive, store, dose and distribute finished petroleum products.

The eastern section of the Clyde Terminal is proposed to be modified to contain the finished product tanks required for continuing terminal operations (refer **Figure 2**). Products stored will include Unleaded Petrol 91, 95 and 98, Jet A1 fuel and Automotive Gas Oil (AGO) and the site will continue to store Butane for dosing with Gasoline. The current Gore Bay – Clyde pipeline would continue to be used to transfer product.

The conversion would reduce the number of tanks currently in use at the Clyde Terminal, including 16 fuel product storage tanks and at least 5 slops tanks. Products stored will include Unleaded Gasoline 91, 95 and 98; Jet A1 fuel; and Automotive Gas Oil (Diesel). Two existing tanks would be converted to firewater tanks following the results of inspection. Additionally, Shell also proposes to install two new small sampling slops tanks (given their relatively small size, these were not considered further as part of the AQIA). The Project Area will also continue to store butane. LPG will be stored for use by Basell for a period of time; after this time, the LPG tanks are also expected to be demolished. The current Gore Bay – Clyde pipeline would continue to be used to transfer petroleum products between Gore Bay and Clyde.

It is expected that the conversion works would be undertaken progressively and would be completed within five to 10 years after the grant of development consent.

2.2 Potential Pollutant Sources

The Project is being undertaken simultaneously with a significant reduction of the release of pollutants into the atmosphere from the Clyde Terminal. The previous refining processes at the Project Area that were likely to have been the major contributor to the Clyde Terminal's emissions have been removed, with fuel storage remaining as the primary operation and potential source of pollution. A review of the previously reported VOC emissions from the Project Area and those proposed under the proposed Projects operations is provided in **Section 8.0**.

Table 1 lists the emission sources associated with the operation of the Project, which consist of the various fuel tank types. Each tank has various emission mechanisms including breathing losses; working (filling) losses, including tank wall exposure for floating roof tanks; rims seal losses; and deck seam and fitting losses. The various emission sources were included within the TANK emissions estimation model (TANKS is described in **Section 5.1.1**) and were included in the dispersion model and air quality assessment. Further detail of the tank emissions are provided in **Appendix A**.

Table 1 Potential Pollution Sources from the Project Operation

Potential Pollution Source
2 x Unleaded 95 (U95) Tanks
5 x Unleaded 98 (U98) Tanks
3 x Unleaded 91 (U91) Tanks
3 x Jet A1 Tanks
3 x Automotive Gas Oil (Diesel) Tanks

Potential Pollution Source
5 x Slops Tank
2 x Sampling slops tanks

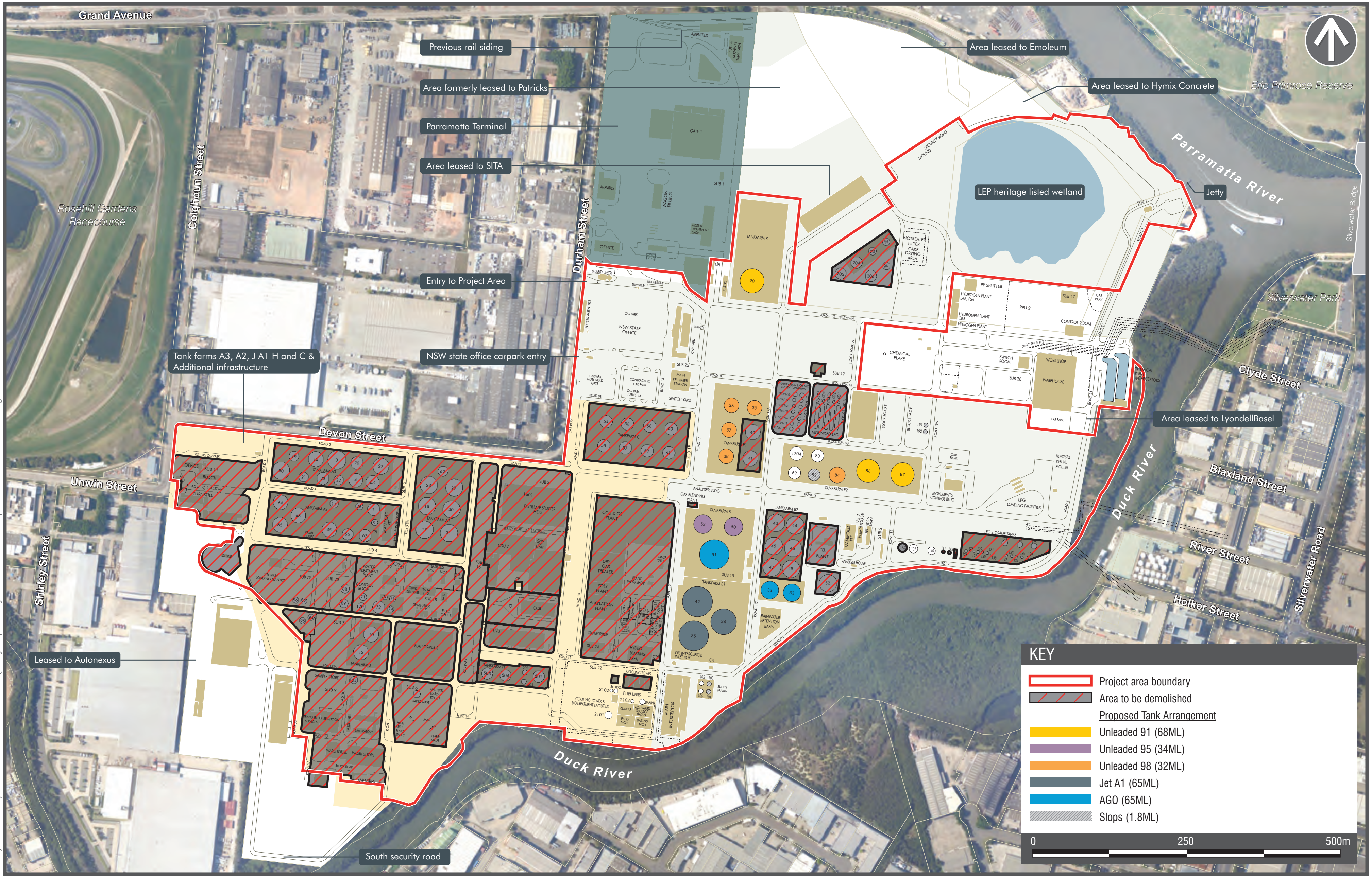
Fugitive emissions from sources not included in the above list may be present during the Project's operation, and could include transfer pipe fixtures (gaskets, valves, manifolds), open ended lines, accidental spillages, water/slops retention systems, and pressure relief valves. Shell operates a leak detection and repair procedure for all its tanks and associated equipment. The purpose of this procedure is to provide guidance on the inspection of process components for leaks to atmosphere and remedial repair of any components found to be leaking. As a result of the implementation of this procedure, the emission rate from equipment is minimised, particularly fugitive emissions, as discussed below.

As previously discussed in **Section 2.1**, Butane would continue to be dosed with winter grades of Gasoline. This dosing process is carried out in an enclosed system and is not exposed to the atmosphere. The process is therefore not considered a significant air quality emission source and, as such, has not been modelled in the assessment. In accordance with the then Clyde Terminal's Environment Protection Licence (EPL) conditions, Shell undertook a leak detection and repair program at the Project Area for the period August 2011 to November 2012. The methodology of the program and the resulting data are provided in the document '*Shell Clyde Refinery & Gore Bay Terminal - Leak Detection and Repair (LDAR) Program Interim Report - Reporting Period August 2011 to November 2012'* prepared for Shell by ATMECO Pty Ltd (2012). The program audited the entire (former) Clyde Refinery site, of which only part will be operational under the operation of the fully converted Clyde Terminal. The area relevant to the proposed operations is categorised as the Movement area. The results of the program for this area returned an estimated total VOC emission of 8 kg per year and no reportable benzene emissions. As provided in **Section 7.0**, the total estimated volatile emissions from the proposed operations are 40,688 kg per year of total VOCs and 148 kg per year of benzene. The fugitive measurements from the Movements area, therefore, contribute less than 0.0002% of the total VOC emissions from the site and no measurable addition to the benzene emissions. Based on this analysis, fugitive emissions are not considered significant and were excluded from the assessment.

The two additional sampling slops tanks listed in **Table 1** are small compared to the storage tanks, with storage capacities of 2,000 L and 1,000 L. Due to their relatively minor size and, subsequently, throughput, any potential emissions from to the two tanks are likely to be very minor, and were excluded from the model.

The demolition and conversion works would be undertaken with standard construction equipment and the emissions would be managed using best practice construction management and mitigation processes. As such, while construction works associated with the proposed Project have the potential to generate combustion, dust and odour emissions, the emissions were not assessed quantitatively.

A figure showing the location of the sources listed is provided in **Figure 2**.



G:\Projects\602 Projects\60236231 Clyde\60236231\FIGURES\Air Quality Report - Clyde\60236231 F2 Proposed Conversion of Existing Infrastructure 06 11 2013 TO Rev G

AECOM

PROPOSED CONVERSION OF EXISTING INFRASTRUCTURE

Clyde Terminal Conversion Project
Environmental Impact Statement

FIGURE 2

3.0 Pollutants of Interest and Assessment Criteria

3.1 Pollutants of Interest

For a proposed development of this type, VOCs are the primary pollutants of interest.

3.1.1 Total VOCs

The World Health Organization definition of VOCs includes all organic compounds (substances made up of predominantly carbon and hydrogen) with boiling temperatures in the range of 50 – 260°C, excluding pesticides. This means that they are likely to be present as a vapour or gas in normal ambient temperatures. Most fossil fuels consist mainly of a mixture of a number of different carbon compounds. Total VOCs are the cumulative concentration of all VOCs within a volume of material, in this assessment a volume of air.

The health effects depend on the specific composition of the volatile organic compounds (VOCs) present, their concentration and the length of exposure. General effects of exposure to VOCs include: irritation to the eyes, nose and throat; headaches; loss of coordination; nausea; and damage to the liver, kidney and central nervous system. Some VOCs are known or suspected carcinogens.

VOCs are a known causative agent of photochemical smog and react with oxides of nitrogen in the atmosphere to produce ozone. Other environmental effects depend on the composition of the VOCs, the concentration and length of exposure. Some VOCs can have serious effects on animals and plants. Effects may also occur due to secondary impacts, such as the impacts of smog. In liquid form VOCs may also impact on water and soil.

The primary source of VOCs historically from the site is from refining processes as well as the storage of crude and final product liquids on site. The modified Project does not include processing operations or the storage of crude liquids on the site. Final products such as diesel and jet fuel would be stored on site for the Project and hence would be the primary source of VOCs.

3.1.2 Benzene

Benzene, a VOC, is a natural constituent of Crude Oil, and is one of the most basic petrochemicals. Benzene is an aromatic hydrocarbon, and is a colourless and highly flammable liquid with a sweet smell.

In the atmosphere, benzene can react with other chemicals to produce phenol, nitrophenol, nitrobenzene, formic acid and peroxyacetyl nitrate. It is a "precursor" hydrocarbon leading to the formation of photochemical smog. It will usually break down (decompose) over a few days, with the products eventually ending up in the air. It can be washed out of the air by rain, but will evaporate and continue to contaminate the air. It can attach to rain or snow and be carried back down to the ground. Benzene in soil or water will decompose with the presence of oxygen. It does not build up concentration levels in plant or animal tissues. Benzene is expected to be a major component of emissions within the assessed fuel blends.

3.1.3 Odour

Shell has received a limited number of complaints regarding odour from the former Clyde Refinery over the past few years. Most of the complaints were from a neighbouring industrial facility while some were from a residence in the Silverwater area. Of the registered complaints, the majority could not be directly identified to a particular processing activity onsite; one was related to flaring operations and another to a gas leak from a process exchanger. It is believed that all the registered complaints were most likely due to crude processing operations at the then Clyde Refinery. These sources are not part of the converted Clyde Terminal’s operations and hence would no longer be a source of potential odour from the Project Area.

The maximum total VOC emissions over the past four years from the former Clyde Refinery prior to the cessation of crude refining, as discussed in **Section 8.0**, was 263,470 kg/year. The predicted Project total VOC value of 40,688 kg/year represents an 85% reduction from this maximum annual total VOC emission rate. As the Project Area’s odour impacts are primarily related to the amount of VOCs emitted from the Clyde Terminal, the Projects potential odour emissions are expected to be significantly less than those from the previous operations prior to the cessation of refining.

In summary, historical complaint data suggest that odour is not a major issue of concern for the Project Area; the refining processes onsite have ceased and the total VOC emissions from the Clyde Terminal - the primary source of site odour - are expected to have been reduced by around 85%. As a result odour is not expected to be a pollutant of concern for the Project and was excluded from the assessment.

3.2 Assessment Criteria

The EPA specifies impact assessment criteria for pollutants in the *Approved Methods*. The primary purpose of an AQIA is to determine whether emissions from premises will comply with the appropriate environmental outcomes. The assessment criteria outlined in the *Approved Methods* reflect the environmental outcomes adopted by the EPA, and are the primary tool for assessing air dispersion modelling and ambient air quality samples.

The AQIA specifically targets the VOC benzene, as this compound is not only likely to form a large proportion of the VOC emissions from the tanks, but also has a relatively stricter assessment criterion than other pollutants within the fuel blends. The benzene assessment criterion in the NSW EPA *Approved Methods* (DEC 2005) is provided in **Table 2** as a 1-hour 99.9th percentile concentration.

Table 2 Benzene Impact Assessment Criterion 99.9th Percentile

Compound	Assessment Criterion	Units	Averaging Period
Benzene	29	$\mu g/m^3$	1 Hour

The *Approved Methods* does not provide an assessment criterion for total VOCs. A screening level assessment of the total VOCs estimated in the dispersion modelling was undertaken, which reviewed the expected chemical composition of the different fuel blends, and estimated the proportion of individual VOC species in the emissions based on the fuel compositions. Further details are provided in **Section 7.1**.

4.0 Existing Air Quality and Climate

4.1 Ambient Air Quality

The EPA operates a network of monitoring stations around the state, which measures various ambient pollutant levels. The closest station to the Project Area is located at Chullora (approximately 8 km to the south east). The EPA does not measure VOCs at its monitoring stations and as such no background values could be generated for the Project. Given the low VOC values expected to be emitted by the Project (and shown in **Section 7.0**) this is not expected to be an issue.

Refining operations ceased at Shell's Clyde Terminal in late 2012. As the former refining operations were likely to be a potentially significant source of VOCs in the surrounding area, the ambient VOC level in the area are also likely to have decreased.

It should be noted that the *Approved Methods* only stipulates the assessment of incremental VOC impact (predicted impacts due to the pollutant source alone) and does not require a cumulative assessment of site VOC emissions with ambient levels. This would not be possible anyway due to a lack of ambient VOC monitoring data available.

4.2 Regional Climate

The Bureau of Meteorology (BoM) operates a network of meteorological monitoring stations around the country. The closest station to the Project Area is located at Parramatta North, approximately 5 km to the northwest. A summary of the long-term data recorded at this station between 1967 and 2010 is shown in **Table 3**. The data provide a good summary of the expected regional climate of the area surrounding the Project. The BoM data, specifically wind speed and direction, were used in **Section 5.1.2** to verify that the meteorological data used in the assessment are representative of the local climate.

Table 3 Climate Summary, BoM Parramatta North; 1967 to 2010

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Mean maximum temperature (°C)	28.3	27.8	26.2	23.8	20.5	17.8	17.3	19	21.6	23.8	25.4	27.4	23.2
Mean minimum temperature (°C)	17.5	17.6	15.8	12.8	9.9	7.5	6.2	7.1	9.3	11.9	14	16.2	12.2
Rainfall													
Mean rainfall (mm)	102	125.5	109.4	89.8	72.4	86.2	46.8	54.4	53.9	69.9	86.1	71.6	966
Decile 5 (median) rainfall (mm)	90.7	108.5	92.4	58	45.9	62.4	33.9	27.1	39.2	50.9	69.7	65.5	969.6
Mean number of days of rain ≥ 1 mm	9	9.2	9.5	7.1	7.4	7.4	5.5	5.2	5.9	7.8	8.9	7.6	90.5
9 am conditions													
Mean 9 am temperature (°C)	22.5	22.0	20.5	18.0	14.5	11.7	10.8	12.5	15.8	18.6	19.7	21.7	17.4
Mean 9 am relative humidity (%)	74	79	80	76	79	78	75	67	63	62	69	70	73
Mean 9 am wind speed (km/h)	7.3	6.4	6.4	6.7	6.7	7.2	7.7	9.1	9.8	9.8	8.4	8.1	7.8
3 pm conditions													
Mean 3 pm temperature (°C)	26.8	26.3	24.7	22.3	19.2	16.6	16.2	17.8	20	21.9	23.6	25.7	21.8
Mean 3 pm relative humidity (%)	57	59	59	58	60	59	55	46	46	49	54	55	55
Mean 3 pm wind speed (km/h)	14.5	13	12.2	10.8	9.3	10.4	10.6	13.2	15.2	14.9	15.6	15.4	12.9

The warmest temperatures occur during the summer months, with the highest average maximum temperature (28.3°C) occurring in January. July is the coldest month, with a recorded average minimum temperature of 6.2°C. February is the wettest month, with an average rainfall of 125.5 millimetres. Humidity follows a diurnal cycle, with higher humidity in the morning compared to the afternoon. Wind speeds are generally higher in the afternoon compared to the morning, with the highest average wind speeds occurring in November (15.6 km/h).

5.0 Assessment Methodology

The following sections outline the dispersion models used and their inputs; modelling scenarios assessed; emissions estimation methodology; and emission rates entered into the models. The modelling was conducted in accordance with and/or in consideration of the *Approved Methods*.

5.1 Dispersion Model Inputs

5.1.1 Model Choices

The TANKS emission inventory model, TAPM (The Air Pollution Model), CALMET meteorological processers and the CALPUFF dispersion model were used in the assessment. A brief description of each model is provided below.

The TANKS model was used to estimate the emissions of VOCs from the storage tanks, which were then used in the CALPUFF dispersion model to estimate the potential dispersion of these emissions to the surrounding environment. TANKS is based on the emission estimation procedures from the US EPA's *Compilation Of Air Pollutant Emission Factors* (AP-42). TANKS is commonly used in Australia for NPI reporting requirements and annual returns. TANKS uses chemical, local meteorological, roof fitting, and rim seal data to generate emissions estimates for several types of storage tanks, including:

- Vertical and horizontal fixed roof tanks;
- Internal and external floating roof tanks;
- Domed external floating roof tanks; and
- Underground tanks.

TAPM predicts three-dimensional meteorology, including terrain-induced circulations. TAPM is a PC-based interface that is connected to databases of terrain, vegetation and soil type, leaf area index, sea-surface temperature, and synoptic-scale meteorological analyses for various regions around the world. The TAPM model was used to predict meteorological parameters not available in the surface meteorological data file, such as upper air parameters, that are required by the CALMET meteorological processer.

CALMET is a meteorological model that develops hourly wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics and dispersion properties are also included in the file produced by CALMET. CALMET produces a meteorological file that is used within the CALPUFF model to predict the movement of pollution.

CALPUFF is a non-steady state three dimensional Gaussian puff model developed for the US Environmental Protection Agency (US EPA) for use in situations where basic Gaussian plume models are not effective, such as areas with complex meteorological or topographical conditions, including coastal areas with re-circulating sea breezes. The Clyde area may fall into this category. The CALPUFF model substantially overcomes the basic limitations of the steady-state Gaussian plume models, and as such, was chosen as the most suitable dispersion model for the assessment.

Input parameters used in the CALPUFF dispersion modelling are summarised **Table 4**.

Table 4 CALPUFF Input Parameters

Parameter	Input
CALPUFF version	6.42 2011
CALMET domain	8 km x 8 km
Modelling domain	5 km x 5 km
Modelling grid resolution	90 m
Terrain data	Included in CALMET
Dispersion algorithm	PG (Rural, ISC curves) & MP Coeff (urban)
Hours modelled	8760 hours (365 days)
Meteorological data period	1 January 2011 – 31 December 2011

5.1.2 Meteorology

Meteorology in the area surrounding the Project Area is affected by several factors such as terrain, land use and coastal effects. Wind speed and direction are largely affected by topography at the small scale, while factors such as synoptic scale winds affect wind speed and direction on the larger scale.

In the absence of suitable site-specific meteorological data for the Clyde Terminal, the TAPM prognostic model was used to predict local meteorology for use in the modelling. TAPM is an approved model within the NSW Approved Methods where "*neither site-specific nor site-representative meteorological data are available that are suitable for use in regulatory modelling applications*" (DECCW 2005). The TAPM output data were incorporated into the CALMET model for the generation of the required meteorological data sets for the Project Area.

The meteorological data used in the assessment were from the year 2011. These data are the most recent full year available within the TAPM model when the meteorological data file was created in 2012.

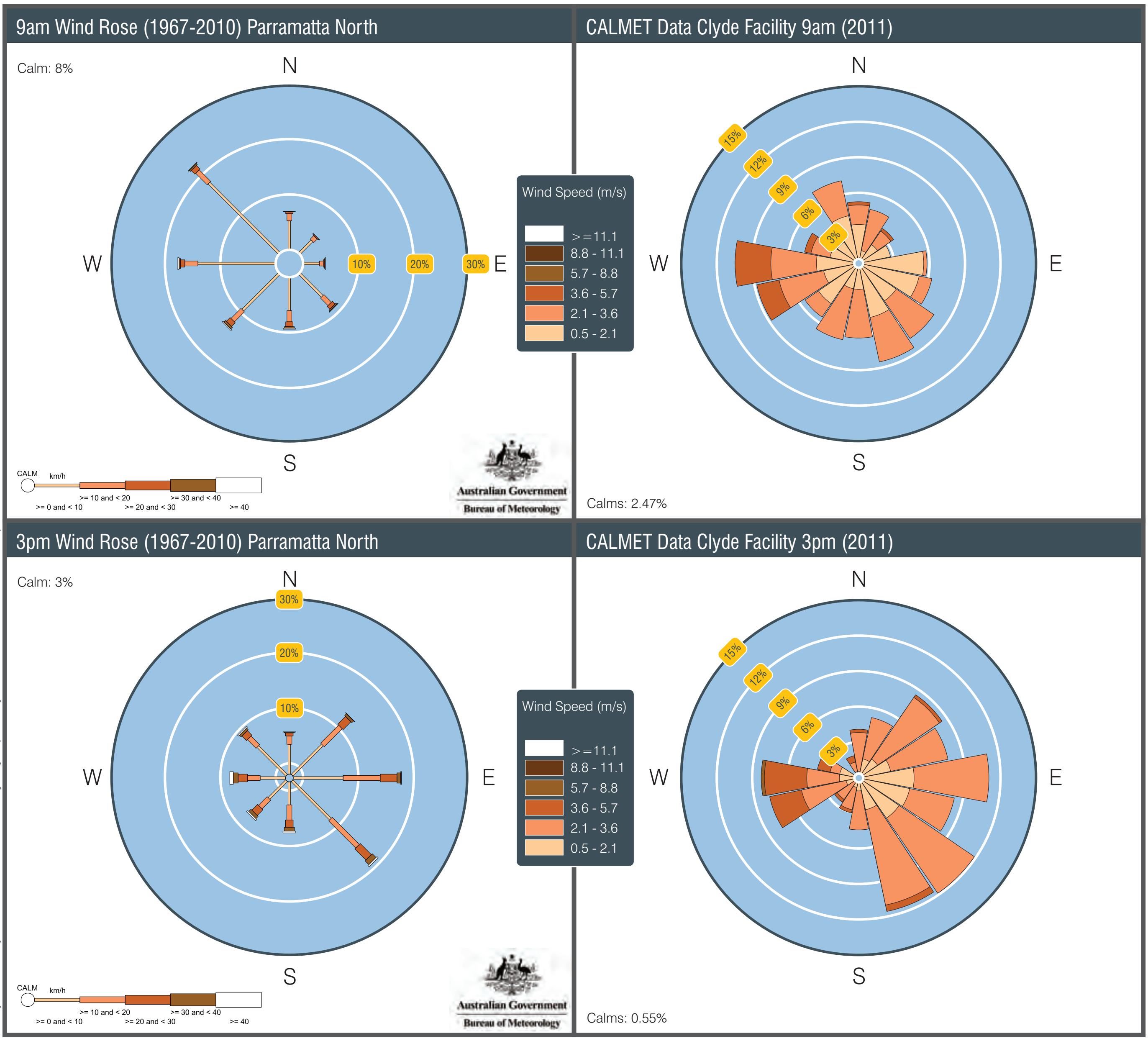
Wind speed and direction are important variables in dispersion modelling, as they dictate the direction and distance pollutant plumes travel. A comparison of the wind roses from the BoM monitoring station at Parramatta North, which are indicative of long-term climatic wind patterns, and the CALMET data is shown in **Figure 3** and summarised in the following paragraphs.

The BoM data indicate that the predominant wind direction in the morning is from the south west to north west. Similarly, morning south westerly and westerly winds are a common occurrence in the CALMET data; the CALMET data, however, predict a greater frequency of winds from the south east quadrant. The wind roses from the afternoon BoM and CALMET data sets correlate well, with winds most commonly occurring from the north east to south east. Calm conditions are most frequent during the morning hours with 9% and 2% calms from the BoM and CALMET data respectively compared to 3% (BoM data) and 1% (CALMET data) in the afternoon.

The CALMET dataset was used in the dispersion modelling. The CALMET wind roses provided in **Figure 3** were generated for a point located at the centre of the Project and are indicative of the larger data set used in the dispersion modelling. As previously discussed, the data provide a good representation of morning and afternoon wind conditions seen at the local BoM monitoring station. Further analysis of the CALMET data is provided in **Appendix B**.

5.1.3 Terrain

Topography may influence the findings of this study. The terrain data were obtained from the NASA Shuttle Radar Topographic Mission (SRTM) at a resolution of approximately 90 metres (standard resolution provided by NASA). Given the fact that the Project area is generally flat, this resolution was considered appropriate for the current assessment. These were incorporated into the CALPUFF input files via TAPM and CALMET.



AECOM

WIND ROSE COMPARISON: BOM PARRAMATTA NORTH AND CALMET

Clyde Terminal Conversion Project
Environmental Impact Statement

FIGURE 3

5.1.4 Building Wakes

PRIME is the US EPA's preferred building wake algorithm for including the effects of large buildings located close to stack sources. CALPUFF includes the PRIME building wake algorithm and uses the Building Profile Input Program (BPIP) for entering the location and dimension of buildings. As the Project does not include stack sources building wake calculations were not included in the assessment.

5.2 Modelling Scenarios

The primary purpose of the assessment was to review the potential impacts from the proposed Project. The following scenario presented in **Table 5** was modelled to meet this objective.

Table 5 Modelling Scenarios

Scenario	Description	Pollutants Modelled
1	Proposed operations	Total VOC Benzene

Demolition / construction emissions were not assessed in the AQIA due to the relatively short duration and intermittent nature of the works. Activities that have the potential to result in airborne pollutants during the demolition / construction works include minor earthmoving during site preparation, demolition of tanks, and handling and stockpiling of excavated and demolished material. Emissions during demolition / construction works can be minimised and mitigated through the application of a construction environmental management plan or similar document. Further discussion of demolition / construction activities is provided in **Section 2.0**, while mitigation measures are discussed in **Section 9.2**.

5.3 Emissions Estimation

The TANKS model was used to estimate the emissions of VOCs from the storage tanks. TANKS uses chemical, meteorological, roof fitting, and rim seal data to generate emissions estimates for several types of storage tanks. The tank properties, working volumes, proposed throughputs and liquid chemical composition were provided by Shell and are reproduced below. The proposed throughputs were based on the Jet A-1, diesel and unleaded gasoline throughputs from the 2011-2012 (then) Clyde Refinery annual return and spread over those tanks that are proposed to hold the same product.

Table 6 provides a summary of the pertinent source parameters required for input into the TANKS model to generate the emission estimates for each storage tank. Further details of the TANKS input data can be provided upon request.

Table 6 Source Parameters

Tank No.	Tank Type	Product Stored	Diameter (m)	Height (m)	Tank Working Volume (m^3)	Annual Turnover	Net Throughput (m^3/yr)
32	Vertical Fixed Roof	Diesel	36.0	16	15,260	22.6	344,770
33	Vertical Fixed Roof	Diesel	36.0	16	15,524	22.6	350,735
34	Internal Floating Roof	JET A-1	39.0	12.8	15,299	10.3	158,258
35	Internal Floating Roof	JET A-1	43.9	18.3	27,699	10.3	286,528
36	External Floating Roof	ULP-98	24.4	16.5	7,715	14.2	109,437
37	External Floating Roof	ULP-98	24.4	16.5	7,715	14.2	109,437
38	External Floating Roof	ULP-98	24.4	16.5	7,715	14.2	109,437
39	External Floating Roof	ULP-98	24.4	16.5	7,715	14.2	109,437
42	Internal Floating Roof	JET A-1	43.9	18.3	27,699	10.3	286,528
50	External Floating Roof	ULP-95	34.1	22.0	20,093	14.2	285,019
51	External Floating Roof	Diesel	48.8	22.0	41,055	22.6	927,558
53	External Floating Roof	ULP-95	34.2	22.0	20,164	14.2	286,027
82	External Floating Roof	Slops	17.1	12.8	2,940	0.9	2,500
84	Internal Floating Roof	ULP-98	24.4	22.0	10,287	14.2	145,921
86	External Floating Roof	ULP-91	39.0	22.0	26,281	14.2	372,796
87	External Floating Roof	ULP-91	39.0	22.0	26,281	14.2	372,796
90	External Floating Roof	ULP-91	39.0	22.0	26,281	14.2	372,796
91	Vertical Fixed Roof	Slops	6.09	6.13	160	22.0	3,525
92	Vertical Fixed Roof	Slops	6.09	6.13	160	21.1	3,381
103	Vertical Fixed Roof	Slops/water	7.62	5.49	278	5.2	1,160[1]
104	Vertical Fixed Roof	Slops/water	6.1	7.62	116[1]	10.0	1,160

[1] Assumed to be same as Tank 104 as data not available

5.4 Emissions Inventory

The pollutant emission rates from the operation of the Project were calculated by the TANKS model described above. The model applied the physical tank details, fuel throughput, local meteorology and other parameters to calculate the total annual emission of pollutants. The annual emission rate was scaled to grams per second (g/s) for input into the dispersion model. Total VOCs and benzene emission rates for each tank are presented in **Table 7**, while the TANKS output files can be provided upon request.

The tanks were modelled as elevated volume sources to represent the VOC release from the top of the tanks (from the tank roof for external floating roofs or from vents for other tank types).

Table 7 Tank Emission Rates

Tank Number	Emission Rate (g/s)	
	Total VOCs	Benzene
32	7.65×10^{-5}	5.55×10^{-5}
33	8.45×10^{-5}	6.13×10^{-5}
34	2.54×10^{-3}	1.59×10^{-5}
35	3.37×10^{-3}	1.82×10^{-5}
36	1.69×10^{-1}	4.54×10^{-4}
37	1.73×10^{-1}	4.64×10^{-4}
38	1.37×10^{-1}	3.69×10^{-4}
39	1.32×10^{-1}	3.59×10^{-4}
42	3.43×10^{-3}	1.86×10^{-5}
50	9.30×10^{-3}	8.15×10^{-4}
51	3.86×10^{-2}	1.89×10^{-4}
53	3.52×10^{-2}	1.59×10^{-4}
82	7.67×10^{-4}	2.55×10^{-5}
84	8.84×10^{-2}	1.85×10^{-4}
86	1.90×10^{-1}	5.20x10-4
87	1.51×10^{-1}	4.17×10^{-4}
90	1.53×10^{-1}	4.27×10^{-4}
91	3.79×10^{-4}	3.31×10^{-5}
92	3.76×10^{-4}	3.28×10^{-5}
103	5.27×10^{-4}	3.78×10^{-5}
104	6.51×10^{-4}	4.67×10^{-5}

5.5 Limitations of Dispersion Modelling

The atmosphere is a complex, physical system, and the movement of air in a given location is dependent on a number of variables, including temperature, topography and land use, as well as larger-scale synoptic processes. Dispersion modelling is a method of simulating the movement of air pollutants in the atmosphere using mathematical equations. The model equations necessarily involve some level of simplification of these very complex processes based on our understanding of the processes involved and their interactions, available input data, processing time and data storage limitations.

These simplifications come at the expense of accuracy, which particularly affects model predictions during certain meteorological conditions and source emission types. For example, the prediction of pollutant dispersion under low wind speed conditions (typically defined as those less than 1 m/s) or for low-level, non-buoyant sources, is problematic for most dispersion models. To accommodate these known deficiencies, the model outputs tend to provide conservative estimates of pollutant concentrations at particular locations.

While the models contain a large number of variables that can be modified to increase the accuracy of the predictions under any given circumstances, the constraints of model use in a commercial setting, as well as the lack of data against which to compare the results in most instances, typically precludes extensive testing of the impacts of modification of these variables. With this in mind, model developers typically specify a range of default values for model variables that are applicable under most modelling circumstances.

The results of dispersion modelling, therefore, provide an indication of the likely level of pollutants within the modelling domain. While the models, when used appropriately and with high quality input data, can provide very good indications of the scale of pollutant concentrations and the likely locations of the maximum concentrations occurring, their outputs should not be considered to be representative of exact pollutant concentrations at any given location or point in time.

6.0 Sensitive Receptors

Sensitive receptors are identified by the EPA in the *Approved Methods* as anywhere someone works or resides or may work or reside, including residential areas, hospitals, hotels, shopping centres, play grounds, recreational centres, and the like.

The Project Area is adjacent to commercial/industrial receptors on all sides, although a river separates the Project from receptors to the south. The nearest residential receptors are located approximately 400 m to the north east, 1.1 km to the south east, 600 m to the south and 850 m to the west.

Due to the presence of commercial receptors located adjacent to the Project area, and the expected low emissions from the Project, the maximum measured ground level pollutant concentrations anywhere over the modelling domain were assessed i.e. impacts on the area within and external to the Project Area boundary were assessed.

7.0 Dispersion Modelling Results

7.1 Total VOCs

Modelled predictions for the maximum 1-hour average concentration (99.9th percentile) for total VOCs is presented in a contour plot in **Figure 4**.

The maximum 1-hour average concentration (99.9th percentile) for total VOCs was predicted to be 176 µg/m^3. This value was conservatively predicted within the Project boundary and, as such, the likely concentration at the nearest receptor is likely to be lower than this value.

As discussed in **Section 3.2** there is no criterion for total VOCs. The *National Pollution Inventory Emissions Estimation Technique Manual for Fuel and Organic Liquid Storage* (NPI 2012), however, provides a breakdown of the typical fuel composition for diesel, unleaded gasoline and jet kerosene with regards to VOCs. For the purpose of this assessment, maximum 1-hour average (99.9th percentile) individual VOC pollutant concentrations were conservatively estimated based on the typical composition for the above mentioned fuels. The associated composition percentages were applied to the maximum predicted ground level concentration of 176 µg/m^3 to estimated worst case pollutant values. This method is considered to be highly conservative as it assumes that 100% of the predicted total VOC ground level concentration is one compound, where in reality it is a mixture of compounds. The typical compositions from the NPI are provided in **Appendix D**, with the calculated VOC concentration presented in **Table 8**. A contribution of the concentration to the EPA criteria has also been provided.

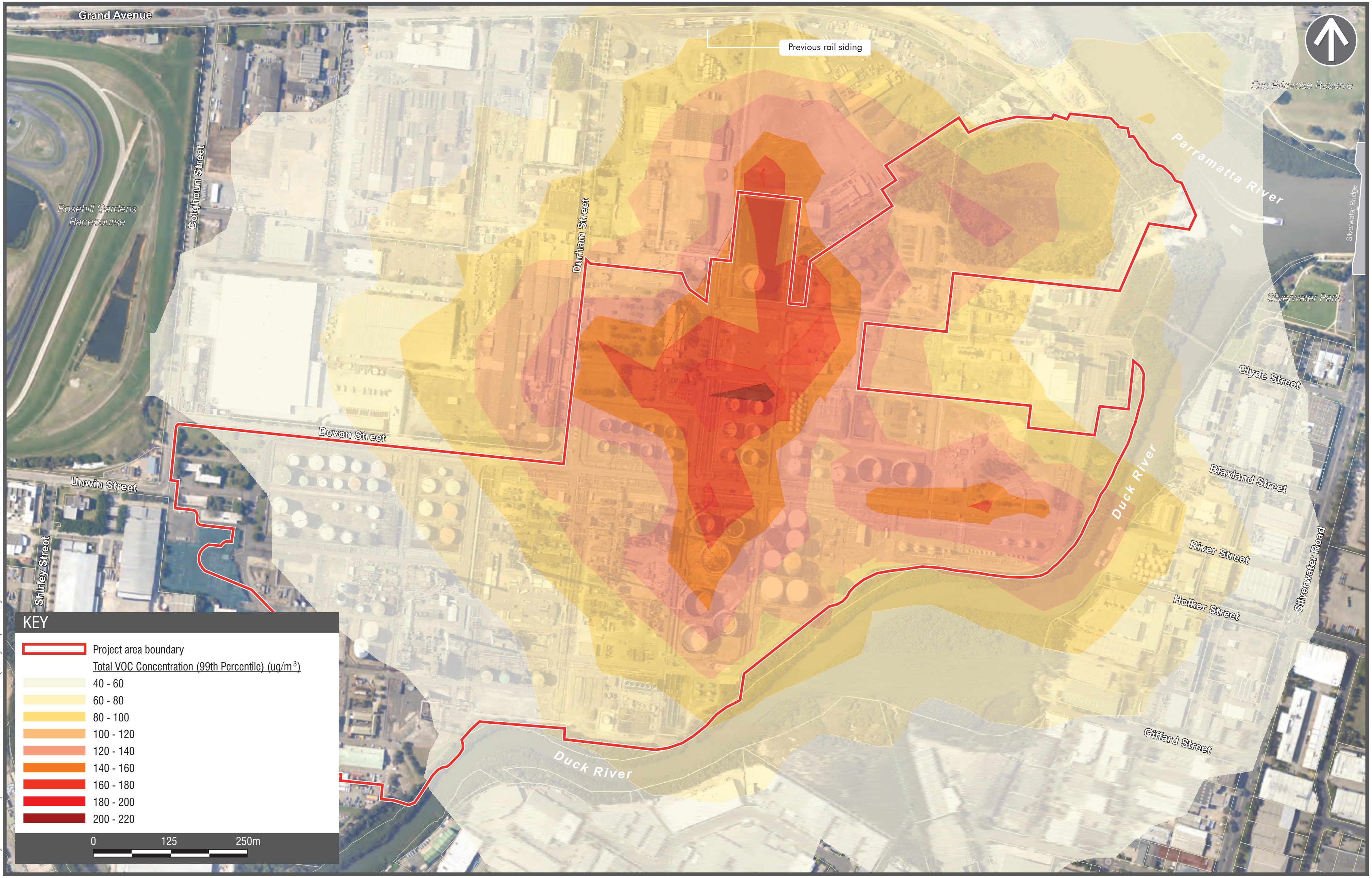
Table 8 Maximum 1-hour Average Concentration (99.9th percentile) for VOCs

VOC	EPA Criteria (µg/m^3)	Maximum 1-hour Average Concentration (99.9th percentile) (µg/m^3)			Maximum Concentration % of EPA Criteria		
		Diesel	Unleaded Gasoline	Jet Kerosene	Diesel	Unleaded Gasoline	Jet Kerosene
Benzene	29	0.1	1.6	0.6	0.3%	5.5%	2.1%
Cumene	21	1.7	0.2	5.0	8.1%	1.0%	23.8%
Cyclohexane	260	0.0	1.3	2.1	<0.1%	0.5%	0.8%
Ethylbenzene	8000	0.2	2.7	0.9	<0.1%	<0.1%	<0.1%
n-Hexane	3200	0.0	3.2	8.2	<0.1%	0.1%	0.3%
PAH	440 [1]	0.6	1.1	1.7	0.1%	0.3%	0.4%
Toluene	360	0.2	9.9	0.3	<0.1%	2.8%	<0.1%
Xylenes	190	0.6	13.6	3.3	0.3%	7.2%	1.7%

[1] A derived criterion for PAH as naphthalene was applied in the assessment as this is the most likely volatile PAH expected. The criterion derivation is detailed in **Appendix C**. The EPA criterion for PAH as benzo[a]pyrene is not considered appropriate for this assessment as it is semi-volatile and unlikely to be volatile at the storage temperatures.

The average calculated value for the three fuels results presented above for benzene from **Table 8** is 0.76 µg/m^3, which is broadly comparable to the maximum modelled benzene concentration of 0.68 µg/m^3 from **Table 9**. As such, the benzene data in **Table 8** validate the screening method employed for assessing total VOC impacts.

Table 8 shows that all predicted concentrations of VOCs were below the applicable maximum 1-hour average concentration (99.9th percentile) EPA criteria for each fuel type assessed. A maximum percentage contribution to the EPA criteria of 24% (Cumene for Jet Fuel) was predicted, while most impacts were expected to have a contribution of less than 1%. These values were based on the maximum total VOC concentration predicted within the Project Area boundary and, as such, concentrations at the nearest receptor would be expected to be lower than the concentrations provided.



G:\Projects\602 Projects\60236231\FIGURES\Air Quality Report - Clyde\60236231 F4 1-Hour Maximum Total VOC Concentration Plot 06 11 2013 TO Rev C

AECOM

1-HOUR MAXIMUM TOTAL VOC CONCENTRATION CONTOUR PLOT (99.9th Percentile) (ug/m^3)

Clyde Terminal Conversion Project
Environmental Impact Statement

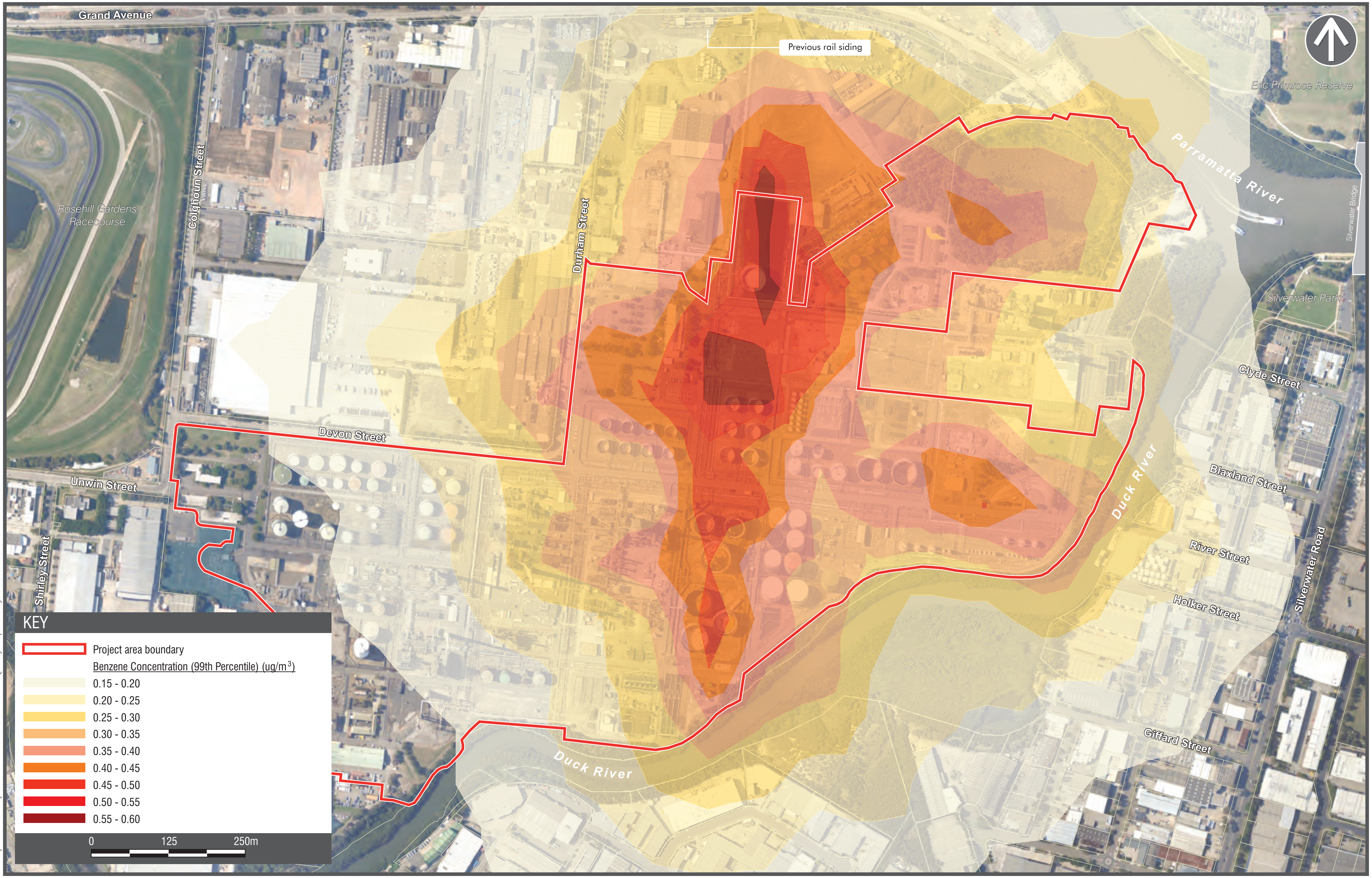
FIGURE 4

7.2 Benzene

Modelled predictions for the maximum 1-hour average concentration (99.9^{th} percentile) for benzene are presented in a contour plot in **Figure 5**, while the maximum gridded 1 hour value is presented in **Table 9**. It can be seen from **Figure 5** that the concentration contours do not exceed the EPA 1-hour maximum criterion (99.9^{th} percentile) of 29 µg/m^3 at any point in the modelled area. The maximum 1-hour average concentration (99.9^{th} percentile) for benzene, which was predicted to occur within the Project Area boundary, was predicted to be 0.68 µg/m^3; 2.3% of the EPA criterion. The predicted value is well below the EPA criterion.

Table 9 Maximum 1-hour Average Concentration (99.9^{th} percentile) for Benzene

VOC	EPA Criteria (µg/m^3)	Maximum 1-hour Average Concentration (99.9^{th} percentile) (µg/m^3)	Maximum Concentration % of EPA Criteria
Benzene	29	0.68	2.3%



G:\Projects\602 Projects\60236231 - Clyde\60236231\FIGURES\Air Quality Report - Clyde\60236231 F5 1-Hour Maximum Benzene Concentration Plot 06 11 2013 TO Rev C

AECOM

1-HOUR MAXIMUM BENZENE CONCENTRATION CONTOUR PLOT (99.9th Percentile) (ug/m^3)

Clyde Terminal Conversion Project
Environmental Impact Statement

Benzene Criteria: 29 ug/m^3

FIGURE 5

8.0 Annual VOC Emission Rates

The annual emission rates calculated from the TANKS model were compared against the annual emission rates from the former Clyde Refinery for the previous four annual return periods as shown in **Table 10**; as presented on the NSW EPA website for EPL number 570 (http://www.environment.nsw.gov.au/prpoeoapp/default.aspx). Where annual return data was not available on the EPA website, the Australian Government National Pollution Inventory (NPI) database available on the web was utilised (http://www.npi.gov.au/npidata/action/load/browse-search) and where used is stated in the table. This data may differ from that provided by the NSW EPA as the reporting time frames are different and the NPI values are rounded differently. The comparison shows the relative reduction in VOC emissions as a result of the Project.

Table 10 Emission Rates for Annual Return Periods and Predicted Emissions from the Project

Period	Emission Rate (kg/yr)	
	Total VOCs	Benzene
2008-2019	229,278	4,749
2009-2010	263,470	8,657
2010-2011	260,000 [1]	12,000 [1]
2011-2012	219,342	20,870
The Project	40,688	148

[1] NPI Data for the Shell Clyde Refinery (Department of Sustainability, Environment, Water, Population and Communities, 2013)

The Project's predicted total VOC emission rate of 40,688 kg/year represents an 85% reduction from the maximum annual total VOC emission rate of 263,470 kg/year that was calculated for 2009 - 2010. The Project's predicted benzene emission rate of 148 kg/year represents a reduction of 99% when compared to the previous maximum annual total emission rate of benzene of 20,870 kg/year for 2011 - 2012. As such, the predicted annual emission rates of total VOCs and benzene associated with the Project represent a significant reduction in emissions compared to historical emissions from the previous Clyde Refinery.

The Clyde Terminal has a current total VOC load limit of 1,250,000 kg/year and a benzene load limit of 26,000 kg/year stipulated in its EPL (EPL number 570). The reported load values for the Project represent 3% of the allowable load limit for total VOC and <1% of the allowable load limit for benzene.

Note this comparison was undertaken to show the relative improvement the proposed Clyde Terminal conversion may have on the local air quality compared to previous refining operations at the Project Area. The comparison was undertaken using the results of the TANKS program and did not include emissions from sources other than tank emissions, such as traffic combustion etc. Such sources would have been present in the previous years and would continue into the future, albeit at varying levels. The assessment is therefore considered a good method for the assessment of predicted reductions and should not be used to review total VOC or benzene emissions from the Project Area.

9.0 Mitigation

9.1 Operational Mitigation Measures

Operational mitigation measures are those that are implemented after the facility has been fully converted in accordance with its consent approval. Operational mitigation measures focus on the undertaking of specific activities in a manner designed to minimise environmental impacts, as well as any environmental monitoring where applicable. The operational mitigation measures for the Projects operations should be detailed in an Operational Environmental Management Plan (OEMP), an Air Quality Management Plan (AQMP) or similar document. For the purpose of the following discussion an OEMP has been referenced.

An OEMP details prevention and management measures for air quality issues associated with the operations of the facility. It defines mitigation measures to be implemented during operations, where appropriate a monitoring program that enables assessment of the impacts of activities on potentially affected areas, and contingency measures that may be implemented if complaints are received or exceedances are measured.

The primary goals of an OEMP are:

- To ensure that operational activities are managed to meet air quality and odour objectives as set out in environmental assessments and the EPL issued by the EPA;
- Where appropriate, to provide a monitoring regime to quantify air quality and odour issues associated with operation; and
- To effectively manage operational activities to prevent potential air quality issues.

Intended outcomes of an OEMP are:

- Mitigation measures are implemented and maintained to achieve ambient air criteria for airborne pollutants that minimise adverse effects on sensitive receptors; and
- Confirm that air quality mitigation measures are effective and properly maintained.

9.2 Demolition/Construction Mitigation Measures

Mitigation of impacts relating to demolition / construction works is essentially a management exercise. For any construction activity, the focus should be on implementing a strict dust and air quality management regime supplemented by the use of ambient pollutant monitoring where appropriate. Mitigation and monitoring measures for the Project are to be detailed in a Construction Environmental Management Plan (CEMP) or similar document.

The key objective of a CEMP is to clearly outline the procedures to address and manage potential environmental impacts associated with the demolition activities. As a minimum, the plan should outline the following aspects related to the works:

- Environmental Policy;
- Environmental Management Structure, Communication and Responsibility;
- Approval and Licensing Requirements;
- Reporting;
- Emergency Contacts and Response;
- Environmental Management Activities and Controls;
- Environmental Monitoring;
- Complaints;
- Corrective Action; and
- Environmental Management Plan Review.

Table 11 summarises the primary management measures to address emissions of dust and other pollutants from the construction activities from the Project. All management plans and monitoring programs should be suitably documented for easy reference throughout the process. These measures can be evaluated at any time during a project life and reviewed accordingly. It should be noted that the list is not comprehensive and would need to be supplemented with additional site-specific measures that are identified as appropriate during construction.

Table 11 Typical Construction Impact Management Measures

Source	Impact	Control Measure
Fugitive dust and odour from operations, vehicles and material handling / stockpiling	Nuisance Discoloration of buildings or structures Increased risk to human health	Covering loads during transport.
		Watering of exposed surfaces and roads.
		Measures to modify or suspend dust-generating activities during periods of high wind speeds or whenever dust plumes from the works are visible. A high wind value should be decided though discussions with regulators, however a typical value is 8 m/s averaged over a 1-hour period.
		Sealing regularly trafficked surfaces as soon as possible after construction.
		Control roadway use i.e. defined road access to minimise dust.
		Complaints management system in place.
		Immediate clean-up of accidental spills.
Fuel combustion emissions from vehicles and equipment	Increased risk to human health	Turn engines off whilst parked onsite.
		Vehicular access confined to designated sealed access roads.
		Equipment, plant and machinery regularly tuned, modified or maintained to minimise visible smoke and emissions.
		Site speed limits implemented.
		Minimising haul road lengths.

9.3 Air Quality Monitoring

Shell currently undertakes air quality monitoring in accordance with the EPL applicable to the Clyde Terminal. The monitoring will continue during the conversion phase of the project, as well when the Terminal is completed, subject to an application to the EPA to remove redundant monitoring requirements. This AQIA predicts that the Project is compliant with the EPA air emission assessment criteria, and as such additional air quality monitoring beyond the sites current EPL requirements is not proposed for the Project.

10.0 Conclusion

This report assessed the air quality impacts associated with the proposed conversion of Shell's Clyde Refinery for the sole use as a finished fuel storage terminal. Dispersion modelling using CALPUFF was used to predict offsite benzene and total VOC concentrations due to storage of unleaded gasoline, jet fuel and automotive gas oil.

The dispersion modelling took account of meteorology and terrain information and used emission estimates of VOCs from the proposed fuel tanks to predict air quality impacts associated with the project. Emission rates of VOCs were estimated using the TANKS model which used chemical, meteorological, roof fitting, and rim seal data to generate emissions estimates.

The maximum dispersion modelling prediction at any gridded location for benzene was found to be well below the EPA criterion; predicted to be 2.3% of the criterion.

Modelling results for total VOCs were broken down by composition to a suite of typical VOCs found in unleaded gasoline, jet fuel and diesel. The analysis revealed all VOCs were within the applicable maximum 1-hour average concentration (99^{th} percentile) EPA criteria. A maximum percentage contribution to the EPA criteria of 24% (Cumene for Jet Fuel) was predicted, while most impacts were expected to have a contribution of less than 1%. These values were based on the maximum total VOC concentration predicted within the Project Area boundary and, as such, concentrations at the nearest receptor would be expected to be lower than the concentrations provided.

A comparison of the annual emission rates calculated from the TANKS model against the annual emission rates from the facility for each of the previous four annual return periods showed a significant reduction in emissions from the Clyde Terminal following the implementation of the proposed Project works. The Project's predicted total VOC and benzene emission rates represent an 85% and 99% reduction respectively from the maximum annual total emission rate of previous years. The comparison also confirmed that the annual loads of total VOC and benzene predicted using the TANKS model for the Project met the Clyde Terminal's EPL load limits with 3% and <1% of the allowable load limits respectively.

As the conservative predicted impacts are well below the required EPA criteria, there is no need for further mitigation at the Clyde Terminal at this time. The requirements for a construction environmental management plan and an operational environmental management plan were, however, discussed.

This AQIA predicts that the Project is compliant with the EPA air emission assessment criteria without any additional mitigation measures. Additional air monitoring beyond the sites current EPL requirements is therefore not proposed.

11.0 References

ATMECO Pty Ltd, 2012, Shell Clyde Refinery & Gore Bay Terminal - Leak Detection and Repair (LDAR) Program Interim Report - Reporting Period August 2011 to November 2012.

Australian Government; 2012, National Pollution Inventory Emissions Estimation Technique Manual for Fuel and Organic Liquid Storage.

Australian Standard (AS) 4323.4; 2009, Stationary source emissions; Method 4: Area source sampling – Flux chamber technique.

Australian Standard AS 4323.3; 2001, Stationary source emissions; Method 3: Determination of odour by dynamic olfactometry.

DEC, 2005, Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.

Department of Sustainability, Environment, Water, Population and Communities, 2013. *Results – Individual Facility: Shell Clyde Refinery*. Available at: http://www.npi.gov.au/npidata/action/load/browse-search/criteria /year/2012/browse-type/Company/reg-business-name/SHELL%2BREFINING%2B%2528AUSTRALIA %2529%2BPROPRIETARY%2BLIMITED. Accessed on 25 May 2013.