9 November 2011

610.10961 Process Emissions Impacts 20111109.docx

Goodman Property Limited
Level 17, 60 Castlereagh St
Sydney NSW 2000

Attention: Nelma Arancibia

Dear Nelma

Process Emissions Impact Assessment
Closure Printing
CCA Eastern Creek Facility

1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR Consulting) has been engaged by Goodman Property Limited (Goodman) on behalf of Coca Cola Amatil (CCA) to undertake a review of the anticipated impacts from process emissions from the Closure printing process at CCA, examine the potential for ground level impacts from those emissions and determine the need for the operation of an afterburner at the CCA Eastern Creek Facility.

It is currently envisaged that the building will be ventilated by the installation and operation of an extraction system, which will emit the building ventilation emissions to atmosphere.

The NSW Office of Environment and Heritage (OEH) have requested that the option for the use of an afterburner is explored, and the preferred building ventilation methodology is justified.

To date, it is understood that CCA has not developed the specifications for an afterburner option that may be operated at the CCA facility, and therefore typical and reasonable parameters applicable for the scope and scale of the use have been sourced from publically available data sources.

1.1 Study Objectives

The objectives of this study are as follows:

- Compile an emissions inventory for the Closure printing process.
- Undertake a process emissions appraisal utilising dispersion modelling screening.
- Discuss the potential impact of emissions of Volatile Organic Compounds (VOCs) and odour from the CCA facility over a distance of 1 km and at the closest residential location.
- Compare methods for emission control, namely:
    - Ventilation.
    - Afterburner.

SLR Consulting Australia Pty Ltd 2 Lincoln Street Lane Cove NSW 2066 Australia
(PO Box 176 Lane Cove NSW 1595 Australia)
T: 61 2 9428 8100 F: 61 2 9427 8200 E: sydney@slrconsulting.com www.slrconsulting.com
ABN 29 001 584 612

1.2 Supplied Information

Information on Closure printing at the CCA facility has been provided by M.E Engineering via email correspondence. The supplied information is summarised below:

- Typical ink flow is 0.3 kg/hour per machine.
- A maximum of 4 machines will be operating simultaneously.
- Each machine has a ventilation gas flow rate of 1,500 m^3/hr, a total of 6,000 m^3/hr (or 1.7 m^3/s) given 4 machines.
- The Ink MSDS has been provided and gives information on the composition of the Ink.

2 PROCESS DETAILS

2.1 Solvent Composition in Printing Ink

The supplied MSDS (ink product name RDF-SERIE) provides information on the ink's composition. Substances presenting a health or environmental hazard are listed below in **Table 1** along with their nominal concentrations.

Table 1 Solvent Composition in Ink

Name of Substance	CAS No.	Moleculer Weight (g/mol)[1]	Concentration Range (%)
Isomers of xylene	1330-20-7	146.18	2.5 -10
Cyclohexanone	108-94-1	106.16	2.5 -10
n-Butyl acetate	123-86-4	116.16	2.5 -10
Propylene glycol monoethyl acetate[2]	54839-24-6	98.15	25 - 50

Note 1: Sourced from Chemical MSDS Search.
Note 2: Trade name is ethoxyproyl acetate.

These identified substances are solvents which have been mixed with resin and pigment to facilitate application of a printed coating to a material surface. These solvents will volatilise (i.e. evaporate) during handling and machine cleaning activities, as well as during printing operations generating solvent emissions.

2.2 Mass Emission Rates for Identified Solvents

Using information provided in **Section 1.2** and **Table 1**, worst case mass emission rates have been calculated for each identified solvent (refer to **Table 2**) by applying the following equation:

$$Solvent\ Emission\ Rate = Ink\ Consumption\ per\ machine\ x\ 4\ x\ Solvent\ Content\ in\ Ink$$

Where:

Solvent emission rate is expressed as kg/hr
Ink consumption is expressed as kg/hr
Solvent content is expressed as percent (%)

In estimating the emission rates for each compound it has been assumed that all solvent is emitted during the printing process, which will result in a worst-case assessment of impacts.

Table 2 Emission Rates for Identified Solvents

Solvent	**Total Emission Rate[1] (kg/hr)**	**Total Emissions Rate[1] (g/s)**
Isomers of xylene	0.12	0.03
Cyclohexanone	0.12	0.03
n-Butyl acetate	0.12	0.03
Propylene glycol monoethyl acetate	0.60	0.17
Total	**0.96**	**0.26**

Note 1: Worst case emission rate of solvent within the CCA facility assuming 4 machines operating simultaneously.

3 ASSESSMENT CRITERIA

3.1 VOC Impact Assessment Criteria

The OEH prescribe impact assessment criteria for individual toxic air pollutants and odorous compounds in their document, *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (hereafter, the Approved Methods). **Table 3** outlines the criteria applicable to the study.

In accordance with the Approved Methods, individual toxic air pollutant criteria must be applied at and beyond the boundary of the facility.

The criteria for individual odorous compounds must be applied at the nearest existing off-site sensitive receptor locations (i.e. residential dwelling).

Table 3 VOC Impact Assessment Criteria

Solvent	**Averaging Period (hrs)**	**Health-Based [1] (µg/m³)**	**Odour-Based [2] (µg/m³)**
Odorous Compounds			
Isomers of xylene	1 hour	na	190
Cyclohexanone	1 hour	na	260
n-Butyl acetate	1 hour	na	1,020
Toxic Air Pollutants			
Propylene glycol monoethyl acetate[3]	1 hour	6,600	na

Note 1: Values sourced from Table 7.2b, Approved Methods.

Note 2: Values sourced from Table 7.4a, Approved Methods.

Note 3: Criteria provided for propylene glycol monomethyl ether

"na": no guideline available

4 DISPERSION MODELLING OF SOLVENT EMISSIONS

4.1 Model Selection

The atmospheric dispersion modelling carried out for the Project Site utilises the Ausplume Gaussian Plume Dispersion Model software (version 6.0) as developed by the EPA, Victoria. This choice of modelling system is considered suitable for the current assessment based on the relatively uncomplicated terrain surrounding the CCA Facility.

The atmospheric dispersion modelling assessment of the operation of the Project was conducted through the use of the Ausplume atmospheric modelling system, and the model was set up in accordance with OEH requirements and principles, as may be derived from the OEH Approved Methods.

The operational modelling scenario developed to assess the potential impact of odour from the Project on the surrounding environment examines worst-case conditions at the CCA Facility (i.e. maximum solvent concentration emission and 4 machines operating).

4.2 Stack and Emission Data

Table 4 below outlines the emissions inventory used for this assessment.

Table 4 Emissions Inventory

Parameter	Units	Value
Total Mass Emissions Rate	g/s	0.27
Gas Flow Rate	m^3/s	1.7
Temperature	^oC	25
Stack Coordinates	m	300480 E, 6255760 S
Stack Height	m	3
Stack Diameter	m	0.4
Cross Sectional Area of the Stack	m^2	0.13
Emission Velocity	m/s	13.3
Approx. Building Height	m	12.2
Hours of Operation	hrs/day	24

4.3 Meteorological Data

The modelling study was performed as a Level 1 Screening Study, and was based on the use of the METSAMP meteorological data file supplied with Ausplume. METSAMP is a synthetic dataset containing a full range of worst case meteorological conditions (wind speed, ambient temperature, mixing height and stability class category) and can be used to provide a conservative estimate of worst case downwind concentrations for averaging periods of 1 hour or less.

4.4 Receptor Locations

The METSAMP file is based on a constant wind direction. Receptors locations chosen are therefore located downwind of the stack at 10 m resolution, for a distance of 1 km downwind of the stack.

A single discrete receptor was also located 880 m downwind of the stack to simulate the location of the nearest sensitive receptor.

4.5 Building Wake Effects

The CCA building was entered into the model with a roof height of 12.2 m above ground level.

4.6 Terrain Data and Land Use

The terrain surrounding the site is relatively flat and there are no significant topographical features located between the site and the nearest sensitive receptor. Topographical effects on plume dispersion are therefore expected to be minor and the modelling was performed assuming flat terrain.

4.7 Modelling Results

The results of the modelling are presented in **Table 5** and **Table 6**. The results presented in **Table 5** show that based on the stack and emission data used in the modelling study, that downwind ground level concentrations of solvents at the nearest sensitive receptor would be far below regulatory guidelines for both health and odour nuisance impacts.

Table 5 Predicted Solvent Concentrations at Nearest Sensitive Receptor

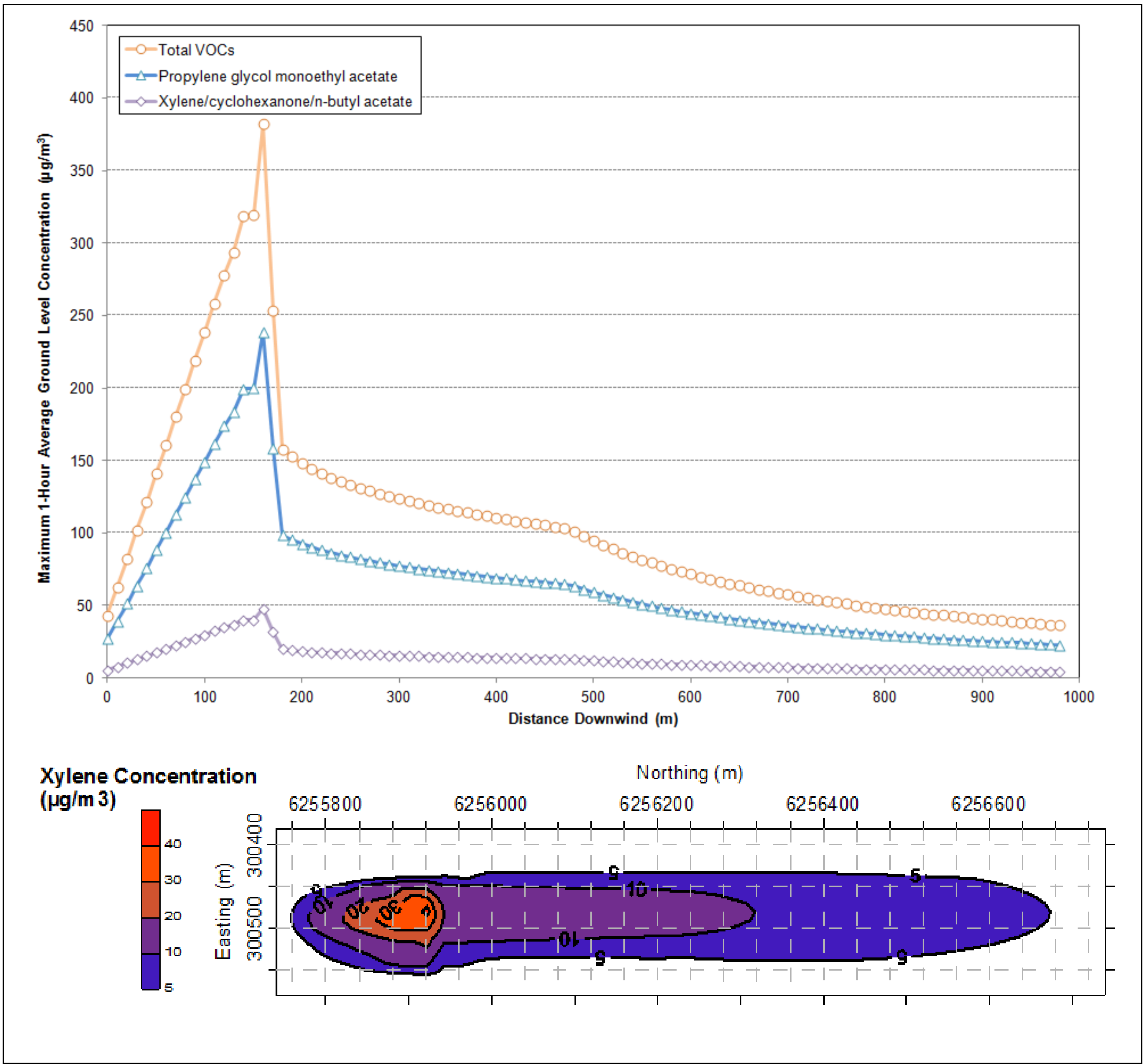
Pollutant	Maximum Predicted Concentration (µg/m^3, 1-Hour Average)	NSW Assessment Criteria (µg/m^3, 1-Hour Average)
Isomers of xylene	21	190
Cyclohexanone	21	260
n-Butyl acetate	21	1,020
Propylene glycol monoethyl acetate	103	6,600

Table 6 Predicted Maximum Solvent Concentrations

Pollutant	Maximum Predicted Concentration (µg/m^3, 1-Hour Average)	NSW Assessment Criteria (µg/m^3, 1-Hour Average)
Isomers of xylene	48	190
Cyclohexanone	48	260
n-Butyl acetate	48	1,020
Propylene glycol monoethyl acetate	239	6,600

Figure 1 presents plots of the maximum predicted ground-level VOC concentrations with distance from the stack. These are the plume centreline concentrations and represent worst case impacts predicted for emissions from the site. A contour plot of the xylene concentrations is provided underneath the X-Y plot to illustrate the plume spread.

Figure 1 Maximum Predicted Ground Level VOC Concentrations



5 REVIEW OF ENVIRONMENTAL FACTORS ASSOCIATED WITH AFTERBURNER

Solvent emissions may be reduced using air pollution control equipment such as an afterburner which uses a process of thermal oxidation to combust and destroy hydrocarbons present in the air stream. Given efficient operating conditions an afterburner will typically destroy approximately 95-98% of Volatile Organic Compounds (VOCs) or solvent emissions.

The energy consumption of an afterburner is an important sustainability consideration. Afterburners operate most efficiently where there is a high concentration of VOCs to act as the fuel source (instead of natural gas or oil) for complete combustion at a targeted operating temperature. Waste heat is then recovered and recycled back into the process thereby reducing primary fuel requirements.

Therefore, unless the vented air stream contains a high concentration of VOCs, the use of an afterburner represents a high operational cost option.

The combustion process also needs to be properly controlled to avoid the production of carbon monoxide (CO) which can occur from poor fuel and air mixing. Nitrogen oxides (NO_X) will also be formed due to the high operating temperature of an afterburner, and the combustion of the low-hydrocarbon content gas stream and combustion support fuels will also generate additional carbon dioxide (CO_2) emissions. These by-products may contribute to acid rain and smog, and may cause respiratory problems and other ill-health effects in humans.

5.1 Cross Examination of Emission Control Options

To demonstrate the potential for environmental impacts due to the operation of a typical afterburner, the following scenarios are briefly reviewed:

Scenario 1: Exhaust extraction of machine vented air stream to the afterburner chamber, and the operation of a typical afterburner receiving an air stream low in VOCs.

Scenario 2: Exhaust extraction of machine vented air stream to the atmosphere through a stack.

It can be assumed that the amount of electricity consumed due to exhaust extraction of the air stream to the roof (either for release to the atmosphere or to the afterburner) will be comparable in both scenarios. Therefore the differences between **Scenario 1** and **2** will include the following:

- Electricity use due to the operation of the afterburner (additional to exhaust requirements).
- CO_2, methane (CH_4) and nitrous oxide (N_2O) emissions released to atmosphere (expressed as CO_2-equivalent (CO_2-e) for greenhouse gas (GHG) contribution) due to gas combustion (assumed natural gas use as primary fuel).
- Use of natural resources in relation to electricity use and primary fuel requirement of the afterburner.
- Concentrations of VOCs released to the atmosphere.

To provide context to the above and to demonstrate the very low VOC concentration present within the machine extracted air streams at the CCA facility, typical pollutant loadings necessary for afterburner operational efficiency (i.e. the volume of solvent emissions present in the air stream) have been sourced.

The US EPA provide a typical pollutant loading within the afterburner emission stream of 1,500 to 3,000 ppmv (parts per million volume).

Using molecular weights and calculated emission rates for each solvent as presented in **Table 2**, and a volume of 6,000 m^3/hr (i.e. the total volume of air vented from four machines per hour), the pollutant loading of the machine vented air streams for the CCA facility may be calculated as follows:

$$ppmv = \frac{mg}{m^3} \times \frac{22.4 \times \left(\frac{273 + Temp}{273}\right)}{mw}$$

Where:

ppmv	=	*the volume of gaseous pollutant per 10^6 volumes of ambient air*
mg/m³	=	*milligrams of solvent emission per cubic metre of ambient air*
22.4	=	*volume of ideal gas (L/mole)*
Temp	=	*temperature in degree centigrade (assumed to be 20°C)*
mw(g/mol)	=	*molecular weight of the solvent*

Table 7 provides a comparison of calculated CCA facility pollutant loadings to typical pollutant loadings for an afterburner. It is noted that air streams with VOC concentrations below 2,000 ppmv result in decreases in reaction rates and in maximum VOC destruction efficiency (US EPA).

Table 7 Afterburner Air Stream Pollutant Loading – CCA facility vs Typical

Pollutant	**Solvent Emissions per volume extracted air (mg/m^3)**	**Pollutant Loading (ppmv)**	**Typical Pollutant Loading (ppmv)**
Isomers of xylene	0.01	0.002	
Cyclohexanone	0.01	0.003	
n-Butyl acetate	0.01	0.002	
Propylene glycol monoethyl acetate	0.06	0.014	
Total	**0.09**	**0.021**	**1,500 – 3,000**

Note 1: Sourced from the US EPA's "*Air Pollution Control Technology Fact Sheet*".

Given the above, it is considered that **Scenario 1** would result in significant unnecessary primary fuel and electricity consumption, as well as the undesired release of combustion products into the atmosphere.

As demonstrated by the modelling results presented in **Section 4.7**, **Scenario 2** would result in downwind ground level concentrations of solvents at the nearest sensitive receptor which would be far below regulatory guidelines for both health and odour nuisance impacts.

6 CONCLUSION

The above emission appraisal demonstrates that using the worst-case emission rates associated with 4 printing machines operating continuously, and worst-case meteorological conditions (as synthesised through the use of the METSAMP meteorological data file), that the ground level concentrations predicted in the vicinity of the CCA facility are significantly below the relevant NSW OEH Impact Assessment Criteria. The corresponding impacts at the nearest identified sensitive receptor location is correspondingly lower than the relevant Impact Assessment Criteria.

On this basis, it may be reasonably recommended that the requirement for supplementary emission controls cannot be justified.

A further assessment of the respective pollutant loading has also been performed, to quantify the likely solvent emission concentration against that anticipated from the process emissions at the CCA facility. The US EPA suggest that for effective afterburner use, pollutant loading in the range of 1,500 to 3,000 ppmv is required in order to avoid the unsustainable use of supplementary fuel. It has been demonstrated that the pollutant loading from the process is significantly below this recommended (or 'typical') range, and that the consumption of support fuel to heat the afterburner to the required destruction temperatures does not provide a sustainable solution.

On the basis that the emissions will not cause any exceedence of the respective NSW OEH Impact Assessment Criteria and that the estimated pollutant loading is significantly below the range which sustainable energy use may be achieved, it is recommended that an afterburner is not considered appropriate technology for emissions control at the CCA facility, and it would represent an inefficient and unsustainable use of natural resources.

Yours sincerely

T. Henley

TANYA HENLEY
Senior Project Consultant