Appendix D

Greenhouse Gas Assessment

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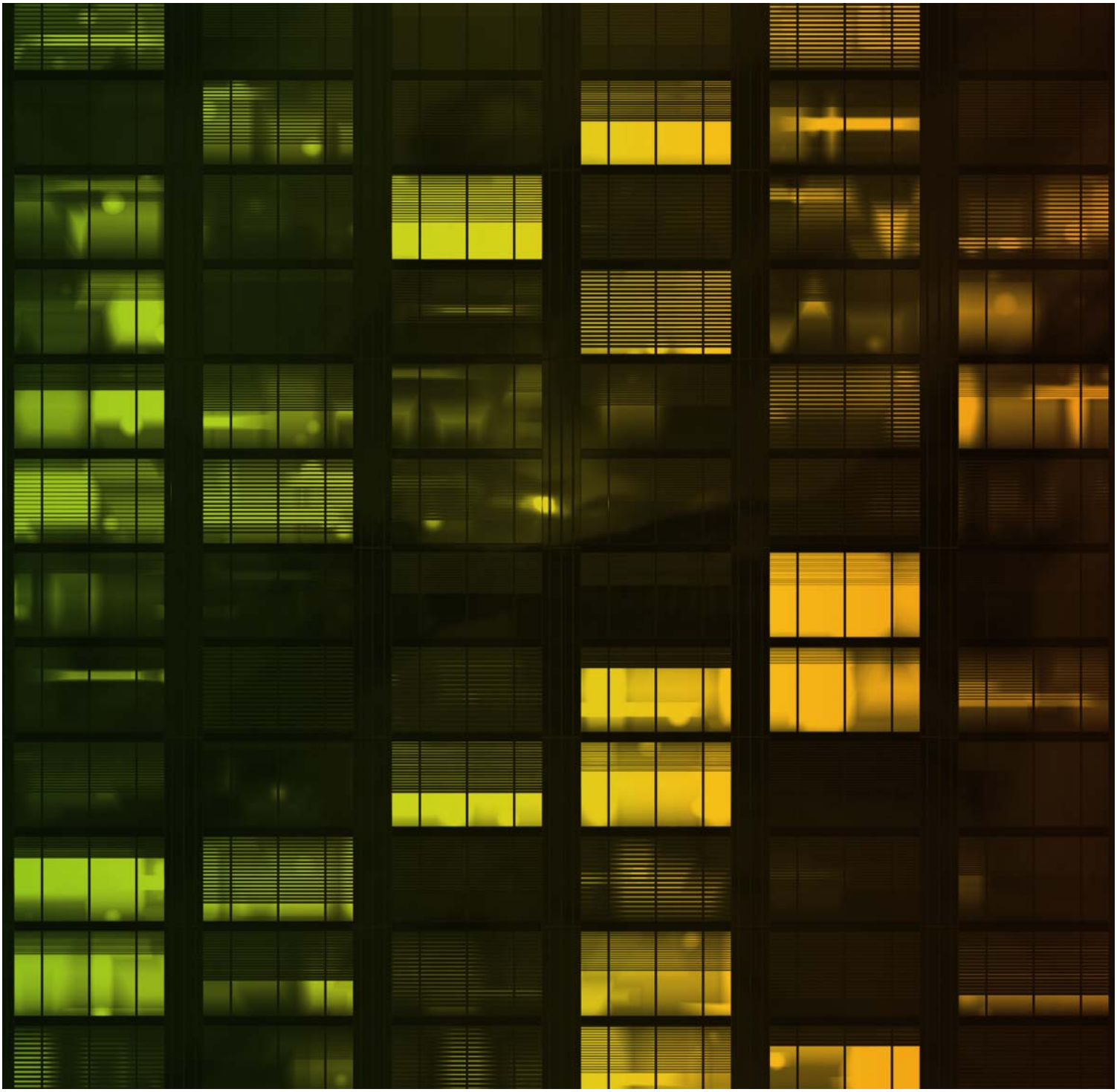
FINAL

National Ceramic Industries Australia
23 February 2010
N6050104

Greenhouse Gas Assessment

NCIA Expansion



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Greenhouse Gas Assessment

NCIA Expansion

Prepared for

National Ceramic Industries Australia

Prepared by

AECOM Australia Pty Ltd
17 Warabrook Boulevard Warabrook NSW 2304,
T +61 2 4911 4900 F +61 2 4911 4999 www.aecom.com
ABN 20 093 846 925

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1	**Len Pereria** **Managing Director** **National Ceramic Industries Australia** PO Box 765 Maitland NSW 2000	1	**AECOM** Project file

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1.0 Introduction

AECOM was commissioned by National Ceramic Industries Australia Pty Limited (NCIA) to conduct a greenhouse gas (GHG) assessment for the proposed expansion of tile production at its Rutherford facility (the Facility), located 35 km northwest of Newcastle. This study was undertaken as part of an Environmental Assessment to support NCIA's application for Project Approval under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The proposed expansion (the Project), known as Stages Five to Eight, includes the construction and operation of a second factory building with four additional production lines on a parcel of land adjacent to the existing Facility. The Project would involve increasing the currently approved maximum production capacity from 12.8 million square metres (m^2) to 25.6 million m^2, equating to 506,880 tonnes per annum (tpa).

1.1 Scope of Works

The Director-General's Requirements (DGRs) issued for the Project (25 February 2009) indicated that the Environmental Assessment was to address GHG and energy efficiency aspects, including:

> *"…an assessment of the energy use on site, and demonstrate what measures would be implemented to ensure that the proposal is energy efficient. "*

GHG emissions from the Facility are associated with:

- The manufacturing of tiles (combustion of fuel by stationary plant and on-site transport vehicles);
- Electricity use; and
- Transport of product to customers (indirect emissions).

Emissions were assessed for two scenarios using data provided by NCIA and emission factors specified in the National Greenhouse Account (NGA) Factors (DCC, June 2009):

- Currently approved maximum production (12.8 million m^2 per annum, or 253,440 tpa); and
- Proposed maximum production (506,880 tpa).

Production data for the 2008/09 production year (1 August 2008 to 31 July 2009) were obtained from NCIA and factored up to estimate emissions for the two scenarios assessed assuming a linear relationship between production levels and resource use. Results were compared to historical Australian emission levels.

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2.0 Climate Change and Greenhouse Gases

GHGs are gases found in the atmosphere that absorb outgoing heat that is reflected from the sun. The absorption of the heat energy warms the air, enabling life to survive, and is known as the Greenhouse Effect. The primary GHG is carbon dioxide (CO_2).

Human activities, such as the combustion of carbon-based fuels, increase the amount of GHGs in the atmosphere. This leads to greater absorption of heat and increases in atmospheric temperature, known as the Enhanced Greenhouse Effect. The atmospheric concentration of CO_2 has risen from 280 parts per million (ppm) in 1860 to approximately 388 ppm in January 2010[1]. At the same time, the average global temperature has increased by nearly 1 °C. Projections show that if this trend continues, global temperatures could rise between one and four degrees by the end of the 21st century, with annual average temperatures in Australia projected to increase by 0.4 - 2.0 °C by 2030 and by 1 – 6 °C by 2070 compared to 1990 levels[2].

Australia's per capita GHG emissions are among the highest in the world[3] (AGO, 1998) and, overall, the total net GHG emissions in Australia increased by 2.2 % between 1990 and 2005. Most of the increases resulted from energy generation and industrial processes.

The NSW Government has committed to a long-term target of a 60 % reduction in GHG emissions by 2050 and a return to year 2000 GHG emission levels in NSW by 2025. There are, however, no legislative limits for emissions of GHGs.

2.1 Global Warming Potential

Different GHGs have different heat absorbing capacities. In order to achieve a basic unit of measurement, each GHG is compared to the absorptive capacity of CO_2, and measurements and estimates of GHG levels are reported in terms of CO_2 equivalent emissions (CO_2-e). Global warming potentials (GWPs) are used to compare the abilities of GHGs to trap heat in the atmosphere. A GWP is based on the radiative efficiency of a gas (i.e. its heat-absorbing ability), relative to that of CO_2, and its decay rate (i.e. atmospheric lifetime), also relative to CO_2. The GWP provides a means to convert emissions of GHGs into CO_2-e units. The global warming potentials of the primary GHGs adopted by Australian regulatory authorities are shown in **Table 1**.

Table 1: Greenhouse Warming Potentials - Select Greenhouse Gases

Greenhouse Gas	Global Warming Potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310
Source: Table 27, National Greenhouse Accounts (NGA) Factors, Department of Climate Change, June 2009	

2.2 National Greenhouse Gas Inventory

Australia's National Greenhouse Gas Inventories are designed to provide estimates of Australia's net GHG emissions and track Australia's progress towards its internationally-agreed target of limiting emissions to 108 % of 1990 levels over the period 2008 – 2012. Australia has updated and published annual national GHG inventories

[1] National Oceanic and Atmospheric Administration, US Department of Commerce, ftp://ftp.cmdl.noaa.gov/ccg/co2/trends/co2_mm_mlo.txt; accessed 16 February 2010

[2] WBCSD (2004). *The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard, Revised edition.* World Business Council for Sustainable Development / World Resources Institute, Washington, D.C.

[3] *AGO. (1998). National Greenhouse Strategy, Strategic Framework for Advancing Australia's Greenhouse Response, Australian Greenhouse Office, Commonwealth of Australia, Canberra, 1998.*

for each year from 1990 to 2007 inclusive. The inventories are prepared according to international guidelines. Details of the most recent inventory (2007) are shown in **Table 2**.

Table 2: Australian National Greenhouse Gas Emissions, 2007

Sector	Mt CO_2-e
Agriculture, forestry, fishing	150.1
Mining	56.9
Manufacturing	71.5
Non- metallic mineral products Ceramics	*1.2*
Electricity, gas, water	205.9
Construction	1.8
Commercial Services	17.4
Transport & storage	39.2
Residential	54.3
Total of all Economic (ANZSIC) Sectors	597.2
Source: Australian Greenhouse Emissions Information System, Department of Climate Change (Wed Oct 28 10:58:26 2009)	

In 2007, Australia's net GHG emissions were 597.2 Mt CO_2-e. Of these emissions, 1.2 Mt CO_2-e (0.2 % of the total Australian emissions) were emitted by the ceramic manufacturing industry. The change in emissions from ceramic manufacturing in Australia between 1990 and 2007 are shown in **Figure 1**. Emission levels appear to have followed a five-year cycle about a constant average between 1990 and 2007.

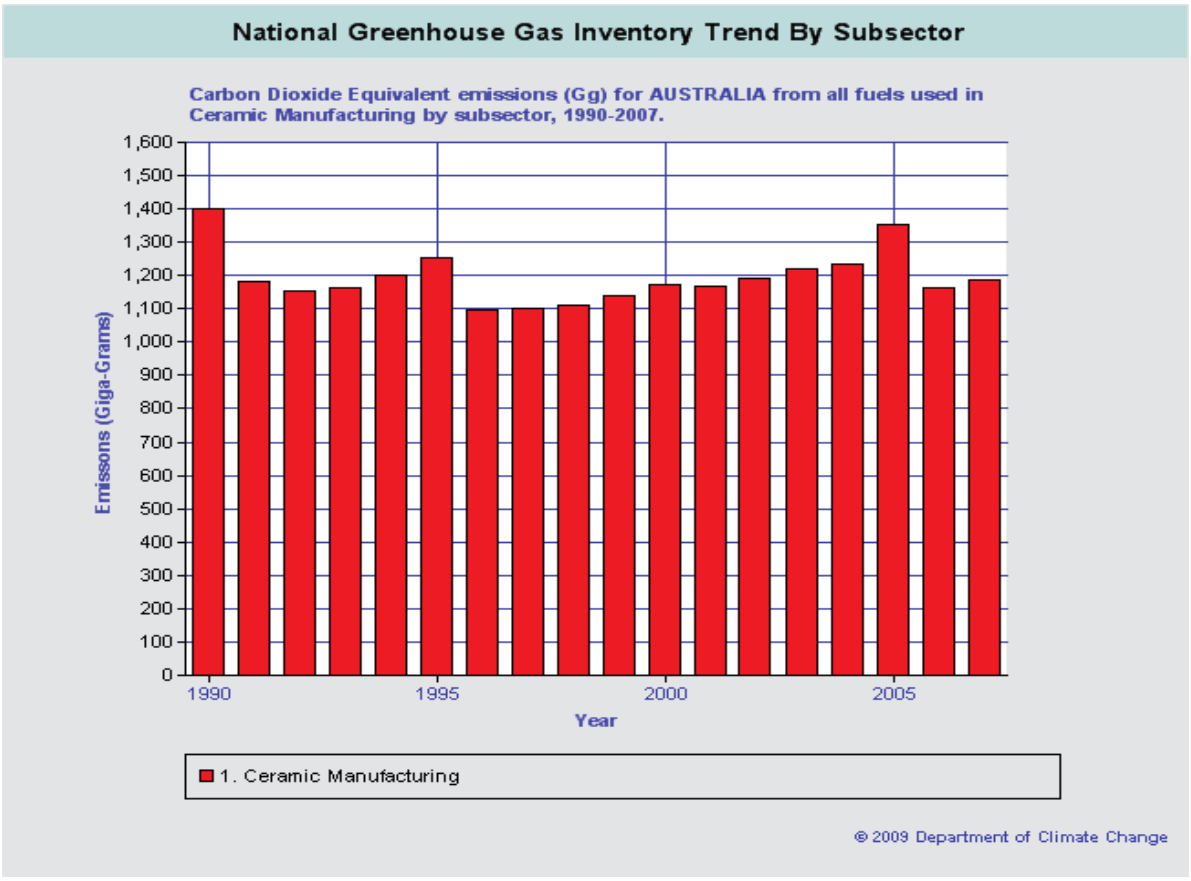

Figure 1: Greenhouse Gas Emissions from Ceramic Manufacturing - Australia, 1990 - 2007

2.2.1 Greenhouse Gas Reporting

The *National Greenhouse and Energy Reporting Act 2007* (the Act) was passed in September 2007, establishing a mandatory reporting system for corporate GHG emissions and energy production and consumption in Australia. The first reporting period under the Act commenced on 1 July 2008. Information obtained from the reporting process is intended to be used for the development of the Carbon Pollution Reduction Scheme.

The National Greenhouse and Energy Reporting (NGER) Guidelines were developed to help corporations understand their obligations under the Act. The Reporting Guidelines are applicable across industry sectors and cover important concepts under the Act and the *National Greenhouse and Energy Reporting Regulations 2008*, including determining the need to report, how to register, reporting obligations, and record keeping requirements. The Reporting Guidelines were designed for use with the NGER Technical Guidelines.

The NGER Technical Guidelines (2008) were developed to assist stakeholders understand and apply the NGER (Measurement) Determination 2008, which outlines calculation methods and criteria for GHG emissions, energy production and consumption. The National Greenhouse Accounts (NGA) Factors were designed for companies and individuals to estimate GHG emissions for reporting under the above government programs. The methods are based on Method 1 of the NGER (Measurement) Determination 2008 and the NGER Technical Guidelines (2008), but apply to a broader range of applications. The NGA Factors are typically specified as the relevant methodology to follow when preparing GHG assessments for Project Applications to the Department of Planning in NSW. The latest version was released in June 2009.

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3.0 Emissions Estimates

3.1 Methodology

Estimation of the GHG emissions associated with the approved and proposed operations was undertaken using the emission factors and methods outlined in the NGA Factors for three assessment categories:

- **Scope 1**, which covers direct emissions from sources within the boundary of an organisation, such as fuel combustion and manufacturing processes;
- **Scope 2**, which covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation; and
- **Scope 3**, which includes all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation, such as product transport emissions and emissions from the generation of purchased electricity.

This assessment estimated emissions relating to:

- The manufacturing of tiles (Scope 1);
- Electricity consumption (Scope 2 and Scope 3); and
- Transport of product to customers (Scope 3).

Emissions were assessed for two scenarios:

- Approved maximum production (253,440 tpa); and
- Proposed maximum production (506,880 tpa).

Production data for the 2008/09 production year (equating to 67,293 tonnes from 1 August 1008 to 31 July 2009) were obtained from NCIA. To estimate emissions for the two scenarios, these data were factored up assuming a linear relationship between all variables (fuel consumption, number of deliveries etc.) and the tile production rate. This approach was considered to be conservative as the new plant to be installed for the expansion would be more energy efficient than the existing plant as discussed in **Section 3.4.1**; as such, actual GHG emissions associated with the Project, and the change in emission levels, are expected to be lower than the estimates provided in this assessment. The differences in emissions between the approved and proposed production rates were calculated to determine the change in impact.

3.2 Emissions Estimates

3.2.1 Manufacturing of Tiles

GHG emissions associated with manufacturing tiles arise from the combustion of fuels in stationary plant (such as the kilns) and on-site transport vehicles (forklifts and front-end loaders that load and unload raw product into the process and manage the final product stockpile). Emissions for these sources were estimated using factors provided in the NGA Factors (June 2009) as outlined below.

Emission factors for the combustion of natural gas in stationary plant are shown in **Table 3**; these were used to estimate the GHG emissions from the approved and proposed facilities, shown in **Table 4**. The proposed expansion would increase GHG emissions associated with stationary plant by approximately 0.08 Mt CO_2-e per year.

Table 3: Emission Factors – Combustion of Compressed Natural Gas

Greenhouse Gases	Emission Factor (kg CO_2-e/G)
CO_2	51.2
CH_4	0.1
N_2O	0.03
Source: Table 2, NGA Factors, June 2009	

Table 4: Scope 1 Emissions - Combustion of Natural Gas (Stationary Plant)

Scenario	Amount (G)	GHG Emissions (t CO_2-e)			
		CO_2	CH_4	N_2O	Total
Approved	1,396,482	71,499.9	139.6	41.9	71,681.4
Proposed	2,792,965	142,999.8	279.3	83.8	143,362.9
Difference (proposed – approved)					**71,681.4**

Emission factors for the on-site transport emissions are shown in **Table 5**. The estimated GHG emissions associated with diesel-powered mobile plant on the site are shown in **Table 6**. The proposed expansion would increase GHG emissions associated with mobile plant by approximately 0.0003 Mt CO_2-e per year.

Table 5: Emission Factors - Diesel Combustion (Transport)

Transport equipment type	Fuel combusted	Energy content factor (G /kL)	Emission Factor (kg CO_2-e/G)		
			CO_2	CH_4	N_2O
General transport	Diesel	38.6	69.2	0.2	0.5
Source: Table 4, NGA Factors, June 2009					

Table 6: Scope 1 Emissions - Diesel Combustion (Mobile Plant)

Scenario	Amount (kL)	GHG Emissions (t CO_2-e)			
		CO_2	CH_4	N_2O	Total
Approved	118.8	317.3	0.9	2.3	320.6
Proposed	237.6	634.7	1.8	4.6	641.1
Difference (proposed – approved)					**320.6**

3.2.2 Emissions from Electricity Use (Scopes 2 and 3)

NCIA's 2009 NGER report indicated an electricity consumption of 13,463,357 kWh for the reporting period, during which a total of 67,293 tonnes of tiles were manufactured at the Facility. These data indicate an electricity consumption rate of 200.1 kWh per tonne of tiles manufactured. This factor was used to determine electricity consumption of the Facility under the approved (253,440 tpa) and proposed (506,880 tpa) scenarios. Emission factors for Scope 2, 3 and full fuel cycle (i.e. Scope 2 + Scope 3) emissions were obtained from the NGA Factors (June 2009) for emissions from electricity purchased in NSW; results are shown in **Table 7**. The proposed increase in production would result in an additional 0.05 Mt CO_2-e per year compared to existing levels.

Table 7: GHG Emissions from Electricity Use

Emissions Type	Emission Factor (kg CO_2-e/kWh)	GHG Emissions (t CO_2-e)		
		Approved	Proposed	Difference (proposed – approved)
Scope 2	0.89	45,128	90,257	45,128
Scope 3	0.18	9,127	18,254	9,127
Full Fuel Cycle (total)	1.07	54,255	108,511	54,255
Source: Table 39, NGA Factors, June 2009				

3.2.3 Transport Emissions

Details of the tile transport operations are shown in **Table 8**.

Table 8: Tile Transport Data

Transport of tiles to customers	Approved	Proposed
Total tiles transported (tpa)	253,440	506,880
Number of trips per year	14,914	29,828
Fuel consumption rate of trucks (L/km)^	0.546	
Average distance per trip (km)*	640	
Total annual distance travelled (km)	9,545,099	19,090,198
Total fuel consumed (L)#	5,211,624	10,423,248
** Provided by NCIA* *^Australian Bureau of Statistics data* *#Assumed all vehicles were diesel-powered; tonnage calculated using a density of 0.836 kg/L (Table 61, NPI Emission Estimation Technique Manual for Combustion Engines, v3.0, June 2008)*		

The above data were used together with the data shown in **Table 9** to estimate the associated GHG emissions from NCIA's tile transport activities, shown in **Table 10**. An additional 0.001 Mt CO_2-e would be produced from the transport of the tiles under the proposed scenario.

Table 9: Scope 3 Emission Factors - Diesel Use

Fuel type	Emission Factor (kg CO_2-e/G)
Diesel	5.3
Source: Table 38, NGA Factors, June 2009	

Table 10: Greenhouse Gas Emissions - Product Transport

Scenario	Diesel Use (G)	GHG Emissions (t CO_2-e)CO_2
Approved	198,675	1,053.0
Proposed	397,351	2,106.0
Difference (proposed – approved)		**1,053.0**
* Assuming an automotive diesel energy content of 45.6 GJ/t		

3.3 Emissions Summary

Emissions estimates from all sources outlined above are summarised in **Table 11**.

Table 11: Greenhouse Gas Emissions Summary

Activity	Estimated Emissions (t CO_2-e)		
	Approved	Proposed	Difference
Fuel combustion – stationary plant	71,681	143,363	71,681
Fuel combustion – on-site transport	320.6	641.1	321
Electricity use	54,255	108,511	54,255
Total (excluding product transport)	**126,257**	**252,515**	**126,257**
Product transport (truck)	*1,053*	*2,106*	1,053
Total	***127,310***	***254,621***	***127,310***

The greatest source of GHG emissions from the Facility is stationary plant, followed by electricity use. The approved operations would generate an estimated 0.127 Mt CO_2-e per year (direct and indirect GHG emissions). Emissions would increase to approximately 0.25 Mt CO_2-e at the proposed maximum production rate of 506,880 tpa, which is equivalent to approximately 21 % of national emissions from the ceramics sector (1.2 Mt CO_2-e in 2007) and 0.04 % of the total national emission levels (597.2 Mt CO_2-e). As such, the additional emissions associated with the proposed project will not substantially increase the total national emissions or impede emission reduction actions.

3.4 Emission Reduction Opportunities

3.4.1 Energy Saving

The NSW Government's Energy Efficiency Action Strategy established a number of energy saving initiatives under the *Energy and Utilities Administration Act 1987 No 103 Part 6A*, which commenced in 2005. The initiatives include the requirement for high energy users (i.e. those using more than 10 GWh of electricity per year) to prepare an Energy Savings Action Plan (ESAP) in accordance with the Guidelines for Energy Savings Action Plans (DEUS).

As the Facility uses more than 10 GWh of electricity per year, NCIA is required to prepare an ESAP. This plan is to provide a comprehensive analysis of the facility's energy use and strategies to minimise current electricity consumption. When prepared, this plan should also identify the expected increases in consumption associated with the use of the additional approved plant and that associated with the proposed expansion (if approved). Wherever possible, potential energy savings actions should be identified prior to the selection and installation of new plant and equipment.

NCIA proposes to implement the innovative tile manufacturing process technology known as Continua from Italian plant manufactures SACMI, who has developed three energy recovery systems applicable to all the latest-generation kilns. The installation of plant with the energy recovery features described below will result in greater energy efficiency.

BSR system (Combustion air heated at low temperature)

The combustion air passes through a heat exchanger in the rapid cooling section before being sent on to the burners at a temperature of approximately 100 °C. By subtracting heat from the rapid cooling zone, the exchanger also reduces the volumes needed to cool the material, giving energy savings in the order of 6 % over conventional kiln systems.

MDR system (Combustion air heated at medium temperature)

To allow further energy savings in addition to those provided by the BSR system, the final cooling zone of the latest generation kilns has been modified. The air gathered from the slow and final cooling areas is evacuated via a duct at a temperature of 100 - 120 °C and diverted to the heat exchanger in the rapid cooling zone and then used as combustion air at a temperature of approximately 150 °C. The additional energy consumption savings associated with the installation of the heat exchanger are in the order of 5 %.

SPR system (Super-heated combustion air)

To obtain further energy savings with respect to the MDR system, it is possible to double up the air expulsion chimneys in the slow and final cooling zones of the kiln. Calculated additional energy savings with respect to energy consumption rates achieved with the installation of the MDR system are in the order of 5 %.

3.4.2 Co-generation Plants

Co-generation is the simultaneous production of electricity and heat using a single fuel source. The heat produced by the electricity generating process is captured and utilised to produce high and low level steam. The steam can then be used as a heat source for numerous industrial applications. This process is most common in European countries, but has been increasingly adopted in industrial applications in Australia. Co-generation harnesses heat that would otherwise be wasted, leading to substantial reductions in GHG emissions while achieving greater thermal efficiency.

NCIA proposes to design and develop the Facility expansion in a way that would enable the future integration of electricity co-generation plants across their production lines (both existing and proposed). The co-generation plants would be located at the clay preparation spray drier area. It is envisaged that the co-generation plants would capture waste exhaust and heat from the boiler that runs the turbine, which would be used to operate the

spray driers. Each co-generation plant would generate enough electricity to operate the two stages / production lines it is integrated with and deliver excess electricity (estimated at 30 % of the amount produced) back into the grid.

3.4.3 Carbon Offsets

NCIA also proposes to invest in carbon offset projects to reduce the impact of emissions associated with the Facility. While prevention and minimisation of emissions are generally accepted to be best practice, carbon offsets play an important role in mitigating residual emissions. Such projects can include native tree planting or forestry sequestration, renewable energy technology investment, and greenhouse abatement certificates.

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4.0 Conclusion

NCIA proposes to expand its tile manufacturing Facility at Rutherford, including the construction and operation of a second factory building with four additional production lines on a parcel of land adjacent to the existing Facility. The expansion would increase the approved maximum tile production rate of 12.8 million m^2 (253,440 tpa) to 25.6 million m^2 (506,880 tpa), and increase GHG emissions associated with:

- Combustion of fuel from stationary plant;
- Combustion of fuel from transport vehicles for the on-site product movements;
- Electricity use; and
- Product transport.

The proposed expansion would increase total GHG emissions (direct and indirect) by approximately 0.127 Mt CO_2-e to a total of 0.25 Mt CO_2-e per year. Total GHG emissions from the expanded Facility would equate to approximately 0.04 % of Australian GHG emissions; as such, the proposed expansion is not expected to substantially increase total national GHG emissions. NCIA proposes to implement a number of processes that will reduce energy consumption of the Facility and serve to minimise GHG emissions associated with electricity use. Carbon offset investments could further serve to mitigate the Facility's emissions.

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Australia +61-2-8484-8999

Azerbaijan +994 12 4975881

Belgium +32-3-540-95-86

Bolivia +591-3-354-8564

Brazil +55-21-3526-8160

China +86-20-8130-3737

England +44 1928-726006

France +33(0)1 48 42 59 53

Germany +49-631-341-13-62

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