APPENDIX 10

Greenhouse and Energy Profile

Orica Australia Pty Limited

Proposed Ammonium Nitrate Emulsion (ANE) Production Facility, and Continued Operation of Orica Mining Services Technology Centre, Richmond Vale, NSW

Greenhouse Gas and Energy Impact Assessment

December 2009

Umwelt
Environmental Consultants

Proposed Ammonium Nitrate Emulsion (ANE) Production Facility, and Continued Operation of Orica Mining Services Technology Centre, Richmond Vale, NSW

Greenhouse Gas and Energy Impact Assessment

Prepared by

Umwelt (Australia) Pty Limited

on behalf of

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Report No.	2586/R07/Final	Date:	December 2009

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Executive Summary

Umwelt (Australia) Pty Limited was commissioned by Orica Australia Pty Limited (Orica) to conduct a Greenhouse Gas and Energy Impact Assessment (GHGEIA) of existing and proposed operations at the Orica Mining Services Technology Centre (the Technology Centre) at Richmond Vale near Kurri Kurri, New South Wales (NSW). Orica Mining Services offers commercial explosives, initiating systems, and blast-based services to the mining, quarrying and construction industries. Orica has operated the Technology Centre since 1991, which currently includes offices, research and manufacturing facilities, stores, water storage, sewage treatment and car parking.

Orica is seeking a new project approval for the continuation of existing operations at the Technology Centre and the construction and operation of a proposed Ammonium Nitrate Emulsion (ANE) Production Facility (the Project). ANE is an explosive precursor that forms part of an explosives mixture, such as ammonium nitrate/fuel oil (ANFO). The Project will allow an increase in production capacity at the Technology Centre to 250,000 tonnes per annum (tpa) of ANE, operating 24 hours per day, 7 days per week. Orica proposes to distribute the ANE product by road to other Orica operations for on-distribution and directly to mining and quarry sites predominantly in the Hunter Valley. The ANE is distributed to customers as a bulk ingredient.

The Project is the subject of this GHGEIA, which forms a component of the Environmental Assessment (EA) prepared for the Project in accordance with Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Project will require the approval of the NSW Minister for Planning.

The proposed ANE production facility will be located to the west of existing infrastructure at the Technology Centre. Production in the first year of operation is expected to be 125,000 tpa. The production increase will be achieved over a 12 year period through increased raw material deliveries and in response to market demand. The proposed ANE Production Facility is expected to reach the maximum production of 250,000 tpa in 2023.

For the purposes of the GHGEIA, the Project will be considered an ongoing operation that is expected to continue at maximum production from 2023. All energy and greenhouse calculations have therefore been based on timeframe increments to accurately represent the ongoing nature of the Project. Construction of the proposed ANE Production Facility infrastructure is expected to be completed in approximately 12 months.

The GHG emissions that occur on site that are a direct result of Project operations account for only 8.8 per cent, of the proposed total direct and indirect Orica operations. Orica have no direct management or control over the combustion efficiency or mitigation measures of 91.2 per cent of the GHG emissions that result from the Project, however, Orica can influence the amount of Scope 2 emissions through improved on-site energy efficiency measures. While Orica purchase and will continue to purchase electricity to operate the Project, these emissions are considered indirect and will ultimately be considered a Scope 1 emission of the respective electricity generator in national inventories or through the NGERS reporting. The direct and indirect emissions are also expected to be accounted for by national and international inventories.

On-site Scope 1 fugitive emissions (fuel combustion) have been described in incremental assessment periods of ten years for the operational phase, plus one year of construction. The Project has an estimated emission total of 8,013 t CO_2-e over 10+1 years, 15,363 t CO_2-e over 20+1 years, 22,713 t CO_2-e over 30+1 years, 30,063 t CO_2-e over 40+1 years and 37,413 t CO_2-e over 50+1 years.

Indirect Scope 2 emissions (electricity consumption) and Indirect Scope 3 emissions (off-site transport) have been described in incremental assessment periods of ten years for the operational phase, plus one year of construction. Scope 2 emissions from the Project have been estimated to total 65,140 t CO2-e / kWh over 10+1 years, 129,290 t CO_2-e / kWh over 20+1 years, 193,440 t CO_2-e / kWh over 30+1 years, 257,590 t CO_2- / kWh over 40+1 years and 321,740 t CO_2-e / kWh over 50+1 years. Scope 3 emissions for the Project have been estimated to 12,185 t CO_2-e over 10+1 years, 24,317 t CO_2-e over 20+1 years, 36,448 t CO_2-e over 30+1 years, 48,579 t CO_2-e over 40+1 years and 60,709 t CO_2-e over 50+1 years.

The construction and operation of the Project will contribute an estimated **0.00003** per cent to international annual GHG emissions and **0.001** per cent to national annual GHG emissions.

Orica may be considered an industry leader in GHG and energy management, and energy efficiency. The existing operations at the Technology Centre and the proposed Project are subject to current Orica climate change, sustainability, GHG and energy objectives. The current Orica corporate climate change and sustainability system incorporates reporting, policies, programs and plans. Management and mitigation recommendations that result from this GHGEIA are directly based on Orica sustainability performance requirements including the company milestone at 2010 to reduce N_2O by 50 per cent and reduce CO_2 emissions by 15 per cent. This equates to a combined reduction of 35 per cent in total CO_2-e emissions).

The National Greenhouse and Energy Reporting Streamlining Protocol (DCC, 2009a) establishes a detailed protocol and framework by which corporations and facilities may actively manage and assess the reduction of energy consumption and GHG emissions. A range of energy reduction measures will be considered as part of the ongoing operations at the Technology Centre.

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1.0 Introduction

1.1 Description of the Project

Umwelt (Australia) Pty Limited was commissioned by Orica Australia Pty Limited (Orica) to conduct a Greenhouse Gas and Energy Impact Assessment (GHGEIA) of existing and proposed operations at the Orica Mining Services Technology Centre (the Technology Centre) at Richmond Vale near Kurri Kurri, New South Wales (NSW). Orica Mining Services offers commercial explosives, initiating systems, and blast-based services to the mining, quarrying and construction industries. Orica has operated the Technology Centre since 1991, which currently includes offices, research and manufacturing facilities, stores, water storage, sewage treatment and car parking.

Orica is seeking a new project approval for continuation of the existing operations at the Technology Centre and the construction and operation of a proposed Ammonium Nitrate Emulsion (ANE) Production Facility (the Project). The Project will allow for production of up to 250,000 tonnes per annum (tpa) of ANE, operating 24 hours per day, 7 days per week. Orica proposes to distribute the ANE product by road to other Orica operations for on-distribution and directly to mining and quarry sites predominantly in the Hunter Valley. The ANE is distributed to customers as a bulk ingredient.

The Project is the subject of this GHGEIA, which forms a component of the Environmental Assessment (EA) prepared for the Project in accordance with Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The Project will require the approval of the NSW Minister for Planning.

The proposed ANE Production Facility will be constructed to the east of existing infrastructure at the Technology Centre, according to the following project objectives:

- capability of meeting the projected ANE demand to 2020 and beyond with an incremental increase in production from approximately 125,000 tpa in the first year of production (nominally 2011) up to a maximum of 250,000 tpa;
- minimise operating costs through improved technologies;
- apply Orica Mining Services global standard technology to produce the ANE; and
- establish sufficient raw material storage, including the capacity to manage a guaranteed ammonium nitrate solution (ANS) supply from Kooragang Island.

The construction of an office, quality control laboratory, control room and switch room are proposed with the Project. Production in the first year of operation is expected to be 125,000 tpa. The production increase will be achieved over a 12 year period through increased raw material deliveries and in response to market demand. The proposed ANE Production Facility is expected to reach the maximum production of 250,000 tpa in approximately 2023.

For the purposes of the GHGEIA, the Project will be considered an ongoing operation that is expected to continue at maximum production from 2023. All energy and greenhouse calculations have therefore been based on timeframe increments to accurately represent the ongoing nature of the Project. Construction of the proposed ANE Production Facility infrastructure is expected to be completed in approximately 12 months.

1.2 Greenhouse Gas and Energy Operational Boundaries

As applicable to the GHGEIA, the existing and proposed ANE production framework includes the primary and ancillary activities outlined in **Table 1.1**. These activities are the assumed sources of energy consumption and greenhouse gas (GHG) emissions for the Orica operations at the Technology Centre.

The existing operations approved by the existing development consents will remain unchanged as a result of the introduction of the proposed ANE Production Facility to the site. Specifically, offices, a mixing laboratory, a research laboratory, a research magazine, a quarry services depot, a test cell, an engineering stores depot, a site compound, a water storage area, sewerage treatment plant and car parking have been constructed and operate on site.

Table 1.1 – Orica Mining Services Operational Activities

Orica Mining Services Energy and Greenhouse Activities	
Activity	**Description**
Proposed Principal Activity • ANE production.	• Oxidiser solution preparation, fuel blend preparation, ANE manufacturing and ANE storage on site.
Ancillary Activities • Administration; • Explosives research; • Packaged explosives manufacture for testing; • Quarry services depot; and • Support services.	• Office buildings, research facilities, production facilities; and, support facilities, equipment and vehicles.

Orica Mining Services operations are assumed to be part of the Australian and New Zealand Standard Industrial Classification (ANZSIC) 2006 Division C Manufacturing, Subdivision 18 Basic Chemical and Chemical Product Manufacturing, Group 189 Other Basic Chemical Product Manufacturing, Class 1892 Explosive Manufacture (ABS, 2006).

1.2.1 Principal Activity

The principal activity will involve construction and operation of the following proposed ANE Production Facility components (as applicable to the GHGEIA):

- an ANE Production Facility for the production of up to 250,000 tpa of ANE;
- storage facilities for ammonium nitrate solution (ANS), weak ANS, acetic acid, sodium nitrite, caustic soda, thiourea and fuel;
- emulsion storage and load-out for export tankers;
- internal access road and truck weighing facilities;
- office, control room, switch room and quality control laboratory;
- relevant utility services including an on-site transformer;

- road transport of chemicals for ANE manufacture from Kooragang Island and other locations, including Sydney, to the Technology Centre; and
- road transport of ANE products from the Technology Centre to Orica or customer operations in the Hunter Valley.

1.3 Greenhouse Gas and Energy Management

The existing operations at the Technology Centre and the proposed ANE Production Facility are subject to current Orica climate change, sustainability, GHG and energy objectives. The current Orica corporate climate change and sustainability system incorporates reporting, policies, programs and plans.

1.3.1 Orica 2008 Sustainability Report

Orica currently manages climate change impact and regulatory requirements and physical risks of climate change by way of the following (Orica, 2008):

- carbon abatement opportunities in the Clean Development Mechanism (CDM) countries where Orica currently operate;
- significant energy savings identified through participation in the Australian Energy Efficiency Opportunities (EEO) legislation;
- opportunity to sell recycled water from the Orica Water Treatment Plant in Botany, Sydney, leading to a reduced reliance on potable water;
- technology that will provide significant abatement of nitrous oxide (N_2O) emissions; and
- investment in products and services designed to minimise carbon emissions from the provision of blasting services to global mining customers.

1.3.1.1 Orica Key Sustainability Performance Indicators

Orica measures sustainability performance and establishes benchmarking with the world's best practice. Of relevance to the GHGEIA, is the following Key Performance Indicators (KPIs): energy usage per tonne of production; and total GHG emission per tonne of production. Orica considers the management of GHG emissions as a key sustainability challenge (Orica, 2008). The KPIs are driven by the performance indicators listed in **Table 1.2**.

Table 1.2 - Orica Sustainability KPIs: Energy and Greenhouse

Orica Energy and Greenhouse KPIs*	
Performance Indicator	**Description**
EN3	Direct energy consumption by primary energy source.
EN4	Indirect energy consumption by primary source.
EN16	Total direct and indirect GHG emissions by weight.
EN17	Other relevant indirect GHG emission by weight.

* Source: Orica 2008 Sustainability Report: Promising to Deliver on our Sustainability Aspirations.
http://www.orica.com.au/BUSINESS/COR/orica/rwpattach.nsf/PublicbySrc/Orica_2008_Sustainability_Report.pdf/$file/Orica_2008_Sustainability_Report.pdf

Orica has also established company goals to reduce N_2O by 50 per cent and reduce CO_2 emissions by 15 per cent by 2010. This equates to a combined reduction of 35 per cent in total CO_2-e emissions (Orica, 2008).

1.3.2 Energy Efficiency Opportunities (EEO) Program

In 2005 Orica volunteered to be a trial company for the Australian Federal Government's Energy Efficiency Opportunities (EEO) program. For energy, the internal target is a 15 per cent reduction in energy consumption per tonne of product between 2005 and 2010. For CO_2 the targeted reduction is 15 per cent per tonne of product for energy related emissions and 50 per cent reductions per tonne of product for non-energy CO_2-e emissions. In 2007 to 2008 the energy use per tonne was 14 per cent lower and the CO_2 emissions are 22 per cent lower than 2005.

The Energy Efficiency Opportunities Assessment (EEOA) program has been completed at Orica's Kooragang Island (NSW) and Yarwun (Qld) sites. Kooragang Island was part of an EEO trial assessment programme in 2006. At both sites, a Sustainability Champion is in place who leads the site team through the EEOA process.

The Orica Sustainability Team publishes a quarterly newsletter *Towards No Harm* that details the activities underway within Orica to enable the organisation to meet its Sustainability Vision. This newsletter is available on the company intranet.

2.0 Impact Assessment Objectives

2.1 Objectives and Scope

The objective of this GHGEIA is to assess and analyse the national and international GHG emissions that are expected to result from the proposed Project and potential climate change impacts. As introduced in **Section 1.1**, the scope of this GHGEIA will include an assessment of the following:

- emissions produced and energy consumed from the on-site construction of the proposed ANE Production Facility and associated infrastructure;
- emissions produced and energy consumed from the ANE production process;
- emissions produced and energy consumed from the transport of the raw materials to the Technology Centre and the ANE product from the Technology Centre to domestic markets;
- placement of the estimated GHG emissions from the Project in existing and projected national and international GHG reporting accounts;
- potential global climate change impacts from the GHG emissions produced from the Project according to the principles of ecologically sustainable development (ESD); and
- management and mitigation recommendations to guide Orica in reducing energy and GHG emissions generated from the Project.

3.0 Impact Assessment Methodology

A detailed description of the national, international and industry methodology used in this GHGEIA is provided in **Appendix A**.

3.1 Definitions and Sources

3.1.1 Greenhouse Gas Emission Scopes

The standard approach to coverage of sources of GHG emissions is set out in the NGER Determination 2009. The NGER Determination 2009 emission sources are based on the UNFCCC and IPCC emission categories (refer to **Section 3.1.3**)).

To delineate direct and indirect emissions sources, improve transparency and provide for flexibility, three 'scopes' (Scope 1, Scope 2 and Scope 3) have been defined for GHG assessment, accounting and reporting purposes in the Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (the GHG Protocol) published by the World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) (WRI/WBCSD, 2001).

Scope 1 Scope 1 (also referred to as direct) emissions are GHG emissions which occur as a direct result of activities at a facility, for example, emissions from combustion in facility boilers and vehicles. Direct emissions are emissions over which entities have a high level of control. All point source emissions from the proposed ANE Production Facility's operational activities have been considered as occurring within the boundary of the organisation and as such have been defined as Scope 1 emissions in this assessment.

Scope 2 Scope 2 (also referred to as energy indirect) emissions cover GHG emissions from the generation of purchased electricity, steam, heating or cooling consumed by a facility. 'Purchased' under the GHG Protocol definition means brought into the organisational boundary of the entity. Scope 2 emissions are indirect emissions that entities can easily measure and significantly influence through energy efficiency measures.

Scope 3 Scope 3 covers all indirect emissions that are not included in Scope 2. Scope 3 emissions are a consequence of the activities of the facility/entity, but occur at sources or facilities not owned or controlled by the entity. For example, GHG emissions associated with the entity's product or service across all relevant stages (production, delivery, use and disposal) of the life cycle. Scope 3 emissions are generally covered by voluntary programs aimed at assessing or reducing the life cycle emissions of an entity's products or services. The rigor and burden of calculation methodologies of Scope 3 emissions is considerable with a significant element of uncertainty, unreliability and variability.

3.1.2 Greenhouse Gas Definitions and Sources

As defined by the *National Greenhouse and Energy Reporting Act (2007),* the UNFCCC and the IPCC, this GHGEIA refers to the six Kyoto Protocol GHGs as indicated in **Table 3.1**. Also indicated are current Global Warming Potential (GWP) estimations as identified through the recently released Climate Change 2007: the Fourth Assessment Report (AR4) of the

United Nations Intergovernmental Panel on Climate Change by Working Group 1 (UNFCCC, 2008).

Table 3.1 – Kyoto Protocol GHG Categories Applied to Orica GHGEIA

Kyoto Protocol GHG Category Applied to Orica GHGEIA	
Kyoto GHG	**Global Warming Potential (GWP)**
	100 year time interval (UNFCCC, 2008)
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_20)	310
Sulphur hexafluoride (SF_6)	23,900
A hydrofluorocarbon (HFC): of a kind specified in the NGER Regulations	120 – 11,700
A perfluorocarbon (PFC): of a kind specified in the NGER Regulations	6,500 - 9,200

GWP is a measure of how much a given mass of GHG is estimated to contribute to global warming. It is a relative scale which compares a specified GHG to that of the same mass of CO_2 (whose GWP is, by definition 1) over a specific time interval (UNFCCC, 2008).

3.1.3 Assumptions and Exclusions

The GHGEIA relies directly on data provided by Orica. The impact assessment assumes that the aggregate energy demand, electricity consumption and fuel consumption data, provided by Orica, is full, complete and accurate. No physical testing or auditing has been conducted by Umwelt to verify the accuracy of the data. The data provided for the current activities at the Technology Centre are considered the baseline in this GHGEIA. The year 2010 is considered the commencement date of the Project. Additionally, this GHGEIA excludes the following emission sources and activities (refer to **Table 3.2**). The activities and emission sources are currently considered variable, immaterial and incidental (IHAP, 2007).

Table 3.2 – Orica GHGEIA Emissions Exclusions

Orica GHGEIA Emissions Exclusions	
UNFCCC Category	**Description**
UNFCCC Category 2 Emissions from *(Scope 1)*	• Employee business travel; • Employees commuting to and from work; • Extraction, production and transport of other purchased materials and goods; • Fugitive emissions that result from the combustion of a complete explosives mix; and • Outsourced activities.
UNFCCC Category 6 Emissions from Waste Disposal *(Scope 1)*	• Disposal of waste generated on site.

3.2 Project Emissions

Detailed calculations of the Project Emissions, using the methodology detailed in **Appendix A**, are provided in **Appendix B**. A summary of the Project Emissions are provided in **Section 4**.

3.2.1 Direct (Scope 1) Project Emissions

Construction Phase (Scope 1)

Construction will involve the use of earthmoving equipment, cranes, forklifts and delivery vehicles. It is estimated that diesel consumption as a result of these activities would be in the order of **792 litres** per day, with a construction timeframe of **12 months**, 6 days per week. The total diesel usage during the construction phase is estimated to **247 kL,** with resultant GHG emissions of **663 tonnes CO_2e.**

Operational Phase (Scope 1)

On-site fuel combustion from the operation of the Project occurs as a result of the operation of a stationary combustion engine (hot water generator) and forklifts. It is estimated that the diesel consumption (at maximum production rate) due to these activities would amount to **274kL/annum**, resulting in emissions of **735 tonnes CO_2e per annum.** GHG emission totals due to fuel usage are estimated to be 7,350 t CO_2-e over 10 years, 14,700 t CO_2-e over 20 years, 22,050 t CO_2-e over 30 years, 29,400 t CO_2-e over 40 years and 36,750 t CO_2-e over 50 years.

3.2.2 Indirect (Scope 2) Project Emissions

Construction Phase (Scope 2)

Electricity will be provided to the construction site for construction offices and equipment and will continue to be provided to the existing research and testing facilities. It is estimated that the daily power usage will be **100 kWh** for site construction infrastructure and **2,944kWh** for existing research and testing facilities. This would result in the emission of **990 t CO_2e** over the 12 month construction period.

Operational Phase (Scope 2)

The activities that are predicted to consume electricity on site include the proposed ANE Production Facility and the existing office buildings, research facilities, production facilities; and support facilities. It is estimated that the annual power usage will be **1,074,420** kWh for the existing research and testing facilities and **6,132,000** kWh for the proposed ANE Production Facility. This would result in the emission of 64,150 t CO_2-e over 10 years, 128,300 t CO_2-e over 20 years, 192,450 t CO_2-e over 30 years, 256,600 t CO_2-e over 40 years and 320,750 t CO_2-e over 50 years.

3.2.3 Orica Indirect (Scope 3) Impact Emissions

Scope 3 fugitive emissions relating to the Project are those that occur outside of the parameters of Orica. With the stated exclusions (refer to **Section 2.1.2**), the GHGEIA includes an assessment of Scope 3 fugitive emissions for context, global perspective, and consideration of ESD principles only. These emissions are produced by third party organisations outside the parameters and direct influence of the Project and Orica.

Construction Phase (Scope 3)

During the construction period, it is expected that the proposed ANE Production Facility will be accessed by approximately two to three heavy delivery vehicles per day (estimated 780 movements in total). The estimated construction traffic movement framework is indicated in **Table 3.3**. An estimated 70 per cent (%) of heavy vehicles will originate from Newcastle. The remaining estimated 30% will originate from Sydney. During the initial three month period, an additional three heavy vehicles per day on average will access the proposed ANE Production Facility to deliver road base from Newcastle.

Table 3.3 – Project Construction Traffic Movement

Expected Project Construction Truck Movements			
Traffic Origin	**Movement Quantity**	**Percentage (%)**	**Travelling Distance (km)**
Newcastle	546	70	22
Sydney	234	30	140
Additional Movements – Three Month Inception			
Newcastle	216	-	22

It is estimated that this traffic will result in GHG emissions of **54 t CO_2e** over the 12 month construction period. The estimation of emissions for the supply of construction materials, equipment and services by road is provided with reference to industry studies.

Operational Phase (Scope 3)

During the operational phase the Scope 3 emissions will include:

1. operational traffic movement to supply feedstock to the Project; and
2. operational traffic movement to transport the ANE product to market.

The feedstock transport fleet will be a combination of single-tankers and B-double-tankers. Water will be delivered by local suppliers. The expected feedstock delivery movements per annum are detailed in **Table 3.4**.

Table 3.4 – Expected Project Feedstock Truck Movements (per annum)

Expected Project Feedstock Truck Movements (per annum)			
Feedstock Origin	**Estimated Truck Type**	**Movement Quantity (#)**	**Travelling Distance (km)**
Kooragang Island	Single-tankers; B-double tankers	2190 3650	35
Sydney	Single-tankers; B-double tankers	260 520	140
Newcastle	Single-tankers	2340	22

The finished ANE product will be transported via road to other Orica operations and customers located in the Hunter Valley and possibly in other parts of south-eastern Australia. The expected production supply movements are detailed in **Table 3.5**.

Table 3.5 – Expected ANE Production Supply Truck Movements (per annum)

Expected ANE Production Supply Truck Movements (per annum)			
Feedstock Origin	**Estimated Truck Type**	**Movement Quantity (#)**	**Travelling Distance (km)**
Hunter Valley	Single-tankers	3650	95
	B-double tankers	4380	

It is estimated that this traffic will result in GHG emissions of 12,140 t CO_2-e over 10 years, 24,280 t CO_2-e over 20 years, 36,420 t CO_2-e over 30 years, 48,560 t CO_2-e over 40 years and 60,700 t CO_2-e over 50 years. The estimation of emissions for the supply of feedstock to the Project and transport of ANE product to market by road is provided with reference to industry studies.

4.0 Impact Assessment Results

For the purposes of the GHGEIA, the results of the Project will be considered representative of the ongoing operation. The Project is expected to continue at maximum production from 2023. As indicated, all energy and greenhouse calculations have therefore been based on timeframe increments to accurately represent the ongoing nature of the Project. Construction of the proposed ANE Production Facility infrastructure is expected to be completed in approximately 12 months.

Detailed results of the Project Emissions are provided in **Appendix B**. A summary of the direct (Scope 1) and indirect (Scope 2 and Scope 3) GHG emissions that result from the proposed Orica Project are provided in **Table 4.1**. A comparison of the total Project GHG emissions to national and global GHG emission totals are provided in **Table 4.2**. The percentage contribution of the proposed Orica operations to national and international GHG inventories is provided in **Table 4.3**.

The construction and operation of the proposed ANE Production Facility at the Technology Centre will allow for the progressive decommissioning of the current Orica ANE production facility at Liddell. The Liddell site may continue to be used as a distribution depot for ANE but will cease to operate as a production facility. Orica has advised that, while there will be increased GHG emissions resulting for the proposed ANE Production Facility at the Technology Centre, this will coincide with an estimated 90 per cent reduction in GHG emissions at the Liddell facility. The offset of GHG emissions due to the decommissioning of the Liddell facility has not been factored into the calculations of greenhouse gas emissions for the Project.

The GHG emissions that occur on site, and are a **direct** result of Project operations **account for only 8.8 per cent,** of the proposed total direct and indirect Orica operations. **Orica has no direct management or control over the combustion efficiency or mitigation measures of 91.2 per cent** of the GHG emissions that result from the Project, however, Orica can influence the amount of Scope 2 emissions through improved on-site energy efficiency measures.

The construction and operation of the Project will contribution to national and international GHG emissions. It is estimated that the Project will contribute **0.00003** per cent to international annual GHG emissions and **0.001** per cent to national annual GHG emissions.

Table 4.1 – GHG Emission Summary from the Project (Construction Phase Excluded from Annual Mean Calculations)

Emission Scope	UNFCCC Emission Source	Emission Type	Total (t CO_2 – e)	On-site Emissions
Scope 1 (Direct)	On-site Fuel (Fugitive) Combustion (Diesel)	Fuel Combustion	735 (per annum)	**Yes**
		Annual Mean Scope 1 (Direct) Emissions tonnes CO_2-e	**735**	**Yes**
Scope 2 (Indirect)	Electricity Consumption Emissions	Purchased Electricity	6,415 (per annum)	No
		Annual Mean Scope 2 (Indirect) Emissions tonnes CO_2-e	**6,415.00**	No
Scope 3 (Indirect)	Indirect Emissions from Domestic (Off-site) Transport	Fuel Combustion (Road)	1,214 (per annum)	No
Annual Mean Scope 3 (Indirect) Emissions tonnes CO_2-e			**1,214**	No
ANNUAL MEAN EMISSIONS DIRECTLY (SCOPE 1) RELATED TO THE PROJECT			**735**	**Yes**
ANNUAL MEAN EMISSIONS INDIRECTLY (SCOPE 2+3) RELATED TO THE PROJECT - DOWNSTREAM			**7,629**	No
ANNUAL MEAN PROJECT GHG EMISSIONS (SCOPE 1+2+3)			**8,364**	Majority No
10+1 YEAR (OPERATIONAL + CONSTRUCTION) PROJECT GHG EMISSIONS (SCOPE 1+2+3)			**85,686**	Majority No
20+1 YEAR (OPERATIONAL + CONSTRUCTION) PROJECT GHG EMISSIONS (SCOPE 1+2+3)			**169,326**	Majority No
30+1 YEAR (OPERATIONAL + CONSTRUCTION) PROJECT GHG EMISSIONS (SCOPE 1+2+3)			**252,966**	Majority No
40+1 YEAR (OPERATIONAL + CONSTRUCTION) PROJECT GHG EMISSIONS (SCOPE 1+2+3)			**336,606**	Majority No
50+1 YEAR (OPERATIONAL + CONSTRUCTION) PROJECT GHG EMISSIONS (SCOPE 1+2+3)			**420,246**	Majority No

Table 4.2 – Comparison of Project Totals to National/Global GHG Totals Contribution of Project to National/International Greenhouse Inventories

Comparison of Project GHG Emissions to National / International Emissions	
Scope/Category	Total t CO_2 -e
Annual Mean Scope 3 (Indirect) Emissions	1,214
Annual Mean Scope 1 (Direct) Emissions Related to the Project Operations	735
Annual Mean Emissions Indirectly Related to the Project (Scope 2 + 3) – DOWNSTREAM	7,629
Annual Mean Project Emissions (Scope 1 + Scope 2 + Scope 3)	8,364
CURRENT TOTAL GLOBAL EMISSIONS ^	29,000,000,000
CURRENT TOTAL NATIONAL EMISSIONS **	597,156,550

^ Source: International Energy Outlook, 2009 (Energy Information Administration, U.S. Department of Energy) (EIA, 2009): http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2009).pdf

** Source: National Greenhouse Gas Inventory: Kyoto Protocol Accounting Framework, 2009 (DCC, 2009b): http://ageis.climatechange.gov.au

Table 4.3 – Contribution of the Project to National/International GHG Inventories

Contribution of Project GHG Emissions to National/International Emissions	
Scope/Category	Total t CO_2 -e
Annual Mean Project Emissions (Scope 1 + Scope 2 + Scope 3)	8,364
Current Total Global GHG Emissions Inventory	29,000,000,000
Current Total National GHG Emissions Inventory	597,156,550
Contribution to International Emissions Inventory	**0.00003**
Contribution to National Emissions Inventory	**0.001**

5.0 Orica Impact Assessment Summary

The objective of this GHGEIA was to quantify the energy consumption and GHG emissions from the Project and assess and analyse the national and international GHG and climate change impacts as a result of the proposed Project. Additionally, the GHGEIA is required to addresses the ESD considerations and the broader potential impact on climate change and the enhanced Greenhouse Gas Effect from anthropogenic activity. As indicated in **Section 2.0**, a number of issues arise in the quality and application of predicted energy and GHG data. The accuracy of projected data generally declines as the time period to which the projection applies stretches further into the future, for example, over the length of an ongoing continuous production process.

The uncertainty of the calculation and predictions must be added to the complexity of climate change science in assessing the impact of the Project on global GHG emissions and anthropogenic climate change. The Fourth Assessment Report of the IPCC stated that most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in (human produced) GHG concentrations (IPCC, 2007). There exists then a general correlation between the Project and climate change.

5.1 Global and National Climate

As indicated, there is a positive correlation between GHG emissions and climate change. The potential climate change impacts from the GHG emissions that result from the Project are put into perspective by the negligible contribution it is expected to make at a national and global level. The Project is expected to contribute approximately **0.00003%** to current global GHG emissions and approximately **0.001%** to the current national GHG emissions.

Despite the predicted negligible contribution to global and national climate change, the following considerations are addressed in an anthropogenic climate change context.

5.1.1 Global Warming

Climate scientists are confident that anthropogenic climate change will continue. In Australia, average temperature increases of 0.4 to 2.0°C are likely by 2030 together with changes in rainfall patterns and the frequency and/or intensity of extreme weather events such as drought and severe storms. This section presents information about projected changes in Australia's climate, including projections for climate change in different parts of the country (DCC, 2009b). Australian temperatures have increased by approximately 0.9°C since 1910, mostly since 1950.

5.1.2 Global and National Sea Level

Sea levels around Australia are naturally variable, although records indicate that global sea level has been rising at an increasing rate over the past 130 years. The largest source of sea level rise is expansion of the oceans as they warm under enhanced greenhouse conditions (DCC, 2009b).

5.1.3 Projections and Scenarios

Possible impacts of climate change in Australia have been indicated by the Department of Climate Change (DCC, 2009b). Key climate change projected impacts indicated for NSW include:

- by 2030 the annual average number of days over 35°C in Sydney could grow from the current 3 to 4-7 days;
- urban water security may be threatened by projected increases in demand and climate driven reductions in water supply;
- more frequent and severe droughts, with greater fire risk, are likely;
- by 2020 the annual number of days with very high or extreme fire danger could increase;
- by 2020 a 10-40 per cent reduction in snow cover is likely with potentially significant consequences for alpine tourism and ecosystems;
- increases in extreme storm events are expected to cause more flash flooding affecting industry and infrastructure, including water, sewerage and stormwater, transport and communications, and may challenge emergency services; and
- in coastal areas infrastructure is vulnerable to sea level rise and inundation.

6.0 Management and Mitigation

Orica is committed to minimising the company's emissions of GHG and improve its energy efficiency, with performance targets and projects identified to assist the organisation in meeting these goals. The current Orica corporate climate change and sustainability system incorporates reporting, policies, programs and plans.

For the Project, the primary measures that may assist in the reduction of greenhouse gas emissions will be energy efficiency measures, focusing on increased energy efficiency for the proposed ANE Production Facility and equipment. The Project will seek to provide for maximum production with maximum efficiency.

Some of the opportunities for improving energy efficiency and reducing greenhouse gas emissions that will be implemented, as appropriate, during the life of the Project include:

- Orica undertaking a review of energy efficiency as part of plant and equipment procurement during the project planning phase. Consideration will be given to the life cycle cost advantages obtained by using energy efficient components (for example, efficient external lighting);

- reviewing and seeking to minimise the electricity consumption for offices and workshops, including such measures as automatic control of external and internal lighting;

- reviewing and implementing, where relevant, potential energy efficiency opportunities in water pumping systems (for example, variable speed drive pumps); and

- improvements in energy measurement and monitoring to assist with the management focus on energy efficiency.

The operations at the Technology Centre are subject to current Orica climate change, sustainability, GHG and energy objectives. Orica will undertake monitoring and reporting of greenhouse gas emissions in accordance with Orica and government requirements.

7.0 References

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APPENDIX A

Greenhouse Gas and Impact Assessment Methodology

Appendix A - Greenhouse Gas and Impact Assessment Methodology

GHGEIA CALCULATION METHODOLOGY

1. International, National and Industry Reference

The following international, national and industry reports listed in **Table 1** below are referred to directly in the Orica GHGEIA.

Table 1 – International, National and Industry Reports

Scope	Report/Reference
International	United Nations Framework Convention on Climate Change: 4th Assessment Report for the Intergovernmental Panel on Climate Change (UNFCCC, 2007) (UNFCCC 4AR).
International	The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UN, 1998) (Kyoto Protocol).
International	The Greenhouse Gas Protocol: GHG Protocol for Project Accounting (WRI/WBCSD, 2004) (GHG Protocol).
National	National Greenhouse and Energy Reporting Streamlining Protocol (DCC, 2009a) (NGER Protocol).
National	National Greenhouse and Energy Reporting (Measurement) Technical Guidelines 2009, (DCC, 2009b) (the NGER Technical Guidelines).
Industry	Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance: Optional Emissions from Commuting, Business Travel, and Product Transport (USA EPA, 2008).
Industry	Independent Hearing and Assessment Panel, Anvil Hill Coal Project: Report to the Director-General, Department of Planning (IHAP, 2007).

2. Calculation of Project Emissions

Orica ANE Production Facility Direct (Scope 1) Project Emissions

Direct (Scope 1) Fugitive Emissions

Scope 1 Fugitive Emissions are those that are produced from activities within the parameters of Orica's ANE production facility and existing operations and result from current and projected operational activities. These emissions specifically arise from activities which release or combust solid, liquid or gaseous fuels.

Onsite Fuel Combustion

Emission Source 1

UNFCCC Category 1.A

Emission Source Reference: *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines 2009. Part 2.4: Emissions Released from the Combustion of Liquid fuels.*

Onsite fuel combustion from the construction of the ANE production facility has been estimated using average fuel consumption rates for equipment usage specified by Orica. Onsite fuel combustion from the operations of the ANE production facility is included in the projection data provided by Orica. The majority of liquid fuel (diesel oil) combusted onsite will be for stationary combustion purposes (hot water generation). These emissions comprise CO_2 emissions due to the oxidation of fuel carbon content during fuel combustion and also CH_4, N_2O, NOx, carbon monoxide (CO), sulphur dioxide (SO_2) and non-methane volatile organic compounds (NMVOCs) emission.

The CO_2 emissions from the combustion of liquid fuels for stationary combustion purposes are calculated by *Tier 1* methods by multiplying the fuel consumption for each type of engine by a country-specific or default CO_2 emissions factor (in g/MJ) and an oxidation factor. This assigns the total carbon content of the fuel to CO_2 emissions and solid products, even though under actual engine operating conditions a portion of the carbon in fuel is released as CH_4, CO and NMVOCs. All emissions factors relating to energy consumption are given in terms of gross calorific value (GCV) (DCCc, 2008).

Emissions Formula 1

Division 2.41 of the NGER Technical Guidelines defines the use of Method 1 to estimate emissions from the carbon dioxide, methane and nitrous oxide (DCC, 2009) as a result of fuel combustion. The formula below estimates GHG emissions from the combustion of liquid fuel. The formula refers to Table 2.4.2A in the NGER Technical Guidelines for the calculation of Energy Content Factor in gigajoule per kilolitre (GJ/kL) and the emission factor (EF) (kg CO_2-e/GJ) with relevant oxidation factors incorporated. The emissions are generally expressed in tonnes of CO_2 per GJ and the GWP of the relatively small quantities of CH_4 and N_2O emitted. Orica has provided an annual diesel consumption estimate. The calculations are provided in **Appendix 2**. The results are presented in **Section 4.0**.

The GHG emissions from diesel fuel combustion (stationary energy purposes) were estimated using the following equation.

E_{ij} = **DU_{onsite}** x EC_i x EF_{ikoxec} / 1000 **(Formula 1)**

where:

E_{ij} emissions of GHG, being CO_2, CH_4 or N_2O, released from the combustion of diesel fuel from the operation of the project, during the year measured in CO_2-e tonnes;

DU_{onsite} estimated diesel combusted onsite from the project operation (kilolitres (kL/annum) (Orica estimate is 247 kL for the construction phase and 274 kL/annum for the operational phase);

EC_i energy content factor for diesel measured as energy content in gigajoules (GJ) per kL (Item 54 in Table 2.4.2A – Stationary Energy Purposes, Diesel Oil is 38.6 GJ/kL); and

EF_{ikoxec} is the emission factor for diesel released from the operation of the facility during the year, measured in kilograms CO_2-e per gigajoule of fuel type (Item 54 in Table 2.4.2A – Stationary Energy Purposes, Diesel Oil) is 69.5 kg CO_2-e/kg.

Orica ANE Production Facility Indirect (Scope 2) Project Emissions

Electricity Consumption Emissions

Emissions Source 2

UNFCCC Category 1.A and Scope 2

Emission Source Reference: *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines 2009. Part 7: Scope 2 Emissions.*

The electricity consumption estimate has been provided by Orica (Orica, 2009) and is based on the current operations and the proposed construction and operation of the ANE production facility. As detailed in **Section 2.2**, such estimates can be imprecise therefore electricity consumption for the Project can be considered a general estimate only. The activities that are predicted to consume electricity onsite include the ANE Production Facility and the existing office buildings, research facilities, production facilities; and support facilities.

Emissions Formula 2

Division 7.2 of the NGER Technical Guidelines (DCC, 2009b) provides methodology to estimate GHG emissions from the combustion of thermal coal to produce electricity. Orica then use this purchased electricity for project operations. Table 7.2 of the NGER Technical Guidelines provides the Indirect (Scope 2) emission factors for consumption of purchased electricity from a grid. The emission factors are categorised by State. This is because electricity that flows between States is constrained by the capacity of the interstate interconnectors and in some cases there are no interconnections. The GHG emissions in tonnes of CO_2-e attributable to the quantity of electricity purchased may be calculated with the following equation. Orica has provided estimates for current annual electricity consumption, annual electricity consumption estimates for the construction period and annual consumption estimates for maximum production of the proposed facility. The calculations are provided in **Appendix 2**. The results are presented in **Section 4.0**.

$E_{CO2\text{-}e}$ = Q x EF_{ep} / 1000 **(Formula 2)**

where:

$E_{CO2\text{-}e}$ emissions of GHG from the consumption of electricity purchased (t $CO_{2\text{-}e}$/annum);

Q is the electricity consumed expressed in kWh (Orica estimates the quantity to be 7,206,420 kWh per annum – excludes construction electricity consumption) during the year and consumed from the operation of the project; and

EF_{ep} is the emission factor expressed in kg $C0_2$-e/kWh for State or Territory or electricity grid in which the consumption occurs as detailed in Table 7.2 (Item 77 in Table 7.2 New South Wales and Australian Capital Territory has an emission factor of 0.89 kg CO_2-e/kWh).

Orica Indirect (Scope 3) Impact Emissions

Scope 3 fugitive emissions relating to the Project are those that occur outside of the parameters of Orica. The World Business Council for Sustainable Development and the World Resources Institute *Greenhouse Gas Protocol 2004* (WRI/WBCSD, 2004) specifically acknowledge the importance of the avoidance of double-counting of GHG emissions. On an international scale, double-counting needs to be avoided when compiling national inventories under the Kyoto Protocol.

There are considerable speculative and assumption-based scientific and practical implications from such assessment of Scope 3 and indirect emissions. The GHGEIA includes an assessment of Scope 3 fugitive emissions for context, global perspective, and consideration of ESD principles only. These emissions are produced by third party organisations outside the parameters and direct influence of the Project and Orica.

Transport (Scope 3) Indirect Fugitive Emissions

Domestic Offsite Transport (Road)

Emission Source 3

UNFCCC Category 1.A.3

Emission Source Reference: *Greenhouse Gas Protocol – Mobile Guide v1.3: Calculating CO_2 Emissions from Mobile Sources (Guidance to Calculation Worksheets).*

The GHG emissions from mobile sources consist of gaseous products of engine fuel combustion (exhaust emissions) and gas leakage from vehicles (fugitive emissions). These emissions comprise CO_2 emissions due to the oxidation of fuel carbon content during fuel combustion and also CH_4, N_2O, NOx, CO, SO_2 and non-methane volatile organic compounds (NMVOCs) emission.

The CO_2 emissions from the combustion of transport fuels are calculated by *Tier 1* methods by multiplying the fuel consumption for each type of mobile engine by a country-specific or default CO_2 emissions factor in grams per megajoule (g/MJ) and an oxidation factor. This assigns the total carbon content of the fuel to CO_2 emissions and solid products, even though under actual engine operating conditions a portion of the carbon in fuel is released as CH_4, CO and NMVOCs. All emissions factors relating to energy consumption are given in terms of GCV (DCC, 2009b).

The aggregate traffic movement data set provided by Orica includes:

1. construction traffic movement to supply materials and services to the Project;

2. operational traffic movement to supply feedstock to the Project; and

3. operational traffic movement to transport the ANE product to market.

During the construction period, it is expected that the proposed ANE production facility will be accessed by two to three heavy delivery vehicles per day on a six days per week basis (estimated 780 movements in total). The estimated construction traffic movement framework is indicated in **Table 2** below and **Table 3.3** of **Section 3.2**. An estimated 70 per cent (%) of heavy vehicles will originate from Newcastle. The remaining estimated 30 per cent will originate from Sydney. During the initial three month period, an additional three heavy vehicles per day on a six days per week basis will access the proposed ANE production facility to deliver road base from Newcastle.

Table 2 – ANE Production Facility Construction Traffic Movement

Expected ANE Production Facility Construction Truck Movements		
Traffic Origin	**Movement Quantity**	**Percentage (%)**
Newcastle	546	70
Sydney	234	50
Additional Movements – Three Month Inception		
Newcastle	216	-

The feedstock transport fleet will be a combination of single-tankers and B-double-tankers. Water will be delivered from local suppliers. The expected feedstock delivery movements per annum are detailed in **Table 3** below and **Table 3.3** of **Section 3.2**.

Table 3 – Expected ANE Production Feedstock Truck Movements (per annum)

Expected ANE Production Feedstock Truck Movements (per annum)		
Feedstock Origin	**Estimated Truck Type**	**Movement Quantity (#)**
Kooragang Island	Single-tankers B-double tankers	2190 3650
Sydney	Single-tankers B-double tankers	260 520
Newcastle	Single-tankers	2340

The finished ANE product will be transported via road to other Orica operations and customers located in the Hunter Valley and possibly other destinations in south-eastern NSW. Orica has indicated that the majority of product will go to Liddell from where the ANE will be distributed to various Hunter Valley mines. The expected production supply movements are detailed in **Table 4** below and **Table 3.4** of **Section 3.2**.

Table 4 – Expected ANE Production Supply Truck Movements (per annum)

Expected ANE Production Supply Truck Movements (per annum)		
Feedstock Origin	**Estimated Truck Type**	**Movement Quantity (#)**
Hunter Valley (Liddell)	Single-tankers	3650
	B-double tankers	4380

An estimation of emissions for the supply of construction materials, equipment and services by road is provided with reference to industry studies. The NGERS Technical Guidelines is based on the quantity of diesel fuel used for transport.

The formula used in the Orica GHGEIA is assumed transferable from the guidance document *Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance: Optional Emissions from Commuting, Business Travel, and Product Transport* (USA EPA, 2008).

As the GHGEIA is based on the ANE production facility operating on a continual production process, the offsite fuel consumption data (as required by the NGERS Technical Guidelines formulae) was substituted with a calculation of heavy vehicle movements including supply and delivery routes to estimate distances travelled per annum. Diesel combustion generates CO_2, CH_4 and N_2O gases. The GHG are expressed as together CO_2-e.

<u>Emission Formula 3</u> **(Formula 3)**

The following equation was used to calculate GHG emissions estimates for the supply of construction materials, equipment and services by road to the Technology Centre. All distances were converted to miles to align with the chosen methodology. The calculations are provided in **Appendix 2.** The results are presented in **Section 4.0.**

$$E_{Road} = VMT \times (EF_{CO2} + (EF_{CH4} \times 0.021) + (EF_{N2O} \times 0.310))/1000$$

where:

E_{Road} GHG emissions from road vehicle transport (t CO_2-e);

VMT is the vehicle miles travelled (distance between Newcastle and the Technology Centre is estimated at 13.67 miles (22 km); the distance between Kooragang Island and the Technology Centre is estimated at 21.69 miles (34.9 km), the distance between the Technology Centre and Liddell is estimated at 59.03 miles (95km), and the distance between the Technology Centre and Sydney is estimated at 87 miles (140 km));

EF_{CO2} is the CO_2 emission factor *(1.726 for medium and heavy duty trucks)*;

EF_{CH4} is the CH_4 emission factor *(0.021 for medium and heavy duty trucks)*;

EF_{N2O} is the N_2O emission factor *(0.017 for medium and heavy duty trucks)*;

0.021 CH_4 conversion factor; and

0.310 N_2O conversion factor.

Contribution to National and International Inventories

Emission Inventory Reference: National Greenhouse Gas Inventory: Kyoto Protocol Accounting Framework (DCC, 2009a) and the International Energy Outlook (EIA, 2009)

Emission Source 4

This GHGEIA addresses the principles of Ecologically Sustainable Development (ESD), and in particular, the principle of intergenerational equity and the precautionary principle from the downstream GHG emissions from the project. The precautionary principle requires that the Project's cumulative effects (including downstream emissions) must be assessed, and that indirect climate change impacts of the Project be assessed despite any scientific uncertainty about the extent of impact.

Emission Formula 4

The direct and indirect emissions that are the result of the Project are expected to be accounted for in future national and international total emissions. The Project emissions are therefore represented as a percentage contribution to national and international inventories. The calculations are divided into domestic and international GHG emissions and are provided in **Appendix 2.** The results are presented in **Section 4.0**.

$$PC = PE / IT_{ni} \times 100 \qquad \text{(Formula 4)}$$

where:

PC is the percentage contribution of the total Orica project GHG emissions (Scope 1 + Scope 2 + Scope 3) to national and international greenhouse gas (GHG) emission inventories;

PE is the total project GHG emissions (Scope 1 + Scope 2 + Scope 3); and

IT_{ni} is the total national inventory (n) or international inventory (i).

APPENDIX B

Orica Project Emission Calculations

Appendix B - Orica Project Emission Calculations

ORICA DIRECT EMISSIONS

Direct Scope 1 Fugitive Emissions

A. Onsite Fuel Combustion (Diesel)

The production process for the Project has been defined as continuous. Fugitive emissions from onsite fuel combustion have therefore been calculated as representative of the continuous project. Assessment periods in ten year increments for the operational phase, plus one year of construction have been used as an alternative. The Project has an estimated emission total of 8,013 t CO_2-e over 10 +1 years, 15,363 t CO_2-e over 20+1 years, 22,713 t CO_2-e over 30 +1 years, 30,063 t CO_2-e over 40 +1 years and 37,413 t CO_2-e over 50+1 years (refer to **Table A1**).

Fugitive emissions from onsite fuel combustion during the construction phase are estimated to be 663 t CO_2-e based on the consumption of 247 kL of diesel over the 12 month construction period (refer to **Table A2**).

As mentioned, the production process for the Project has been defined as continuous. Fugitive emissions from onsite fuel combustion have therefore been calculated as representative of the continuous project. Assessment periods in ten year increments for the operational phase have been used as an alternative. Fugitive emissions from onsite fuel combustion during the operational phase are estimated to be 735 t CO_2-e per annum based on an annual mean consumption of 274 kL of diesel. This results in emissions of 7,350 t CO_2-e over 10 years, 14,700 t CO_2-e over 20 years, 22,050 t CO_2-e over 30 years, 29,400 t CO_2-e over 40 years and 36,750 t CO_2-e over 50 years (refer to **Table A3**).

Table A1 – Calculation of Fugitive Emissions (Scope1) from Onsite Fuel Combustion (Project Totals)

Fugitive Emissions (Scope1) from Onsite Fuel Combustion	Calculation
Fugitive Emissions (Scope1) from Onsite Fuel Combustion - Annual Mean (Construction Phase)	= 663 t CO2-e
Fugitive Emissions (Scope1) from Onsite Fuel Combustion - Annual Mean (Operational Phase)	= 735 t CO_2-e
10 +1 Year Emission Total (Operational Phase + ANE Facility Construction)	= (10 x 735) + (1 x 663)
	= 8,013 t CO_2-e
20 +1 Year Emission Total (Operational Phase + ANE Facility Construction)	= (20 x 735) + (1 x 663)
	= 15,363 t CO_2-e
30 +1 Year Emission Total (Operational Phase + ANE Facility Construction)	= (30 x 735) + (1 x 663)
	= 22,713 t CO_2-e
40 +1 Year Emission Total (Operational Phase + ANE Facility Construction)	= (40 x 735) + (1 x 663)
	= 30,063 t CO_2-e
50 +1 Year Emission Total (Operational Phase + ANE Facility Construction)	= (50 x 735) + (1 x 663)
	= 37,413 t CO_2-e

Table A2 – Calculation of Fugitive Emissions (Scope1) from Onsite Fuel Combustion (Construction Phase)

Period	**Formula**		**Calculation**
2009-2010	Onsite Fugitive Emissions ($t\ CO_2$-e)	= Qi x ECi x EFijoxec/1000	= 247 x 39 x 70 / 1000
			= 663
	Annual Mean (Construction Phase)		= 663 t CO_{2-e}
	Construction Phase Total		= 1 x 663
			= 663 t CO_{2-e}

Table A3 – Calculation of Fugitive Emissions (Scope1) from Onsite Fuel Combustion (Operational Phase)

Period	**Formula**		**Calculation**
Per Annum	Onsite Fugitive Emissions ($t\ CO_2$-e)	= Qi x ECi x EFijoxec/1000	= 273.75 x 39 x 70 / 1000
			= 735
	Annual Mean (Operational Phase)		= 735 t CO_{2-e}
10 Year Emission Total (Operational Phase)			= 10 x 735
			= 7,350 t CO_{2-e}
20 Year Emission Total (Operational Phase)			= 20 x 735
			= 14,700 t CO_{2-e}
30 Year Emission Total (Operational Phase)			= 30 x 735
			= 22,050 t CO_{2-e}
40 Year Emission Total (Operational Phase)			= 40 x 735
			= 29,400 t CO_{2-e}
50 Year Emission Total (Operational Phase)			= 50 x 735
			= 36,750 t CO_{2-e}

ORICA INDIRECT EMISSIONS (SCOPE 2)

Indirect (Scope 2) Emissions

Stationary Energy

B. Electricity Consumption Emissions

The annual mean emissions from electricity consumption for the Project are estimated as 957 t CO_2-e / kWh from existing operations, 33 t CO_2-e / kWh from the ANE facility construction (one year in duration) and 5,458 t CO_2-e / kWh from ANE facility operations (refer to **Table B1**).

The production process has been defined as continuous. Indirect emissions from the consumption of electricity have therefore been calculated as representative of the continuous project. Assessment periods in ten year increments for the operational phase, plus one year of construction have been used as an alternative. Emissions from the consumption of electricity for the project have been estimated to total 65,140 t CO2-e / kWh over 10 +1 years, 129,290 t CO_2-e / kWh over 20+1 years, 193,440 t CO_2-e / kWh over 30 +1 years, 257,590 t CO_2- / kWh over 40 +1 years and 321,740 t CO_2-e / kWh over 50+1 years (refer to **Table B1**).

Emissions from the consumption of electricity for the existing operations have been estimated to total 10,527 t CO2-e / kWh over 10 +1 years, 20,097 t CO2-e / kWh over 20+1 years, 29,667 t CO2-e / kWh over 30 +1 years, 39,237 t CO_2-e / kWh over 40 +1 years and 48,807 t CO2-e / kWh over 50+1 years (refer to **Table B2**).

Emissions from the consumption of electricity for the ANE production facility operation have been estimated to total 54,580 t CO_2-e / kWh over 10 +1 years, 109,160 t CO_2-e / kWh over 20+1 years, 163,740 t CO_2-e / kWh over 30 +1 years, 218,320 t CO_2-e / kWh over 40 +1 years and 272,900 t CO_2-e / kWh over 50+1 years (refer to **Table B4**).

The construction period emissions have been estimated as 32.49 t CO_2-e / kWh (refer to **Table B3**). As it is understood that Orica has based electricity consumption estimates on the framework from current and larger operations, the emissions estimates may feasibly be considered an overestimate.

Table B1 – Calculation of (Scope 2) Stationary Energy Source Emissions (Project Totals)

Scope 2 Stationary Source Emissions	Calculation
Annual Mean Stationary Source Emissions (Existing Operations)	= 957 t CO2-e / kWh
Annual Mean Stationary Source Emissions (ANE Facility Construction)	= 33 t CO_2-e / kWh
Annual Mean Stationary Source Emissions (ANE Facility Operation)	= 5,458 t CO_2-e / kWh
10 +1 Year Emission Total (Operational Phase + ANE Facility Construction)	= (11 x 957) + (10 x 5458) + (1 x 33)
	= 65,140 t CO_2-e / kWh
20 +1 Year Emission Total (Operational Phase + ANE Facility Construction)	= (21 x 957) + (20 x 5458) + (1 x 33)
	= 129,290 t CO_2-e / kWh
30 +1 Year Emission Total (Operational Phase + ANE Facility Construction)	= (31 x 957) + (30 x 5458) + (1 x 33)
	= 193,440 t CO_2-e / kWh
40 +1 Year Emission Total (Operational Phase + ANE Facility Construction)	= (41 x 957) + (40 x 5458) + (1 x 33)
	= 257,590 t CO_2-e / kWh
50 +1 Year Emission Total (Operational Phase + ANE Facility Construction)	= (51 x 957) + (50 x 5458) + (1 x 33)
	= 321,740 t CO_2-e / kWh

Table B2 – Calculation of Scope 2 Stationary Energy Source Emissions (Existing Research and Testing Operations)

Period	Formula		Calculation
Per annum	Stationary Source Emissions (t CO_2-e)	= Q x EF/1000	= 1,074,420 x 0.89 / 1000
			= 957
Annual Mean			**= 957 t CO_2-e / kWh**
10 +1 Year Emission Total (Operational Phase + Construction Phase)			= 11 x 957
			= 10,527 t CO_2-e / kWh
20 +1 Year Emission Total (Operational Phase + Construction Phase)			= 21 x 957
			= 20,097 t CO_2-e / kWh
30 +1 Year Emission Total (Operational Phase + Construction Phase)			= 31 x 957
			= 29,667 t CO_2-e / kWh
40 +1 Year Emission Total (Operational Phase + Construction Phase)			= 41 x 957
			= 39,237 t CO_2-e / kWh
50 +1 Year Emission Total (Operational Phase + Construction Phase)			= 51 x 957
			= 48,807 t CO_2-e / kWh

Table B3 – Calculation of Scope 2 Stationary Energy Source Emissions (ANE Facility Construction)

Period	Formula		Calculation
2009 - 2010	Stationary Source Emissions (t CO_2-e)	= Q x EF/1000	= 36,500 x 1 / 1000
			= 33
Annual Mean			= 33 t CO_2-e / kWh
Construction Phase Duration (years)			= 1
Total for Project (estimate)			= 1 x 33
Total Stationary Source Emissions (ANE Facility Construction)			**= 33 t CO_2-e / kWh**

Table B4 – Calculation of Scope 2 Stationary Energy Source Emissions (ANE Facility Operational)

Period	Formula		Calculation
Per Annum	Stationary Source Emissions (t CO_2-e)	= Q x EF/1000	= 6,132,000 x 1 / 1000
			= 5,457
Annual Mean			= **5,457 t CO_2-e / kWh**
10 +1 Year Emission Total (Operational Phase + Construction Phase)			= (10 x 5,458) + (1 x 0)
			= 54,580 t CO_2-e / kWh
20 +1 Year Emission Total (Operational Phase + Construction Phase)			= (20 x 5,458) + (1 x 0)
			= 109,160 t CO_2-e / kWh
30 +1 Year Emission Total (Operational Phase + Construction Phase)			= (30 x 5,458) + (1 x 0)
			= 163,740 t CO_2-e / kWh
40 +1 Year Emission Total (Operational Phase + Construction Phase)			= (40 x 5,458) + (1 x 0)
			= 218,320 t CO_2-e / kWh
50 +1 Year Emission Total (Operational Phase + Construction Phase)			= (50 x 5,458) + (1 x 0)
			= 272,900 t CO_2-e / kWh

<u>ORICA INDIRECT EMISSIONS (SCOPE 3)</u>

Indirect Scope 3 Emissions

<u>Transport</u>

C. Indirect Emissions from Domestic (Offsite) Road Transport

The annual mean emissions from scope 3 offsite road transport for the Project are estimated as 54 t CO_2-e from the ANE facility construction (1 year in duration) and 1,214 t CO_2-e from ANE facility operations (refer to **Table C1**). The ANE facility operations (operational phase) emissions can be further divided into feedstock supply, which accounts for 393 t CO_2-e per annum, and market delivery, which accounts for 821 t CO_2-e per annum.

The production process has been defined as continuous. Indirect (Scope 3) emissions from offsite transport have therefore been calculated as representative of the continuous project. Assessment periods in ten year increments for the operational phase, plus one year of construction have been used as an alternative. Emissions from indirect scope 3 offsite road transport for the project have been estimated as 12,185 t CO_2-e over 10 +1 years, 24,317 t CO_2-e over 20+1 years, 36,448 t CO_2-e over 30 +1 years, 48,579 t CO_2-e over 40 +1 years and 60,709 t CO_2-e over 50+1 years (refer to **Table C1**).

The estimated GHG emissions for the supply of construction materials outside the parameters of the site are 54 t CO_2-e over an estimated one year construction period (refer to **Table C2**). As stated in **Section 3.2**, the distance between the Technology Park and Newcastle is an estimated 13.67 miles. The estimated distance between the Technology Park and Sydney is 87 miles. All distances were converted to miles to align with the chosen methodology.

The estimated GHG emissions for the supply of feedstock outside the parameters of the site have been estimated to total 3,923 t CO_2-e over 10 +1 years, 7,846 t CO_2-e over 20+1 years, 11,769 t CO_2-e over 30 +1 years, 15,691 t CO_2-e over 40 +1 years and 19,614 t CO_2-e over 50+1 years (refer to **Table C3**). As stated in **Section 3.2**, the estimated distance between the Technology Park and Newcastle is 14 miles, to Kooragang Island it is an estimated 22 miles and to Sydney it is an estimated 87 miles. All distances were converted to miles to align with the chosen methodology.

The estimated GHG emissions for the transport of ANE product to market (outside the parameters of the site) have been estimated to total 8,209 t CO_2-e over 10 +1 years, 16,417 t CO_2-e over 20+1 years, 24,626 t CO2-e over 30 +1 years, 32,834 t CO2-e over 40 +1 years and 41,043 t CO_2-e over 50+1 years (refer to **Table C4**). As stated in **Section 3.2**, the distance between the Technology Park and Liddell is an estimated 60 miles. All distances were converted to miles to align with the chosen methodology.

Table C1 - Calculation of Scope 3 Fugitive Emissions from Road Transport (Project Totals)

Scope 3 Fugitive Emissions from Road Transport	Calculation
Total Fugitive Emissions from Road Transport (Construction Phase)	= 54 t $CO_{2\text{-}e}$
Mean Annual Fugitive Emissions from Road Transport (Operational Phase - Feedstock Supply)	= 392 t $CO_{2\text{-}e}$
Mean Annual Fugitive Emissions from Road Transport (Operational Phase Market Delivery)	= 821 t $CO_{2\text{-}e}$
Mean Annual Fugitive Emissions from Road Transport (Operational Phase)	= 1,213 t CO_2-e
10 +1 Year Emission Total (Operational Phase + Construction Phase)	= (10 x 1,213) + 54
	= **12,185 t CO_2-e**
20 +1 Year Emission Total (Operational Phase + Construction Phase)	= (20 x 1,213) + 54
	= **24,316 t CO_2-e**
30 +1 Year Emission Total (Operational Phase + Construction Phase)	= (30 x 1,213) + 54
	= **36,447 t CO_2-e**
40 +1 Year Emission Total (Operational Phase + Construction Phase)	= (40 x 1,213) + 54
	= **48,579 t CO_2-e**
50 +1 Year Emission Total (Operational Phase + Construction Phase)	= (50 x 1,213) + 54
	= **60,710 t CO_2-e**

Table C2 – Calculation of Scope 3 Fugitive Emissions from Road Transport (Construction Phase)

Period	Formula		Calculation
Per annum (Construction Phase)	VMT (Total Construction)	= # Trips (70% Newcastle, 30% Sydney) x Distance	= (546 x 14) + (234 x 87)
			= 27,822 miles
	VMT (3 month Inception)	= # Trips x Distance (Newcastle)	= 234 x 14
			= 3,199 miles
	VMT (Total)		= 31,021 miles
	Offsite Fuel Combustion (t CO_2-e) (Truck)	= VMT x (EF_{CO2} + (EF_{CH4} x 0.021) + (EF_{N2O} x 0.310))/1000	= 31,021 x (2 + (0.021 x.021) +(0.017 x 0.310))/1000
Annual Mean			= 54 t $CO_{2\text{-}e}$
Construction Supply Duration (Years)			= 1
Project Total (Estimate)			= 1 x 55
Total Fugitive Emissions from Road Transport (Construction Supply)			**= 54 t $CO_{2\text{-}e}$**

Table C3 – Calculation of Scope 3 Fugitive Emissions from Road Transport (Feedstock Supply)

Period	Formula		Calculation
Per annum (Operational Phase)	VMT (Newcastle) - Water	= # Trips x Distance	= 2340 x 14
			= 31,988 miles
	VMT (Kooragang Island)	= # Trips x Distance	= 5840 x 22
			= 126,6670 miles
	VMT (Sydney)	= # Trips x Distance	= 780 x 87
			= 67,860 miles
	VMT (Total)		= 226,517miles
	Offsite Fuel Emissions (t CO_2-e) (Truck)	= VMT x (EF_{CO2} + (EF_{CH4} x 0.021) + (EF_{N2O} x 0.310))/1000	= 226,517x (2 + (0.021 x0.021) +(0.017 x 0.310))/1000
			= 392 t CO_{2-e}
Annual Mean			= **392 t CO_{2-e}**
10 +1 Year Emission Total (Operational Phase + Construction Phase)			= (392 x 10) + 0
			= 3,922 t CO_{2-e}
20 +1 Year Emission Total (Operational Phase + Construction Phase)			= (392 x 20) + 0
			= 7,845 t CO_{2-e}
30 +1 Year Emission Total (Operational Phase + Construction Phase)			= (392 x 30) + 0
			= 11,768 t CO_{2-e}
40 +1 Year Emission Total (Operational Phase + Construction Phase)			= (392 x 40) + 0
			= 15,691 t CO_{2-e}
50 +1 Year Emission Total (Operational Phase + Construction Phase)			= (392 x 50) + 0
			= 19,614 t CO_{2-e}

Table C4 – Calculation of Scope 3 Fugitive Emissions from Road Transport (Market Delivery)

Period	Formula		Calculation
Per annum (Operational Phase)	VMT (Liddell)	= # Trips x Distance	= 8030 x 59
			= 474,011 miles
	Offsite Fuel Emissions (t CO_2-e) (Truck)	= VMT x (EF_{CO2} + (EF_{CH4} x 0.021) + (EF_{N2O} x 0.310))/1000	= 474,011 x (2 + (0.021 x 0.021) +(0.017 x 0.310))/1000
			= 821 t CO_{2-e}
Annual Mean			= 821 t CO_{2-e}
10 +1 Year Emission Total (Operational Phase + Construction Phase)			= (821 x 10) + 0
			= 8,209 t CO_{2-e}
20 +1 Year Emission Total (Operational Phase + Construction Phase)			= (821 x 20) + 0
			= 16,417 t CO_{2-e}
30 +1 Year Emission Total (Operational Phase + Construction Phase)			= (821 x 30) + 0
			= 24,626 t CO_{2-e}
40 +1 Year Emission Total (Operational Phase + Construction Phase)			= (821 x 40) + 0
			= 32,834 t CO_{2-e}
50 +1 Year Emission Total (Operational Phase + Construction Phase)			= (821 x 50) + 0
			= 41,043 t CO_{2-e}

D. ORICA EMISSION TOTALS

Table D – Total GHG Emission Summary from Proposed Orica ANE Production Project

	Onsite Fuel Combustion	Electricity Consumption	Offsite Transport Combustion	Total
Unit	(t CO2-e)	(t CO2-e)	(t CO2-e)	(t CO2-e)
Emission Type	Fugitive (Scope 1)	Stationery (Scope 2)	Fugitive (Scope 3)	All
Existing Operations Mean Annual Emissions	NA	957	NA	957
Construction Phase Mean Annual Emissions	663	990	393	2,046
Operational Phase Mean Annual Emissions	735	6,415	1,214	8,364
Scope 1 + 2 Mean Annual Emissions (Construction Phase excluded)		7,150	NA	7,150
Scope 1 and Scope 2 10 + 1 year Emissions Total		73,153	NA	73,153
Scope 1 and Scope 2 20 + 1 year Emissions Total		144,653	NA	144,653
Scope 1 and Scope 2 30 + 1 year Emissions Total		216,153	NA	216,153
Scope 1 and Scope 2 40 + 1 year Emissions Total		287,653	NA	287,653
Scope 1 and Scope 2 50 + 1 year Emissions Total		359,153	NA	359,153
PROJECT Mean Annual Emissions (Construction Phase excluded)				**8,364**
PROJECT 10 + 1 year Emissions Total				**85,686**
PROJECT 20 + 1 year Emissions Total				**169,326**
PROJECT 30 + 1 year Emissions Total				**252,966**
PROJECT 40 + 1 year Emissions Total				**336,606**
PROJECT 50 + 1 year Emissions Total				**420,246**

E. ORICA EMISSION TOTALS

Table E – GHG Emission Summary from Proposed Orica ANE Production Facility (Construction Phase Excluded from Annual Mean Calculations)

Emission Scope	UNFCCC Emission Source	Emission Type	Total (t CO_2 – e)	Onsite Emissions
Scope 1 (Direct)	Onsite Fuel (Fugitive) Combustion (Diesel)	Fuel Combustion	735 (per annum)	**Yes**
Annual Mean Scope 1 (Direct) Emissions tonnes CO_2-e			**735**	**Yes**
Scope 2 (Indirect)	Electricity Consumption Emissions	Purchased Electricity	6,415 (per annum)	**No**
Annual Mean Scope 2 (Indirect) Emissions tonnes CO_2-e			**6,415**	**No**
Scope 3 (Indirect)	Indirect Emissions from Domestic (Offsite) Transport	Fuel Combustion (Road)	1,214 (per annum)	**No**
Annual Mean Scope 3 (Indirect) Emissions tonnes CO_2-e			**1,214**	**No**
ANNUAL MEAN EMISSIONS DIRECTLY (SCOPE 1) RELATED TO THE PROJECT			**735**	**Yes**
ANNUAL MEAN EMISSIONS INDIRECTLY (SCOPE 2+3) RELATED TO THE PROJECT - DOWNSTREAM			**7,629**	**No**
ANNUAL MEAN PROJECT GHG EMISSIONS (SCOPE 1+2+3)			**8,364**	**Majority No**
10+1 YEAR (OPERATIONAL + CONSTRUCTION) PROJECT GHG EMISSIONS (SCOPE 1+2+3)			**85,686**	**Majority No**
20+1 YEAR (OPERATIONAL + CONSTRUCTION) PROJECT GHG EMISSIONS (SCOPE 1+2+3)			**169,326**	**Majority No**
30+1 YEAR (OPERATIONAL + CONSTRUCTION) PROJECT GHG EMISSIONS (SCOPE 1+2+3)			**252,966**	**Majority No**
40+1 YEAR (OPERATIONAL + CONSTRUCTION) PROJECT GHG EMISSIONS (SCOPE 1+2+3)			**336,606**	**Majority No**
50+1 YEAR (OPERATIONAL + CONSTRUCTION) PROJECT GHG EMISSIONS (SCOPE 1+2+3)			**420,246**	**Majority No**

The annual mean emissions from the Project are estimated as **8,364 t CO_2-e (refer to Table E)**. The construction phase emissions have not been included within this estimate due to its one year duration. Within the project annual mean **735 t CO2-e** per annum result from direct onsite (scope 1) emissions, **6,415 t CO2-e** per annum result from indirect offsite (Scope 2) emissions **and 1,214 t CO2-e** per annum result from indirect offsite (scope 3) emissions.

Directly related (Scope 1) sources contribute **8.8%** to the project's annual emissions (excluding construction phase), with **91.2%** of the project's annual emissions arising from indirectly related (scope 2 + 3) sources (excluding construction phase). Scope 2 indirect emissions from the consumption of electricity are the largest individual source. The scope 3 offsite transport emissions are considered to be outside the parameters of the Project and the direct influence of Orica.

Due to the production process being defined as continuous, an emission total from the project can not be defined. Assessment periods in ten year increments for the operational phase, plus one year of construction have been used as an alternative. Emissions from the Project have been estimated as **85,686 t CO2-e** over 10 +1 years, **169,326 t CO2-e** over 20+1 years, **252,966 t CO2-e** over 30 +1 years, **336,606 t CO2-e** over 40 +1 years and **420,246 t CO2-e** over 50+1 years **(refer to Table E)**.

ORICA CONTRIBUTION TO INVENTORIES

CONTRIBUTION TO GREENHOUSE GAS INVENTORIES

F. Contribution to National and International Greenhouse Gas (GHG) Inventory

The construction and operation of the project will contribute an estimated **0.00003** per cent to international annual GHG emissions and **0.002** per cent to national annual GHG emissions (**Table F2**).

Table F1 – Comparison of Project to National and International Greenhouse Inventories (Construction Phase Excluded from Annual Mean Calculations)

Comparison of Project GHG Emissions to National / International Emissions	
Scope / Category	Total t CO_2 -e
Annual Mean Scope 3 (Indirect) Emissions	1,214
Annual Mean Scope 1 (Direct) Emissions Related to the Project Operations	735
Annual Mean Emissions Indirectly Related to the Project (Scope 2 + 3) – DOWNSTREAM	7,629
Annual Mean Project Emissions (Scope 1 + Scope 2 + Scope 3)	8,364
CURRENT TOTAL GLOBAL EMISSIONS ^	29,000,000,000
CURRENT TOTAL NATIONAL EMISSIONS **	597,156,550

^ Source: International Energy Outlook, 2009 (Energy Information Administration, U.S. Department of Energy) (EIA, 2009): http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2009).pdf

** Source: National Greenhouse Gas Inventory: Kyoto Protocol Accounting Framework, 2009 (DCC, 2009b): http://ageis.climatechange.gov.au

Table F2 – Contribution of Project to National and International Greenhouse Inventories (Construction Phase Excluded from Annual Mean Calculations)

Contribution of Project GHG Emissions to National / International Emissions	
Scope / Category	Total t CO_2 –e
Annual Mean Project Emissions (Scope 1 + Scope 2 + Scope 3)	8,364
Current Total Global GHG Emissions Inventory	29,000,000,000
Current Total National GHG Emissions Inventory	597,156,550
Contribution to International Emissions Inventory	**0.00003**
Contribution to National Emissions Inventory	**0.001**