Roads and Maritime Services/Sydney Airport Corporation Limited

Sydney Gateway Road Project

Environmental Impact Statement/ Preliminary Draft Major Development Plan

Technical Working Paper 15

Human Health

November 2019

Sydney Gateway Road Project

Technical Working Paper 15 – Human Health

Roads and Maritime Services

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NSW GOVERNMENT

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Glossary of terms and abbreviations

Term	Definition
A	
ABS	Australian Bureau of Statistics
Acute exposure	Contact with a substance that occurs once or for only a short time (up to 14 days)
Absorption	The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs
Adverse health effect	A change in body function or cell structure that might lead to disease or health problems
ATSDR	Agency for Toxic Substances and Disease Register
B	
Background level	An average or expected amount of a substance or material in a specific environment, or typical amounts of substances that occur naturally in an environment.
BaP	Benzo(a)pyrene
Biodegradation	Decomposition or breakdown of a substance through the action of micro-organisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).
C	
Carcinogen	A substance that causes cancer
CASA	Civil Aviation Safety Authority
CBD	Central business district
CCME	Canadian Council of Ministers of the Environment
Chronic exposure	Contact with a substance or stressor that occurs over a long time (more than one year) [compare with acute exposure and intermediate duration exposure].
CO	Carbon monoxide
COPD	Chronic Obstructive Pulmonary Disease
D	
dB(A)	Decibels (A-weighted)
DECCW	NSW Department of Environment, Climate Change and Water
DEFRA	Department for Environment, Food & Rural Affairs
Detection limit	The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Term	Definition
Dose	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An 'exposure dose' is how much of a substance is encountered in the environment. An 'absorbed dose' is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
DPM	Diesel particulate matter
E	
EC	European Commission
ED	Emergency department
EIS	Environmental Impact Statement
EPA	Environment Protection Authority (in Australia) and Environmental Protection Authority (in the United States)
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
EU	European Union
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Also includes contact with a stressor such as noise or vibration. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].
Exposure assessment	The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.
Exposure pathway	The route a substance takes from its source (where it began) to its endpoint (where it ends), and how people can come into contact with (or get exposed) to it. An exposure pathway has five parts: a source of contamination (such as chemical leakage into the subsurface); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.
G	
Genotoxic carcinogen	These are carcinogens that have the potential to result in genetic (DNA) damage (gene mutation, gene amplification, chromosomal rearrangement). Where this occurs, the damage may be sufficient to result in the initiation of cancer at some time during a lifetime.
GRAL	Graz Lagrangian Model
GRAMM	GRAZ Mesoscale Model

Term	Definition
Guideline value	Guideline value is a concentration in soil, sediment, water, biota or air (established by relevant regulatory authorities such as the NSW Office of Environment and Heritage or institutions such as the National Health and Medical Research Council (NHMRC), Australia and New Zealand Environment and Conservation Council (ANZECC) and World Health Organization (WHO)), that is used to identify conditions below which no adverse effects, nuisance or indirect health effects are expected. The derivation of a guideline value utilises relevant studies on animals or humans and relevant factors to account for inter and intra-species variations and uncertainty factors. Separate guidelines may be identified for protection of human health and the environment. Dependent on the source, guidelines would have different names, such as investigation level, trigger value and ambient guideline.
H	
HI	Hazard Index
HIA	Health impact assessment
I	
IARC	International Agency for Research on Cancer
ICNG	Interim Construction Noise Guideline (NSW DECC 2009)
IHD	Ischaemic heart disease
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see route of exposure].
Intermediate exposure duration	Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].
L	
L_{A1}	A-weighted sound level exceeded for 1% of the measurement period
L_{A10}	A-weighted sound level exceeded for 10% of the measurement period
L_{A90}	A-weighted sound level exceeded for 90% of the measurement period
L_{Aeq}	A-weighted equivalent sound level
L_{Amax}	A-Weighted, maximum sound level
LGA	Local Government Area
LOAEL	Lowest observed adverse effect level – The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.
M	
Metabolism	The conversion or breakdown of a substance from one form to another by a living organism.
N	
NCAs	Noise catchment areas
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides

Term	Definition
NSW	New South Wales
NSW EPA	NSW Environment Protection Authority
O	
OEH	NSW Office of Environment and Heritage
OEHHA	Office of Environmental Health Hazard Assessment, California Environment Protection Agency (Cal EPA)
P	
PAH	Polycyclic aromatic hydrocarbon
PM	Particulate matter
PM_1	Particulate matter below one micron in diameter, often termed very fine particles
$PM_{2.5}$	Particulate matter of aerodynamic diameter 2.5 µm and less
PM_{10}	Particulate matter of aerodynamic diameter 10 µm and less
Point of exposure	The place where someone can come into contact with a substance present in the environment [see exposure pathway].
Population	A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).
PFAS	Per- and polyfluoroalkyl substances
R	
Receptor population	People who could come into contact with hazardous substances [see exposure pathway].
Risk	The probability that something would cause injury or harm.
Route of exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
RWR	Residential, worker and recreational receptors
S	
SA	Statistical area
SEARs	Secretary's environmental assessment requirements
SO_2	Sulfur dioxide
T	
TCEQ	Texas Commission on Environmental Quality
TEQ	Toxicity equivalent
Toxicity	The degree of danger posed by a substance to human, animal or plant life.
Toxicity data	Characterisation or quantitative value estimated (by recognised authorities) for each individual chemical for relevant exposure pathway (inhalation, oral or dermal), with special emphasis on dose-response characteristics. The data are based on based on available toxicity studies relevant to humans and/or animals and relevant safety factors.

Term	Definition
Toxicological profile	An assessment that examines, summarises, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.
TRV	Toxicity reference value
Toxicology	The study of the harmful effects of substances on humans or animals.
U	
Uncertainty factor	Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no observed adverse effect level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure would cause harm to people [also sometimes called a safety factor].
Ultrafines	Particulate matter below 0.1 microns in diameter
UK	United Kingdom
US	United States
USEPA	United States Environmental Protection Agency
V	
VOC	Volatile organic compound
W	
WHO	World Health Organization
Without project	A model that does not incorporate the proposed project infrastructure.
With project	A model that incorporates the proposed project infrastructure.
With project cumulative	A model that incorporates the proposed project infrastructure as well as other approved and proposed infrastructure projects.
Other	
β coefficient	Beta coefficient
µg/m^3	Micrograms per cubic metre

1 Introduction

1.1 Overview

1.1.1 Sydney Gateway and the project

Sydney Kingsford Smith Airport (Sydney Airport) and Port Botany are two of Australia's most important infrastructure assets, providing essential domestic and international connectivity for people and goods. Together they form a strategic centre, which is set to grow significantly over the next 20 years. To support this growth, employees, residents, visitors and businesses need reliable access to the airport and port, and efficient connections to Sydney's other strategic centres.

The NSW and Australian governments are making major investments in the transport network to achieve this vision. New road and freight rail options are being investigated to cater for the forecast growth in passengers and freight through Sydney Airport and Port Botany. Part of this solution is Sydney Gateway, which comprises the following road and rail projects:

- Sydney Gateway road project (the subject of this assessment)
- Botany Rail Duplication.

Sydney Gateway will expand and improve the road and freight rail networks to Sydney Airport and Port Botany to keep Sydney moving and growing. The Sydney Gateway road project forms part of the NSW Government's long-term strategy to invest in an integrated transport network and make journeys easier, safer and faster.

Roads and Maritime and Sydney Airport Corporation propose the Sydney Gateway road project (the project). The project comprises new direct high capacity road connections linking the Sydney motorway network at St Peters interchange with Sydney Airport's terminals and beyond. It involves constructing and operating new and upgraded sections of road connecting to the airport terminals, four new bridges over Alexandra Canal, and other operational infrastructure and road connections.

The project and its location is shown on Figure 1.1.

1.1.2 Overview of approval requirements

The project is subject to approval under NSW and Commonwealth legislation. Parts of the project located on Commonwealth-owned land leased to Sydney Airport (Sydney Airport land) are subject to the Commonwealth *Airports Act 1996* (the Airports Act). In accordance with the Airports Act, these parts of the project are major airport development. A major development plan (MDP), approved by the Australian Minister for Infrastructure, Transport and Regional Development, is required before a major airport development can be undertaken at a leased airport.

Parts of the project located on other land are State significant infrastructure in accordance with the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). As State significant infrastructure, these parts of the project require approval from the NSW Minister for Planning and Public Spaces. An environmental impact statement (EIS) is required to support the application for approval for State significant infrastructure under the EP&A Act.

A combined EIS and preliminary draft MDP is being prepared to:

- Support the application for approval of the project in accordance with NSW and Commonwealth legislative requirements
- Address the environmental assessment requirements of the Secretary of the Department of Planning and Environment (the SEARs), issued on 15 February 2019
- Address the MDP requirements defined by section 91 of the Airports Act.

This report was prepared on behalf of Roads and Maritime and Sydney Airport Corporation to support the combined EIS/preliminary draft MDP.

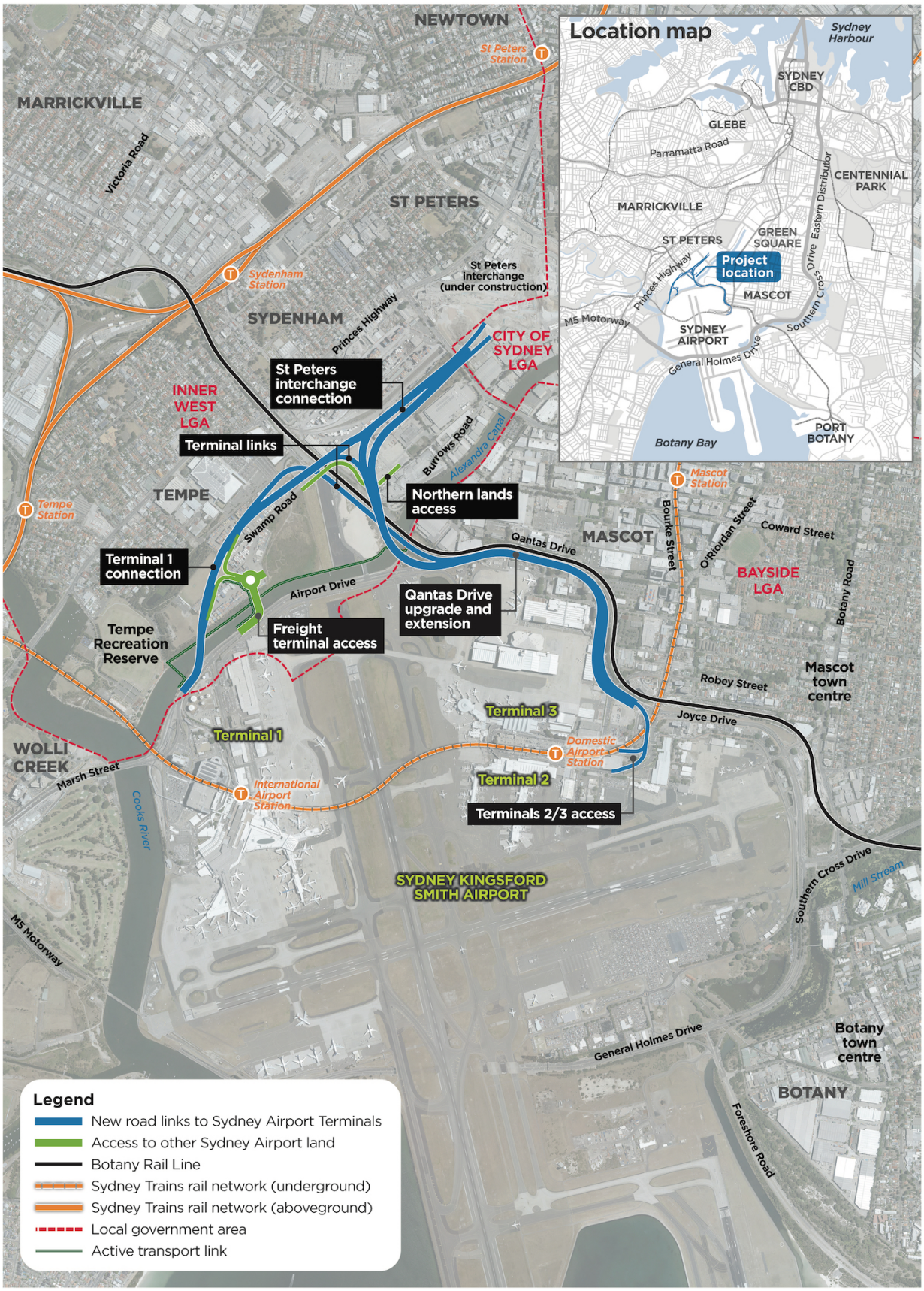


Figure 1.1: Location of the project

1.2 Purpose and scope of this report

The purpose of this report is to assess impacts on community health of constructing and operating the project, which includes consideration of both physical health and wellbeing. The assessment has considered both health benefits as well as health impacts.

The health impact assessment (HIA) draws together and assesses impacts from changes in air quality, noise, public safety and a range of community/social aspects, as these relate to and may impact on the health of the community. As a result, the HIA draws directly on a wide range of other EIS/preliminary draft MDP technical studies, to evaluate how the impacts identified in these studies may then either benefit or impact on the health of the community. As the HIA draws on information from many other technical studies, sufficient detail is provided within this report to capture all aspects relevant to the assessment of community health in the one report.

More specifically, the HIA has been undertaken in accordance with guidance from enHealth (enHealth 2012b, 2017) (also refer to **sections 2.2 and 2.3**), where the following has been presented:

- Outline of the methods used to evaluate health impacts relating to project related changes in air quality noise, public safety and a range of community/social aspects
- An overview of the key characteristics for the existing health of the community evaluated within the HIA
- An assessment of potential impacts on health associated with project related changes in air quality. This involves both a qualitative assessment of construction impacts and the quantitative assessment of health impacts for the community considered within the air quality technical study
- An assessment of potential impacts on health associated with project related changes in noise. This is a largely qualitative assessment of construction and operational noise impacts for the community considered within the noise and vibration technical study
- An assessment of potential impacts of the project on public safety. This is a qualitative review of impacts that have the potential to impact on public safety during construction and operation
- An assessment of potential impacts of a range of other project related impacts on community health. This is a qualitative assessment of project related impacts related to traffic, contamination of land and water, changes in green space and access to recreational facilities, public transport, active transport and acquisitions as outlined in the various relevant technical studies
- Consideration of the overall impact of the project on community health with consideration of the uncertainties
- Consideration of the recommended mitigation measures identified in the technical studies considered in the HIA, and whether these adequately address the potential health impacts identified. Where necessary, additional mitigation measures that may need to be considered to address community health impacts have been outlined.

The report also addresses the relevant SEARs for the EIS, as outlined in **Table 1.1.**

This report has not addressed occupational health and safety aspects for workers and contractors involved in the construction and operation of the project. Occupational health and safety aspects of the project would be managed separately under current occupational health and safety regulations and guidelines as outlined and enforced by SafeWork NSW.

MDP requirements (under section 91 of the *Airports Act 1996*) relevant to community health are outlined in **Table 1.2**.

Table 1.1: SEARs relevant to this assessment

Requirement of SEARs	Section where requirement is addressed
Contamination - SEAR 12(1)(b): 1. The Proponent must assess the potential for contamination and any impacts associated with the management of contaminated soils and water resources including, but not limited to: (b) an assessment of potential risks to human health and the environmental receptors in the vicinity of the site	Section 8.4
Health and safety - SEAR 14(1) to 14(3): 1. The Proponent must assess the potential health impacts of the proposal in accordance with the current guidelines. • Environmental Health Risk Assessment, Guidelines for assessing human health risks from environmental hazards, Commonwealth of Australia (enHealth, 2012) • Methodology for Valuing the Health Impacts of Changes in Particle Emissions (EPA, 2013) • Health Impact Assessment: A practical guide (NSW Health, 2007) • Health Impact Assessment Guidelines, (enHealth, 2017) • SEPP No. 33 - Hazardous and Offensive Development	Section 6, and more specifically sections 6.5, 6.6, 6.7, 6.8, 6.9, 6.10 and 6.11
2. The assessment must:	
(a) describe the current known health status of the affected population	Section 4.5
(b) assess health risks associated with exposure to environmental hazards	Sections 6, 7, 8 and 9
(c) assess the effect of the proposal on other relevant determinants of health such as the level of physical activity and access to social infrastructure	Sections 9.3.4, 9.5 and 9.6
(d) assess opportunities for health improvement	Sections 6, 7, 8 and 9
(e) assess the distribution of the health risks and benefits	Sections 6, 7, 8 and 9
(f) assess the potential for construction fatigue and outline proposed management measures	Section 9.9
(g) discuss how, in the broader social and economic context of the proposal, the proposal will minimize negative health impacts while maximizing the health benefits	Sections 6, 7, 8 and 9
3. The Proponent must assess the likely risks of the proposal to public safety, paying particular attention to pedestrian and cyclist safety, subsidence risks, bushfire risks and the handling and use of dangerous goods.	Section 8

Table 1.2: MDP requirements relevant to this assessment

MDP requirement	Section where requirement is addressed
Airports Act 1996, Part 5, Division 4, Section 91(1) (Contents of major development plan)	
(1) A major development plan, or a draft of such a plan, must set out:	
(d) if a final master plan for the airport is in force—whether or not the development is consistent with the final master plan; and	The Sydney Airport Master Plan 2039 master plan does not include any specific requirements in relation to community health
(h) the airport-lessee company's assessment of the environmental impacts that might reasonably be expected to be associated with the development; and	Impacts on community health associated with environmental impacts detailed in sections 6.10, 7.7, 8.5 and 9.13
(j) the airport-lessee company's plans for dealing with the environmental impacts mentioned in paragraph (h) (including plans for ameliorating or preventing environmental impacts); and	Section 10

1.3 The project

1.3.1 Location

The project is located about eight kilometres south of Sydney's central business district and to the north of Sydney Airport on both sides of Alexandra Canal. The northern extent of the project is located at St Peters interchange, which is currently being constructed to the north of Canal Road in St Peters. The western extent of the project is located near the entrance to Sydney Airport Terminal 1 on Airport Drive, to the north of the Giovanni Brunetti Bridge and south-west of Link Road. The eastern extent of the project is located near the intersection of Joyce Drive, Qantas Drive, O'Riordan Street and Sir Reginald Ansett Drive.

The project is located mainly on government owned land in the suburbs of Tempe, St Peters and Mascot, in the Inner West, City of Sydney and Bayside local government areas.

1.3.2 Key design features

The project provides a number of linked road connections to facilitate the movement of traffic between the Sydney motorway network, Sydney Airport Terminal 1 (Terminal 1) and Sydney Airport Terminals 2 and 3 (Terminals 2/3). The project would connect Terminal 1 and Terminals 2/3 with each other and with the Sydney motorway network. The project would also facilitate the movement of traffic towards Port Botany via General Holmes Drive. It would provide three main routes for traffic:

- Between the Sydney motorway network and Terminal 1, and towards M5 motorway and Princes Highway
- Between the Sydney motorway network and Terminals 2/3, and towards General Holmes Drive, Port Botany and Southern Cross Drive
- Between Terminal 1 and Terminals 2/3.

The key features of the project include:

- Road links to provide access between the Sydney motorway network and Sydney Airport's terminals, consisting of the following components:
  - St Peters interchange connection – a new elevated section of road extending from St Peters interchange to the Botany Rail Line, including an overpass over Canal Road
  - Terminal 1 connection – a new section of road connecting Terminal 1 with the St Peters interchange connection, including a bridge over Alexandra Canal and an overpass over the Botany Rail Line
  - Qantas Drive upgrade and extension – widening and upgrading Qantas Drive to connect Terminals 2/3 with the St Peters interchange connection, including a high-level bridge over Alexandra Canal
  - Terminal links – two new sections of road connecting Terminal 1 and Terminals 2/3, including a bridge over Alexandra Canal
  - Terminals 2/3 access – a new elevated viaduct and overpass connecting Terminals 2/3 with the upgraded Qantas Drive
- Road links to provide access to Sydney Airport land:
  - A new section of road and an overpass connecting Sydney Airport's northern lands either side of the Botany Rail line (the northern lands access)
  - A new section of road, including a signalised intersection with the Terminal 1 connection and a bridge connecting Sydney Airport's existing and proposed freight facility either side of Alexandra Canal (the freight terminal access)
- An active transport link approximately 1.3 kilometres in length along the western side of Alexandra Canal to maintain connections between Sydney Airport, Mascot and the Sydney central business district
- Intersection upgrades or modifications
- Provision of operational ancillary infrastructure including maintenance bays, new and upgraded drainage infrastructure, signage and lighting, retaining walls, noise barriers, flood mitigation basin, utility works and landscaping.

1.3.3 Construction overview

A conceptual construction methodology has been developed based on the preliminary project design to be used as a basis for the environmental assessment process. Detailed construction planning, including programming, work methodologies, staging and work sequencing would be undertaken once construction contractor(s) have been engaged.

1.3.3.1 Timing and work phases

Construction of the project would involve four main phases of work. The indicative construction activities within each phase are outlined below:

Phase	Indicative construction activities
Enabling works	• construction of the temporary active transport link, • modification of various road intersections to facilitate main construction works.
Site establishment	• installing site fencing, hoarding and signage, • establishing construction compounds, work areas and site access routes.
Main construction works	• clearing/ trimming of vegetation, • removal (or partial removal) of a number of buildings and other existing infrastructure eg concrete hardstand areas, drainage infrastructure, sheds, advertising structures, containers, etc, • roadworks, including bridge and viaduct construction and drainage works, • utility works.
Finishing works	• erecting lighting, signage and street furniture, landscaping works and site demobilisation and rehabilitation in all areas.

Specific construction issues which will require careful planning and management and close co-ordination with relevant stakeholders include:

- Works within the prescribed airspace of Sydney Airport
- Works interfacing with the Botany Rail Line
- Piling in the vicinity of the T8 Airport and South line underground rail tunnels
- Works within the former Tempe Tip site and Alexandra Canal which are subject to remediation orders and specific management plans
- Excavation, storage and handling of contaminated soils generally within the project site and contaminated groundwater from the Botany Sands aquifer.

Construction is planned to start in mid 2020, subject to approval of the project, and is expected to take about three and a half years to complete. Further information on construction is provided in Chapter 8 (Construction) of the EIS.

The project would include work undertaken during recommended standard hours as defined by the *Interim Construction Noise Guideline* (DECC, 2009):

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sundays and public holidays: no work.

It would also include work outside these hours (out-of-hours work) to minimise the potential for aviation and rail safety hazards.

1.3.3.2 Construction footprint

The land required to construct the project (the construction footprint) is shown on Figure 1.2. The construction footprint includes the land needed to construct the proposed roadways, bridges and ancillary infrastructure and land required for the proposed construction compounds. Utility works to support the project would generally occur within the construction footprint; however, some works (such as connections to existing infrastructure) may be required outside the footprint.

1.3.3.3 Compounds, access and resources

Construction would be supported by five construction compounds located to support the main construction works (shown on Figure 1.2). Construction compounds would include site offices, staff amenities, storage and laydown areas, workshops and workforce parking areas.

Materials would be transported to and from work areas via construction haul routes, which have been selected to convey vehicles directly to the nearest arterial road.

The construction workforce requirements would vary over the construction period based the activities underway and the number of active work areas. The workforce is expected to peak at about 1,000 workers for a period of about 13 months, indicatively from the fourth quarter of 2021. Either side of this peak, workforce numbers are expected to reduce to about two thirds.

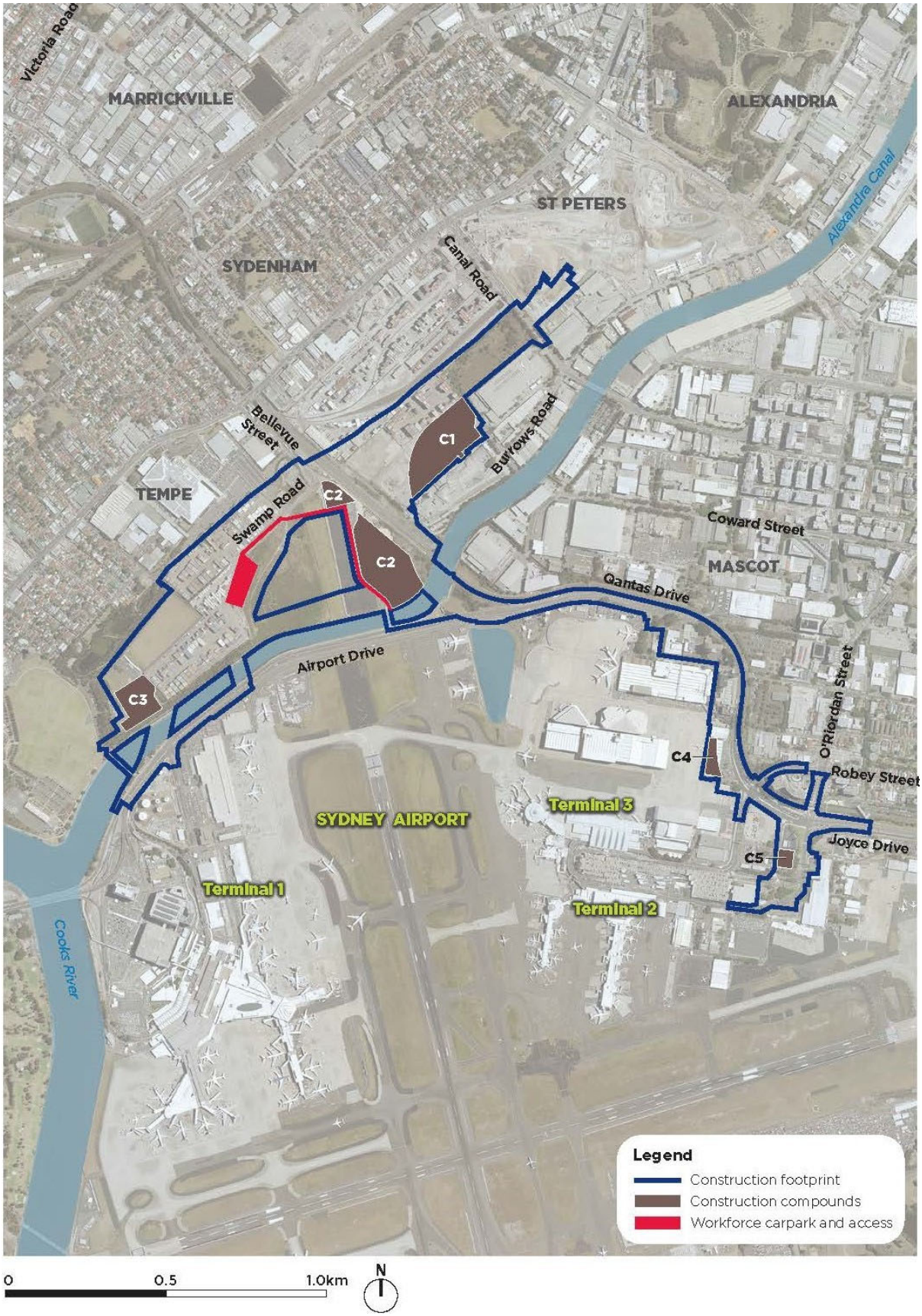


Figure 1.2: Construction footprint and facilities

1.4 Structure of this report

The HIA report addresses both construction and operational impacts to health structured around the key areas where health impacts are of importance, as follows:

- Section 1 – provides an introduction to the project and report
- Section 2 – provides the statutory and policy context for the assessment and the relevant guidance
- Section 3 – provides the methodology adopted for the assessment
- Section 4 – describes the existing environment relevant to the assessment of community health impacts
- Section 5 – outlines the community consultation process and issues identified throughout that process that relate to community health
- Section 6 – presents the assessment of health impacts related to changes in air quality. The section addresses impacts related to construction and operation, including impacts relevant to Commonwealth land
- Section 7 - presents the assessment of health impacts related to changes in noise. The section addresses impacts related to construction and operation, including impacts relevant to Commonwealth land
- Section 8 – presents the assessment of impacts of the project on public safety. The section addresses impacts related to construction and operation, including impacts relevant to Commonwealth land
- Section 9 – presents the assessment of health impacts related to a range of changes in other social aspects of the project. The section addresses impacts related to construction and operation, including impacts relevant to Commonwealth land
- Section 10 – presents recommended mitigation measures that are identified within the HIA
- Section 11 – presents the conclusions of the assessment
- Section 12 – presents a list of references used within the document.

1.5 Personnel

This HIA has been prepared by Dr Jackie Wright with internal technical review by Therese Manning. Staff qualifications are presented in Table 1.3.

Table 1.3: Staff qualifications and experience

Name	Position/Role on the project	Qualifications	Relevant years experience
Dr Jackie Wright	Technical lead and project manager	BE (Hons.) PhD	>25 years
Therese Manning	Technical review	BSc (Hons.) MScApp	>25 years

2 Legislative and policy context

2.1 Overview

The applicable legislative and policy context represents a significant influence on the transport and land use planning elements of the project. In relation to the conduct of a HIA, the following legislation, policies and guidelines are relevant and are required to be considered. The national guidance documents were used as the basis of the design of this HIA. Discussion as to how legislation, policy and guidelines specific to air quality, noise and vibration or social aspects is provided in each of relevant section of this impact assessment report.

The legislation and guidance listed in this section are current at the time of completion of this assessment. Any changes to legislation and guidance that occur post completion of the EIS/preliminary draft MDP, that is relevant to the project, would be expected to be considered and addressed at that time.

2.2 Commonwealth legalisation, policies and guidelines

2.2.1 Airports Act 1996 and associated regulations

The project site includes areas of Commonwealth-owned land leased by Sydney Airport Corporation. The *Airports Act 1996* (Cth) (the Airports Act) and associated regulations provide the assessment and approval process for development on Commonwealth-owned land for the operation of Sydney Airport.

Section 89 of the *Airports Act* specifies types of development that constitute 'major airport development'. Section 70 of the Airports Act requires a major development plan (MDP) be approved by the Australian Minister for Infrastructure, Transport and Regional Development is required before major airport development can be undertaken at a leased airport.

The *Airports Act* and regulations are the statutory controls for ongoing regulation of development activities on Commonwealth-owned land leased from the Australian Government for the operation of Sydney Airport.

Part 5 of the Act also requires that each airport develop an environment strategy which is included in its master plan. Once approved, Sydney Airport Corporation and all persons who carry out activities at the airport are obliged to take all reasonable steps to ensure compliance with the environment strategy.

The act does not make specific reference to human health, however, it does define offences related to serious environmental harm that includes pollution that has the potential to result in harm to public health or public safety.

Neither the Sydney Airport Master Plan 2039 or the Sydney Airport Environmental Strategy 2019-2024 make any reference to community health. Therefore no assessment in relation to these documents has been provided in this report.

2.2.2 Airports (Environment Protection) Regulations 1997

The objective of the *Airports (Environment Protection) Regulations 1997* (the regulations) is to establish a system of regulation for activities at airports that generate or have potential to generate pollution or excessive noise. The regulations impose a general duty to prevent or minimise environmental pollution and have as one of their objects the promotion of improved environmental management practices at Commonwealth-leased airports. The regulations contain detailed provisions setting out:

- Definitions, acceptable limits and objectives for air, water and soil pollution, and offensive noise
- General duties to prevent or minimise pollution, preserve significant habitat and cultural areas, and to prevent offensive noise
- Monitoring and reporting requirements for existing pollution.

Part 4, Division 2 of the regulations outline the general duty to preserve habitat by taking all reasonable and practicable measures to:

- Prevent adverse consequences for the local biota and the ecosystems and habitats of native species
- Prevent adverse consequences for a species or ecological community listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)
- Ensure where there are listed threatened species or ecological communities operations, or other works, are not inconsistent with an action intended to lessen the threat to the species or ecological community
- Ensure operations or other works, are not inconsistent with an international convention, treaty or other agreement to which Australia is a party, and that relates to a matter to which these Regulations apply.

The regulation provides definitions of beneficial use (which includes public health) and pollution (in terms of being harmful to the health or welfare of humans). The regulation includes consideration of human health impacts related to excessive noise, water and soil pollution. The regulations provide objectives for air quality. This regulation does not provide any guidance on the assessment of health impacts.

2.2.3 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is administered by the Australian Department of the Environment and Energy and provides a legal framework to protect and manage nationally important flora, fauna, ecological communities and heritage places defined as 'matters of national environmental significance'.

Under the EPBC Act, proposed actions (ie activities or projects) with the potential to significantly impact matters protected by the EPBC Act must be referred to the Australian Minister for the Environment to determine whether they are controlled actions, requiring approval from the Minister. The following matters are defined as protected matters by Part 3 of the EPBC Act:

- Matters of national environmental significance
- The environment of Commonwealth land
- The environment in general if they are being carried out by an Australian Government agency.

The EPBC Act addresses issues related to species that may pose a serious threat to human health and human health issues related to the import/export of research objects and specimens. The Act does not provide any specific requirements in relation to community health relevant to this project.

As part of the assessment of the draft MDP, DITCARD will, on behalf of the Minister for Infrastructure, Transport and Regional Development, seek advice from the Australian Minister for the Environment under section 160(1) of the EPBC Act.

2.2.4 National Environment Protection Council Act 1994 and associated Measures

The *National Environment Protection Council Act 1994* relates to the establishment and operation of the National Environment Protection Council (NEPC), to meet the objectives that:

- People enjoy the benefits or equivalent protection from air, water or soil pollution and from noise, wherever they live in Australia and
- Decisions of the business community are not distorted, and markets are not fragmented, by variations between participating jurisdictions in relation to the adoption or implementation of major environment protection measures.

The Act provides for the NEPC to make, and vary or revoke, National Environment Protection Measures (NEPM), and assess the implementation of the Measures.

The NEPMs relevant to the assessment of community health are as follows:

- NEPC National Environment Protection (Ambient Air Quality) Measure (NEPC 2016) – this NEPM provides the desired environmental outcomes and protection standards and goals for ambient air quality in Australia. The NEPM sets standards and goals for carbon monoxide, nitrogen dioxide, photochemical oxidants, sulfur dioxide, lead and particulates as PM_{10} and $PM_{2.5}$ for the protection of community health. These standards and goals have been considered in the assessment of health impacts from changes in air quality
- NEPC National Environmental Protection (Air Toxics) Measure (NEPC 2004) – this NEPM provides the desired environmental outcomes, protection protocols, sampling methods, and monitoring investigation levels for benzene, benzo(a)pyrene, formaldehyde, toluene and xylenes in ambient air in Australia. The investigation levels are based on the protection of community health, and have been considered in the assessment of health impacts, where these remain current.

2.2.5 Guidance documents

More specific guidance is available from the Commonwealth on the assessment of human health impacts. This is the key guidance followed in the preparation of the HIA presented in this report, and includes the following:

- enHealth Health Impact Assessment Guidelines (enHealth 2017) – this guidance aims to promote and enhance the incorporation of HIA into environmental and planning impact assessment generally, thereby improving the consideration of health issues. The document provides an introduction to the HIA process, the different types of assessments that can be undertaken, the principles that may need to be addressed in an assessment, the roles of those involved in an assessment and general information on the preparation of a HIA
- enHealth Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards (enHealth 2012b) – this document provides an outline of the national approach adopted for the assessment of environmental health risks. While risk assessment is part of the HIA process, the conduct of such an assessment typically focuses on key elements within the HIA where a more detailed quantitative assessment of exposure, toxicity and health risk is required, and can be undertaken. The enHealth guidance provides the Australian framework and approach for the conduct of such assessments
- Health Impact Assessment: A Practical Guide (Harris 2007) – this document provides a more practical overview of the HIA process in Australia. The document outlines the key phases and steps involved in conducting an assessment, the key concepts, the different levels of assessment that can be undertaken within a HIA and approaches that can be considered in the conduct of a HIA

- PFAS National Environmental Management Plan (NEMP) (HEPA 2018) – this document provides guidance in relation to PFAS contaminated sites in Australia. It is a guidance document that is focused on the protection of the environment and, as a precaution, protection of human health.

2.3 NSW legislation

2.3.1 Environmental Planning and Assessment Act 1979

Parts of the project that are not located on Sydney Airport land are declared State significant infrastructure. State significant infrastructure is regulated under the EP&A Act, which requires proponents to apply to the NSW Minister of Planning and Public Spaces for infrastructure approval, supported by an EIS.

The SEARs for the project define the matters to be addressed in the EIS, including the assessment of human health aspects, as addressed in this report.

2.3.2 Public Health Act 2010

The objectives of the *Public Health Act 2010* include controlling risks to public health and the promotion, protection and improvement of public health. Under Part 2, the Minister has the power to undertake actions in regard to risks to public health.

2.3.3 Protection of the Environment (Operations) Act 1997 and Regulations

The *Protection of the Environment (Operations) Act 1997* (POEO Act) provides the legal framework for the protection of the environment in NSW. Regulations relevant to areas evaluated in the HIA are provided in the *Protection of the Environment Operations (Clean Air) Regulations 2010*, *Protection of the Environment Operations (General) Regulation 2009*, *Protection of the Environment Operations (Noise Control) Regulation 2017 and Protection of the Environment Operations (Waste) Regulation 2014.*

The POEO Act and Regulations specify what activities require licences, what such licences should cover, offences in regard to pollution, the development of protection of the environment policies. Such actions relate to noise, emissions to air, water and land and the management of waste.

The POEO Act and regulations state that risks to human health and degradation of the environment must be reduced via a range of mechanisms. The Act also states that the objective of the Environment Protection Authority (EPA) is to protect human health and the environment by reducing the harmful effects of pollution and waste. The Act outlines penalties for pollution of air, water or land. It also addresses objectionable noise and powers to address noise complaints.

2.3.4 Contaminated Land Management Act 1997

This Act specifies how to deal with land that might be contaminated due to historical activities in order to minimise risks to public health. This Act may be relevant for this project during construction, where contamination issues may be present. Where relevant, objectives of this Act that relate to the protection of human health from contamination have been considered in this report.

2.3.5 Guidance documents

More specific guidance is available in NSW on the assessment of human health impacts. This is the key guidance followed in the preparation of the HIA presented in this report, and includes the following:

- NSW Health, Building Better Health, Health considerations for urban development and renewal in the Sydney Local Health District (NSW Health 2016)
- NSW Health, Healthy Urban Development Checklist, A guide for health services when commenting on development policies, plans and proposals (NSW Health 2009)
- Methodology for Valuing the Health Impacts of Changes in Particle Emissions (EPA 2013)
- Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW EPA 2016)
- State Environmental Planning Policy (SEPP) 33 - Hazardous and Offensive Development.

In addition, the detailed assessment of potential impacts related to changes in noise associated with the project has considered the level of health protection within NSW noise policies and guidelines. This is discussed further in **section 7.4**, where the following noise policies and guidelines are of relevance:

- NSW Road Noise Policy (NSW DECCW 2011)
- NSW Noise Policy for Industry (NSW EPA 2017)
- Interim Construction Noise Guideline (NSW DECC 2009)
- Assessing Vibration: a technical guideline (NSW DEC 2006).

2.4 Other standards and guidelines

Additional specific technical guidelines relevant to the more detailed assessment of health impacts associated with changes in air quality, noise and social stressors (ie changes in stress from changes in the social environment) from international agencies such as the World Health Organization (WHO) and US EPA are referred to where relevant. These references are included in the HIA as they relate to specific details and assessment methods in the assessment. References to these documents are included in each section of this report where they are relevant.

3 Methodology

3.1 Introduction to risk assessment

3.1.1 Risk

Risk assessment is used extensively in Australia and overseas to assist in decision making on the acceptability of the risks associated with the presence of contaminants or stressors in the environment and assessment of potential risks to the public. Risk is commonly defined as the chance of injury, damage, or loss. Therefore, to put oneself or the environment 'at risk' means to participate, either voluntarily or involuntarily, in an activity or activities that could lead to injury, damage, or loss.

Voluntary risks are those associated with activities that the community decide to undertake such as driving a vehicle, riding a motorcycle and smoking cigarettes. Involuntary risks are those associated with activities that may happen to the community without our prior consent or forewarning. Acts of nature such as being struck by lightning, fires, floods and tornados, and exposures to environmental contaminants are examples of involuntary risks.

3.1.2 Defining risk

Risks to the public and the environment are determined by direct observation or by applying mathematical models and a series of assumptions to infer risk. No matter how risks are defined or quantified, they are usually expressed as a probability of adverse effects associated with a particular activity. Risk is typically expressed as a likelihood of occurrence and/or consequence (such as negligible, low or significant) or quantified as a fraction of, or relative to, an acceptable risk number.

Risks or impacts from a range of facilities (eg industrial or infrastructure) are usually assessed through qualitative and/or quantitative risk assessment techniques. In general, risk or impact assessments seek to identify all relevant risks; assess or quantify their likelihood of occurrence and the consequences associated with these events occurring; and provision of an estimate of the risk levels for people who could be exposed, including those beyond the perimeter boundary of a facility. In this report, quantitative risk is assessed in terms of acceptable, tolerable or unacceptable risk.

Definitions of some of the key terms that are used in the assessment are presented in **Annexure A** and a more detailed discussion on the determination of acceptable, tolerable or unacceptable risks is presented in **Annexure C** of this report.

3.2 Approach to the health impact assessment

3.2.1 General

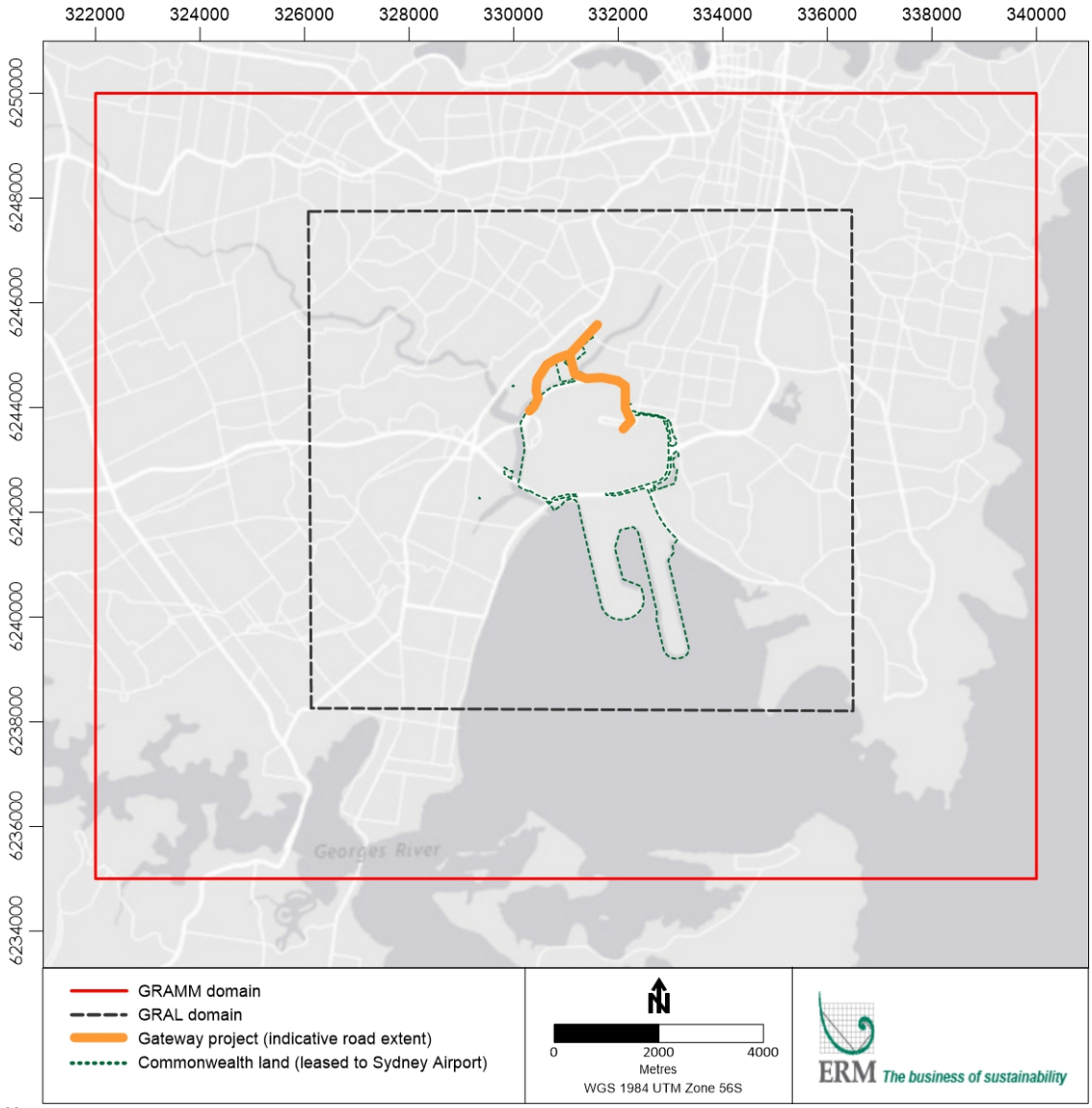
The HIA was undertaken as a desk-top assessment. The term desk-top assessment is used to describe that the assessment has not involved the collection of any additional data over and above that which would be provided from project-specific technical studies, community consultation and statistics on the existing population. Rather the assessment has been conducted using existing information with additional detail obtained via literature review only.

The impact assessment was undertaken in accordance with the scope as outlined in **section 1.3** and the guidelines outlined in **section 2** and involved both quantitative and qualitative evaluations. Following this approach, the assessment of health impacts relevant to the different areas of evaluation has utilised a range of different methods and approaches, with each specifically relevant to the technical aspect being considered. The following provides an overview of the approach adopted for the assessment of health impacts related to air quality, noise, safety and other social determinants. Specific details related to the assessments undertaken in each of these areas is presented in the relevant chapter (where it specifically relates to the assessment presented).

3.2.2 Study area

The HIA has drawn directly on other specific technical studies undertaken for the combined EIS/preliminary draft MDP such as traffic, air quality, noise and social impacts. Both wider aspects addressed in the EIS/preliminary draft MDP (eg broad community benefits), and specific technical working papers (eg contamination and soils) that address issues related to the health of the community were also evaluated in the HIA where relevant. As the HIA has relied on the assessments undertaken in other technical studies, the study areas evaluated in relation to health impacts are the same as the study areas considered in each of the individual technical working paper. These study areas are specific to each technical study and are, therefore, further described in the more detailed assessment of each key area such as air quality (refer to **sections 6.3 and 6.4**), noise (refer to **section 7.3**) and social aspects (refer to discussion in **section 9** where relevant).

The largest of the study areas evaluated in the technical studies is defined in the *Technical Working Paper 4 – Air Quality*, and illustrated in **Figure 3.1**. This study area is adopted in the HIA as the larger population area to be considered in terms of changes in health.



Note:
GRAMM domain is the larger meteorological domain evaluated in the air quality assessment
GRAL domain is the area in which changes in air quality have been predicted and is the study area adopted for the assessment of health impacts

Figure 3.1: Health study area

3.2.3 Assessment scenarios

The assessment of impacts presented in the technical working papers associated with the project has considered a range of scenarios that include the existing situation, construction works and various future operational scenarios both with and without the project. In addition, a cumulative scenario, associated with impacts from the project as well as the Botany Rail Duplication and other road projects was assessed.

The air modelling scenarios have included the following:

- **2016 – Base year**: This scenario represented the current road network with no new projects/upgrades, and was used to establish existing conditions. The main purpose was to enable the dispersion modelling methodology to be verified against actual air quality monitoring data. This modelling has not been further considered in the HIA
- **2026 – Without Project**: This scenario represented conditions in the opening year of the project (2026), including M4 East, New M5 and M4-M5 Link but without the Sydney Gateway road project. It assumed that some improvements would be made to the broader transport network to improve capacity and cater for traffic growth
- **2026 – With Project**: As 2026 Without Project, but with Sydney Gateway road project also completed
- **2026 – With Project Cumulative**: As 2026 Without Project, but with Sydney Gateway road project and Stage 1 of the F6 Extension also completed
- **2036 – Without Project**: As 2026 Without Project, but for 10 years after project opening and without the project. This took into account changes in traffic and the emission behaviour of the fleet with time
- **2036 – With Project**: As 2036 Without Project, but with Sydney Gateway road project also completed
- **2036 – With Project Cumulative**: As 2036 Without Project, but with Sydney Gateway road project, all stages of the F6 Extension, Western Harbour Tunnel and Beaches Link also completed.

All scenarios, with the exception of the 2016 – Base year have been considered in the HIA.

3.2.4 Health impacts from changes in air quality

Section 6 provides a detailed assessment of the potential for changes in air quality due to the project and how these changes might impact health within the community. This assessment has drawn on information provided in the *Technical Working Paper 4 – Air Quality* and, in some areas, provides a summary of key (and relevant) aspects. All details relevant to the underlying assumptions, methodology and interpretation of impacts relevant to changes in air quality are provided within *Technical Working Paper 4 – Air Quality*.

The HIA has provided an overview of the key aspects of the air quality impact assessment, as it is important to understand how the data used in the HIA has been estimated. Where more detail related to how the air quality assessment was undertaken is required, refer to the *Technical Working Paper 4 – Air Quality.*

The characterisation of health impacts from changes in air quality as a result of the project is complex.

The assessment undertaken in relation to evaluating health impacts related to changes in air quality involved:

- Presenting a summary of the existing air quality relevant to the study area (*Technical Working Paper 4 – Air Quality*), presented in **section 6.2**
- Providing a summary of the air quality impact assessment, which provides inputs to the assessment of health impacts (*Technical Working Paper 4 – Air Quality*) including the study areas considered in the air quality impact assessment for construction and operation, presented in **sections 6.3 and 6.4**
- Assessment of construction impacts on health, presented in **section 6.3.** The assessment undertaken for construction impacts is qualitative where potential impacts and the identification of relevant management measures to minimise impacts (including nuisance[1] dust) were evaluated
- Detailed assessment of the potential health impacts from changes in air quality during operations (exposure and potential impacts), presented in **sections 6.5 to 6.9.** Further discussion on the aspects considered in the quantification of operational impacts on health is provided below
- Outline of the uncertainties within the assessment undertaken in relation to health impacts from air quality (which is key to understanding if the assessment of potential health impacts is conservative, or not) (**section 6.12**).

The assessment of health impacts associated with the operation of the project involves the quantification of health risks and impacts. The assessment has utilised outputs from the air quality modelling that are presented within *Technical Working Paper 4 – Air Quality*. Additional data generated from the air modelling, that is relevant to the characterisation of health impacts have also been provided.

The air quality impact assessment provided modelled incremental changes in the relevant air quality parameters (ie changes in concentrations due to the project alone) and cumulative/total (ie background plus project) changes in the study area. Both the incremental and cumulative/total changes, relevant to the operational phase of the project, were used for the HIA to assess potential impacts to health.

The quantification of health impacts from changes in air quality during operations requires the use of a few different approaches to address the range of air pollutants relevant to this project:

- **Use of health based air guidelines**: For air pollutants where there is a threshold for acute and chronic effects (ie a level below which there are no health impacts), published health based guideline have been identified and used in this assessment. The assessment of health impacts has focused on the maximum impacted locations and compared the predicted concentration of these air pollutants (from the project as well as other urban sources) with the air guideline. Where the exposure concentration is less than the air guideline, there is no risk. This approach applies to a number of air toxics (discussed further in **section 6.5**) as well as carbon monoxide (discussed further in **section 6.6**)
- **Calculation of an incremental lifetime cancer risk:** For air pollutants that are considered to be genotoxic carcinogens, there is no threshold. Hence the approach adopted for the assessment of these chemicals is to calculate an incremental lifetime cancer risk, utilising published non-threshold inhalation toxicity reference values (or unit risk values), and an estimation of the maximum increase in air concentration (or exposure) within the community. This results in the calculation of an incremental carcinogenic risk and utilises common risk assessment methods as outlined by enHealth (enHealth 2012b). This

[1] Nuisance, as considered in this report relates to: nuisance dust which is dust particles that are too large to penetrate into the lungs (and result in adverse health effects) but will settle out on various surfaces and may create a visible dust layer or require cleaning; nuisance odours which are odours that are noticeable and may be considered offensive. Health effects associated with exposure to chemicals that are the cause of the odours are assessed separately.

approach applies to the assessment of some air toxics (discussed further in **section 6.5**) as well as diesel particulate matter (discussed further in **section 6.5**)

- **Calculation of impacts, risks and health burden, for changes in nitrogen dioxide and particulate matter concentrations:** The data available on health impacts from exposure to nitrogen dioxide and particulate matter, particularly within urban air environments, comes from large population or epidemiological studies (discussed further in **sections 6.7 and 6.8**). These studies enable relationships between exposure and various health effects (specifically mortality [ie a shortening of life-span] and morbidity effects). These concentration-response or exposure-response relationships are developed based on large population exposures and are utilised in the assessment of population health, and for establishing ambient (population wide) air guidelines. These relationships are not developed for the assessment of specific sources or localised impacts, as is the case for the assessment of impacts from the project.

The project involves the construction of new roadway infrastructure that would result in the redistribution of traffic within the community, rather than constructing a new source. As a result, vehicle and truck emissions within the broader community remain much the same which makes the conduct of community or larger population wide assessments of health impacts difficult as the overall health impact is expected to reflect the small change in total vehicle movements. However, as traffic is redistributed at a local level, it is important to also evaluate the potential significance of this redistribution, particularly localised increases in exposure to pollutants with no threshold such as nitrogen dioxide and particulate matter. While this may only affect a small number of households, increases in risk associated with these maximum changes need to be considered.

Based on the methodology outlined above, potential health impacts from changes in nitrogen dioxide and particulate matter associated with the project have been assessed on the basis of two calculations:

- Calculation of a localised annual risk for each health endpoint. This is the localised change in risk that differs from the baseline risk (or incidence) of the effect occurring for any member of the population, where exposed to the change in nitrogen dioxide or particulate matter concentration estimated. The assessment has considered the maximum localised health risks relevant to all receptors as well as selected community receptors
- Calculation of a change in incidence of the health effect occurring within the population or wider community exposed. This calculates the change in the number of cases (mortality or hospitalisations) that may occur for the whole population assumed to be exposed to the changes in nitrogen dioxide or particulate matter concentration estimated.

3.2.4.1 Acceptable risk levels

To determine if the calculated incremental carcinogenic risk, localised annual risk or change in incidence within a population from the project may be considered to be acceptable, a number of factors need to be considered. These are discussed further in **Annexure C**.

Based on the discussion presented in **Annexure C**, for this assessment localised annual risks have been assessed on the basis of the following:

- Risk < 10^{-6} (or 1 in 1,000,000) is considered to be negligible
- Risk ≥ 10^{-6} and ≤ 10^{-4} is considered to be tolerable (or acceptable)
- Risk > 10^{-4} (or 1 in 10,000) is considered to be unacceptable.

The assessment of changes in incidence of particular health indicators in the community results in the calculation of a change in the number of cases (of mortality, hospital or emergency department admissions) within the population evaluated. As discussed in **Annexure C**, where changes in air quality associated with this project are well below ten cases per year they are considered to be within the normal variability of health statistics, and these changes would not be measurable in any health statistics for the area.

For evaluating impacts from this project, a more conservative tenfold margin of safety has been included to determine what changes in incidence may be considered negligible within the study population. This means that changes in the population incidence of any health effect evaluated that is less than one case per year are considered negligible.

3.2.5 Health impacts from changes in noise and vibration

Review of the current science by enHealth (enHealth 2018) concludes there is sufficient evidence that noise adversely affects health and assessment of environmental noise should be included in HIAs of proposed developments. Hence this assessment has included an assessment of the impact of changes in environmental noise, as a result of the project, on the community.

Assessment of health impacts from changes in noise associated with the project is presented in **section 7**. The assessment presented is largely qualitative, with some quantitative assessment included to determine what noise increases are considered to result in unacceptable health impacts.

The approach adopted for the assessment of health impacts from noise and vibration has considered the following (as presented in **section 7**):

- Understanding of the health impacts related to changes in noise (**section 7.2**)
- Review of the noise and vibration assessment criteria adopted in *Technical Working Paper 2 – Noise and Vibration* to determine if these are protective of health (**section 7.4**)
- Summary of the noise and vibration impact assessment (presented in *Technical Working Paper 2 – Noise and Vibration)*, including the existing noise environment and the study area considered in the noise and vibration impact assessment (**section 7.3**), assumptions included in the assessment and outcomes of the assessment (**section 7.5**)
- What the impacts identified in the noise and vibration impact assessment mean in terms of potential health impacts for construction and operation of the project (**section 7.5**)
- Outline of the uncertainties within the assessment undertaken in relation to health impacts from noise (which is key to understanding if the assessment of potential health impacts is conservative, or not) (**section 7.8**).

3.2.6 Health impacts related to safety and social determinants

Assessment of health impacts relevant to public safety aspects as well as changes in the social and community environment associated with the project is presented in **sections 8 and 9**. The evaluation presented relies on information provided in a wide range of other technical studies. The approach adopted in the assessment is as follows:

- Qualitatively assess a range of aspects of the project during construction and operation that may have the potential to affect public safety (**section 8**). This includes consideration of dangerous goods, hazardous materials and contaminated soil/water, acid sulfate soil, flooding, damage to underground utilities, bushfire risks, aviation risks, traffic accidents, pedestrian and cyclist safety
- Qualitatively assess the social characteristics which have potential to affect the health of the community (both positive and negative impacts). This assessment has considered changes in traffic (including travel times), active transport, changes in recreational uses of the local area, changes in the connectivity (or displacement) of the community and changes in the urban environment (including visual changes). The assessment has also considered construction fatigue (ie extended exposure to construction impacts due to consecutive construction projects that affect the same community) and issues related to equity of impacts within the community. The assessment has drawn on published studies relating to health impacts of social changes and the social impact assessment.

The assessment of these issues has addressed both construction and operational phases of the project.

3.3 Incorporation of project design features to improve community health and wellbeing

Where possible, various aspects of the design of the project have been undertaken to minimise impacts on the community, including on health and wellbeing. Some of the key design features that have been incorporated into the project to minimise impacts to community health include:

- The project was designed to reduce existing traffic in the Mascot area, which would reduce air quality and noise health impacts and safety issues in the local areas of Mascot, and improve community wellbeing in this area
- Design of the bridge at the former Tempe landfill to minimise the need to disturb landfill materials which would reduce the potential for disturbance of contaminated and odorous materials that may impact on community health
- During construction, the haulage routes have been designed to minimise the use of local roads, thereby minimising impacts on local residents
- The works have been designed to minimise potential disturbance to existing contaminated sediments in Alexandra Canal. This would minimise potential mobilisation of sediments and movement downstream into recreational areas of Botany Bay
- Urban design elements of the project has incorporated crime prevention through environmental design principles to manage public safety
- Noise mitigation measures (road pavement treatments, noise barriers and/or architectural treatments where necessary) have also been identified to address predicted exceedances of operational noise traffic.

3.4 Limitations and related considerations

There are certain features of HIA methodology that are important to acknowledge particularly in relation to interpreting and understanding the conclusions. These relate to the limitations of the methodology and the constraints applied within the HIA to ensure a focus on aspects that can be influenced as part of the project. These are summarised below:

- A HIA is a systematic tool used to review key aspects of a specific project that may affect the health of the local community. The assessment includes both qualitative and quantitative assessment methods
- Where quantitative assessment methods are presented, a HIA is typically based on a conservative estimate of impacts in the local community and thus is expected to overestimate the risks for all members of the community
- A HIA involves a number of aspects where a qualitative assessment is required to be undertaken. Where this is undertaken, it provides a general indication of potential benefits or impacts only
- The community evaluated in a HIA is limited by the extent of the studies undertaken in informing an EIS/preliminary draft MDP. It is not possible to evaluate impacts on the health of the community outside these areas
- A HIA relies on data provided from other studies. The conclusions of this HIA, therefore, depends on the assumptions and calculations undertaken to generate the data from these other studies utilised in this assessment
- Conclusions can only be drawn with respect to impacts related to a project as outlined in an EIS/preliminary draft MDP. Other health issues, not related to the project, that may be of significance to the local community are not addressed in the HIA
- The HIA for this project did not address occupational health for construction workers.

The HIA reflects the current state of knowledge regarding the potential health effects of identified chemicals and pollutants for this project. This knowledge base may change as more insight into biological processes is gained, further studies are undertaken and more detailed and critical review of information is conducted.

4 Existing environment

4.1 Overview

The HIA has considered potential impacts to the population within the study area, which includes populations in the local government areas (LGAs) or part of the LGAs of Bayside, Randwick, Sydney, Inner West, Canterbury Bankstown and Georges River. The assessment has also considered specific community receptors located close to the project.

The population considered in the study area is generally similar, in terms of health related behaviours, as the overall population in NSW, with the exception of two aspects – lower rate of physical inactivity and lower rate of being overweight and obese compared with NSW. In addition, review of health statistics for this population indicates that rates of mortality and hospitalisations for key health effects such as respiratory and cardiovascular effects, as well as the prescription rates for anti-depressants (which may be considered an indicator of levels of stress and anxiety) are slightly lower than for the NSW population.

This suggests the population in the study area may be slightly less vulnerable to project related impacts, compared with other populations in NSW. The quantification of health impacts on the basis of health statistics for the NSW population would, therefore, be conservative for the population in the study area.

4.2 Community profile

This section provides an overview of the communities potentially impacted by the project and presents a summary of the demographics of the population present, information available on key aspects that influence the health of the community and the existing health of the community. The key focus of the assessment presented is the local community within the study area defined in **section 3.2.2**. The project involves new roadways in the area to the north of Sydney Airport, as well as flow on changes in the distribution of surface road traffic on surrounding, existing roadways.

The population considered in this assessment includes all individuals who live or work (or attend schools and child care facilities) within the study area. The study area covers a large number of individual suburbs that sit within the following LGAs:

- Bayside (amalgamation of former Bayside and Rockdale LGAs)
- Randwick
- Sydney
- Inner West (amalgamation of former Ashfield, Leichhardt and Marrickville LGAs)
- Canterbury Bankstown
- Georges River.

The above list reflects the LGAs as defined in 2019 following amalgamations, and are consistent with the LGAs for which NSW Health provide some data. It is noted that some data is only available for the former LGAs.

These LGAs are densely populated urban areas.

4.3 Community receptors

The assessment of potential impacts on the surrounding community, particularly in relation to air quality, has considered the location where maximum impacts from the project may occur, where it is assumed that community receptors may be located. In addition, impacts in the wider community have also been considered. Within the wider community, a number of additional locations, referred to as community (or sensitive) receptors, have been identified in the suburbs close to the project.

When considering potential health impacts within any community, HIA considers the whole population as well as specific sensitive or vulnerable groups within the population. These communities and their related community or vulnerable groups are:

- Community groups:
  - Residents
  - Recreational users (such as cyclists and users of recreational open space)
  - Commercial and industrial (eg businesses within the project area that may be directly impacted by property acquisitions)
- Sensitive and vulnerable groups within the community groups:
  - Young children (in particular children under the age of 5 years, but also including children up to 14 years)
  - Older populations (greater than 65 years of age)
  - Disabled and those with pre-existing medical conditions
  - Disadvantaged (specifically, those who may be socio-economically disadvantaged).

These receptors may reside or access any areas within the community.

The air quality impact assessment has considered changes in air quality across a large grid, 10.4 kilometres by 9.5 kilometres, with varying levels of grid resolution. The assessment also considered properties located adjacent to key roadways where changes in traffic are anticipated.

To provide a more specific assessment of potential impacts in relation to community receptors, 17 representative individual receptors, comprising hospitals, childcare facilities, schools and aged care facilities have been identified (refer to *Technical Working Paper 4 – Air Quality* for selection of these receptors) (refer to **Table 4.1**). The location of the representative sensitive or community receptors is presented in **Figure 4.1**.

In addition to these community receptors, about 12,145 individual receptors (residential, workplace and recreational (RWR) receptors also shown in **Figure 4-1**) have been modelled in the streets/suburbs located in the study area. These individual RWR receptors represent a range of uses including residential, workplaces or recreational (open space) areas in the surrounding community, as detailed in **Table 4.2**. The RWR include all other community receptors (listed in **Table 4.1**) located in the study area, not only those included in **Table 4.2**.

All these individual receptors have also been considered in this report, so that all community receptors have been adequately addressed.

The assessment of noise impacts considered a range of residential and other sensitive community receptors within a corridor adjacent to the proposed project. This includes the community receptors as detailed above.

Table 4.1: Sensitive/community receptors

Receptor code	Receptor name	Type of receptor	Suburb
CR01	Aero Kids Early Learning Centre	Child care	Mascot
CR02	Guardian Early Learning Centre	Child care	Tempe
CR03	Gardeners Road Public School	School	Rosebery
CR04	Botany Public School	School	Botany
CR05	Mascot Public School	School	Mascot
CR06	Tempe High School	School	Tempe
CR07	JJ Cahill Memorial High School	School	Mascot
CR08	St Bernard's Catholic Primary School	School	Botany
CR09	Active Kids Mascot	Child care	Mascot
CR10	Betty Spears Child Care Centre	Child care	Tempe
CR11	Toybox Early Learning	Child care	Mascot
CR12	Mascot Child Care Centre	Child care	Mascot
CR13	St Theres Catholic Primary School	School	Mascot
CR14	St Peters Public School	School	St Peters
CR15	Tillman Park Child Care Centre	Child care	Tempe
CR16	Tempe Public School	School	St Peters
CR17	Pagewood Kindergarten	Child care	Pagewood

Table 4.2: Summary of residential, workplace and recreational receptors

Receptor type	Number	% of total
Aged care	1	0.01%
Child care / pre-school	20	0.16%
Commercial	1,163	9.58%
Community facility	38	0.31%
Further education	2	0.02%
Hotel	8	0.07%
Industrial	724	5.96%
Medical practice	19	0.16%
Mixed use	50	0.41%
Other	124	1.02%
Park / sport / recreation	102	0.84%
Place of worship	18	0.15%
Residential	9,853	81.13%
School	23	0.19%
Total	**12,145**	**100.00%**

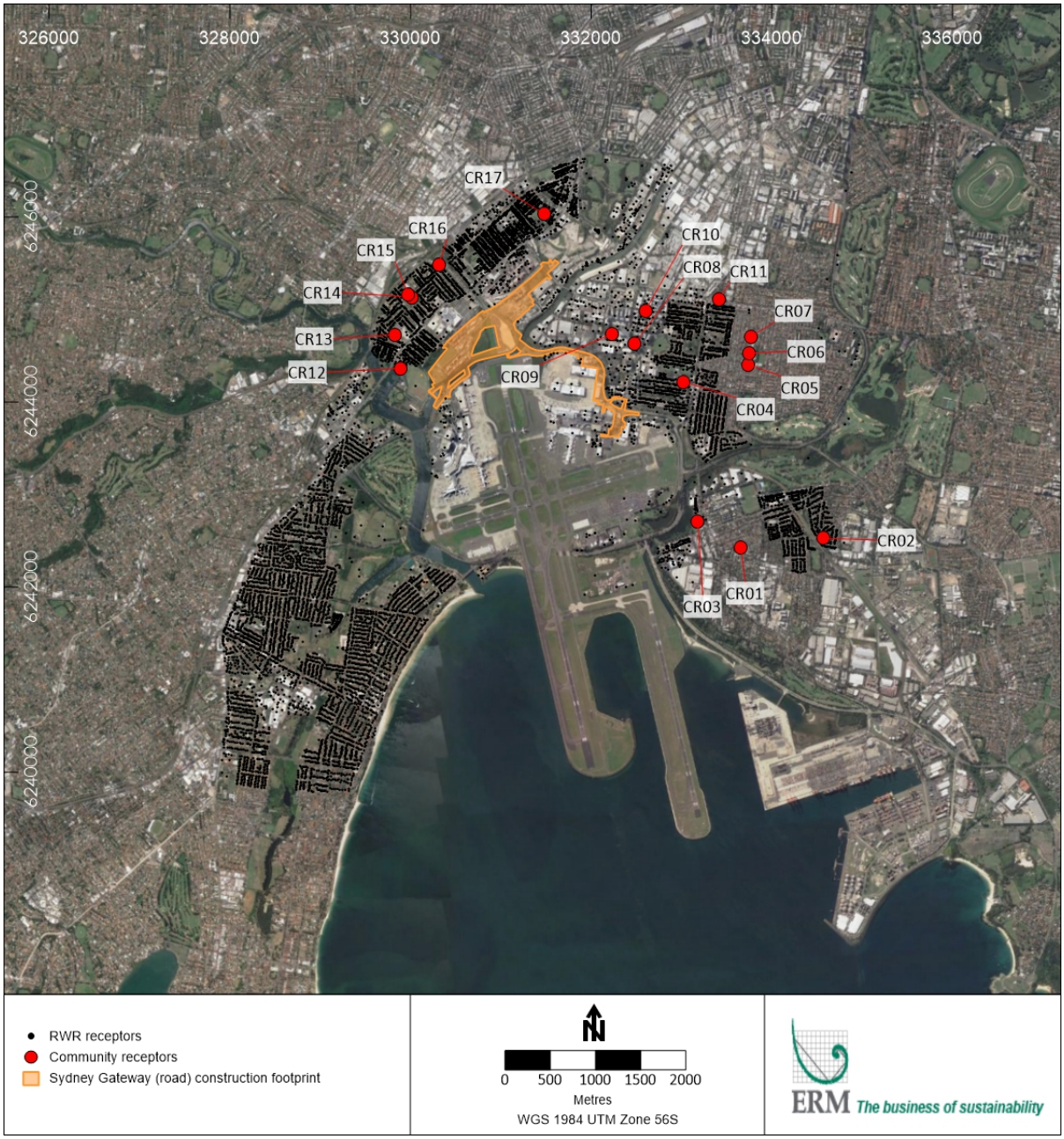


Figure 4.1: Community receptors and Residential, workplace and recreational (RWR) receptors evaluated in health assessment

4.4 Population profile

The population within the study area consists of residents and workers as well as those attending schools, day care centres, hospitals and recreational areas. The composition of the populations located within the study area is expected to be generally consistent with population statistics for the larger individual suburbs that are wholly or partially included in the study area. Population statistics for the LGAs are available from the Australian Bureau of statistics (ABS) for the Census year 2016 and are summarised in Table 4.3. For the purpose of comparison, the population statistics presented also include the statistics for larger statistical population groups in the area (defined by the ABS SA4) and the larger statistical areas of Greater Sydney and the rest of the NSW (excluding Greater Sydney) (as defined by the ABS).

Table 4.3 presents a summary of a selected range of demographic measures relevant to the population of interest with comparison to statistical areas of Greater Sydney and the rest of NSW (excluding Greater Sydney).

Table 4.3: Summary of population statistics in study area

Location	Total population		% Population by key age groups					
	Male	Female	0–4	5–19	20–64	65+[1]	1–14[1]	30+[1]
Local government areas								
Botany[2]	23,229	23,420	6.2	16.5	64.3	13.0	15.7	59.8
Rockdale[2]	54,079	55,325	6.1	14.8	63.8	15.3	14.6	61.5
Randwick	69,179	71,482	5.4	15.3	65.9	13.4	13.8	58.8
Sydney	107,852	100,530	3.3	7.4	81.0	8.2	5.9	57.6
Inner West	88,736	93,302	5.9	13.2	68.7	12.2	14.1	63.8
Canterbury – Bankstown	172,327	173,977	7.2	19.6	59.2	13.9	19.2	58.4
Georges River	71,755	75,086	5.8	17.0	61.8	15.3	15.7	60.8
Larger local statistical areas (SA4 – includes local government areas)								
Sydney - City and Inner South	161,061	154,483	4.1	9.6	76.9	9.4	8.6	58.9
Sydney – Eastern Suburbs	129,505	137,524	5.5	14.7	65.5	14.3	14.1	61.5
Sydney – Inner South West	282,753	288,670	6.7	18.1	60.7	14.6	17.5	59.6
Statistical areas of Sydney and NSW								
Greater Sydney	2,376,766	2,447,221	6.4	18.2	61.4	13.9	17.4	60.4
Rest of NSW (excluding Greater Sydney)	1,301,717	1,341,813	5.8	18.5	55.1	20.6	17.3	64.6

Ref: Australian Bureau of Statistics, Census Data 2016
SA = statistical area
[1] Age groups specifically relevant to the characterisation of risk
[2] Now amalgamated and known as Bayside Council

Comparing the populations of the study area to that of Greater Sydney the following is noted:

- Sydney – City and Inner South has a lower proportion of children (0-19 years), a higher proportion of working aged individuals and a lower proportion of individuals aged over 65 years
- Sydney – Eastern Suburbs has a slightly lower proportion of children and slightly higher proportion of working age individuals
- At a local government area level:
  - Sydney has a lower proportion of young children (0-4 years)
  - Botany, Rockdale, Randwick, Sydney, Inner West, and Georges River have a lower proportion, while Canterbury-Bankstown have a higher proportion of children (5-19 years)
  - Canterbury-Bankstown has a lower proportion while Botany, Rockdale, Randwick, Sydney and Inner West, have a higher proportion of working age individuals
  - Sydney and Inner West has a lower proportion while Rockdale and Georges River have a higher proportion of individuals aged over 65 years.

The estimated population growth from 2011 to 2036 for these areas are (NSW Planning & Environment 2016):

- Botany: 75.2 per cent growth
- Rockdale: 50.2 per cent growth
- Randwick: 30.7 per cent growth
- Sydney: 72.0 per cent growth
- Inner West: 28.7 per cent growth
- Canterbury – Bankstown: 49.7 per cent growth
- Georges River: 28.5 per cent growth.

Table 4.4: Selected demographics of population of interest

Location	Median age	Median household income ($/week)	Median mortgage repayment ($/month)	Median rent ($/week)	Average household size (persons)	Unemployment rate (%)
Local government areas						
Botany[1]	35	1,626	2,400	460	2.7	5.6
Rockdale[1]	35	1,575	2,167	460	2.7	6.2
Randwick	34	1,916	2,600	550	2.5	5.6
Sydney	32	1,926	2,499	565	2.0	6.0
Inner West	36	2,048	2,600	480	2.4	4.8
Canterbury – Bankstown	35	1,298	2,000	380	3.0	8.2
Georges River	37	1,654	2,167	450	2.9	6.5
Larger local statistical areas (SA4 – includes local government areas)						
Sydney - City and Inner South	33	1,894	2,500	550	2.2	5.7
Sydney – Eastern Suburbs	35	2,163	2,900	580	2.4	4.6
Sydney – Inner South West	35	1,431	2,167	415	2.9	7.4

Location	Median age	Median household income ($/week)	Median mortgage repayment ($/month)	Median rent ($/week)	Average household size (persons)	Unemployment rate (%)
Statistical areas of Sydney and NSW						
Greater Sydney	36	1,750	2,167	440	2.8	6.0
Rest of NSW (excluding Greater Sydney)	43	1,168	1,590	270	2.4	6.6

Source: Australian Bureau of Statistics, Census Data 2016
[1] Now amalgamated and known as Bayside Council

The social demographics of an area have some influence on the health of the existing population. As shown in **Table 4.4**, comparing the populations of the study area to that of Greater Sydney:

- Botany, Rockdale, Canterbury-Bankstown and Georges River have a lower, while Sydney, Randwick and Inner West have a higher median income
- Botany, Randwick, Sydney and Inner West have higher, while Canterbury-Bankstown have lower monthly mortgage repayments
- Sydney and Randwick has higher and Canterbury-Bankstown has lower median weekly rental costs
- Sydney, Inner West and Randwick have a smaller average household size
- Canterbury-Bankstown has higher and Inner West have lower unemployment rates.

4.5 Existing health of the population

4.5.1 General

The assessment presented in this report has focused on key pollutants that are associated with construction and combustion sources (from vehicles), including volatile organic compounds, polycyclic aromatic hydrocarbons, carbon monoxide, nitrogen dioxide and particulate matter (namely $PM_{2.5}$ and PM_{10}). For these pollutants, there are a large number of sources in the study area including other combustion sources (wood-fired heating, domestic cooking, industrial emissions), non-combustion sources including other local construction/earthworks. Other aspects that affect the health of an individual include personal exposures (such as smoking) and risk taking behaviours.

When considering the health of a local community there are a large number of factors to consider. The health of the community is influenced by a complex range of interacting factors including age, socio-economic status, social networks, behaviours, beliefs and lifestyle, life experiences, country of origin, genetic predisposition and access to health and social care. Hence, while it is possible to review existing health statistics for the local areas surrounding the project and compare them to the Greater Sydney area and NSW, it is not possible or appropriate to be able to identify a causal source, particularly individual or localised sources.

Information relevant to the health of populations in NSW is available from NSW Health for populations grouped by local health districts (where the project area is located in the South Eastern Sydney Local Health District and Sydney Local Health District). Not all of the health data is available for all of these areas.

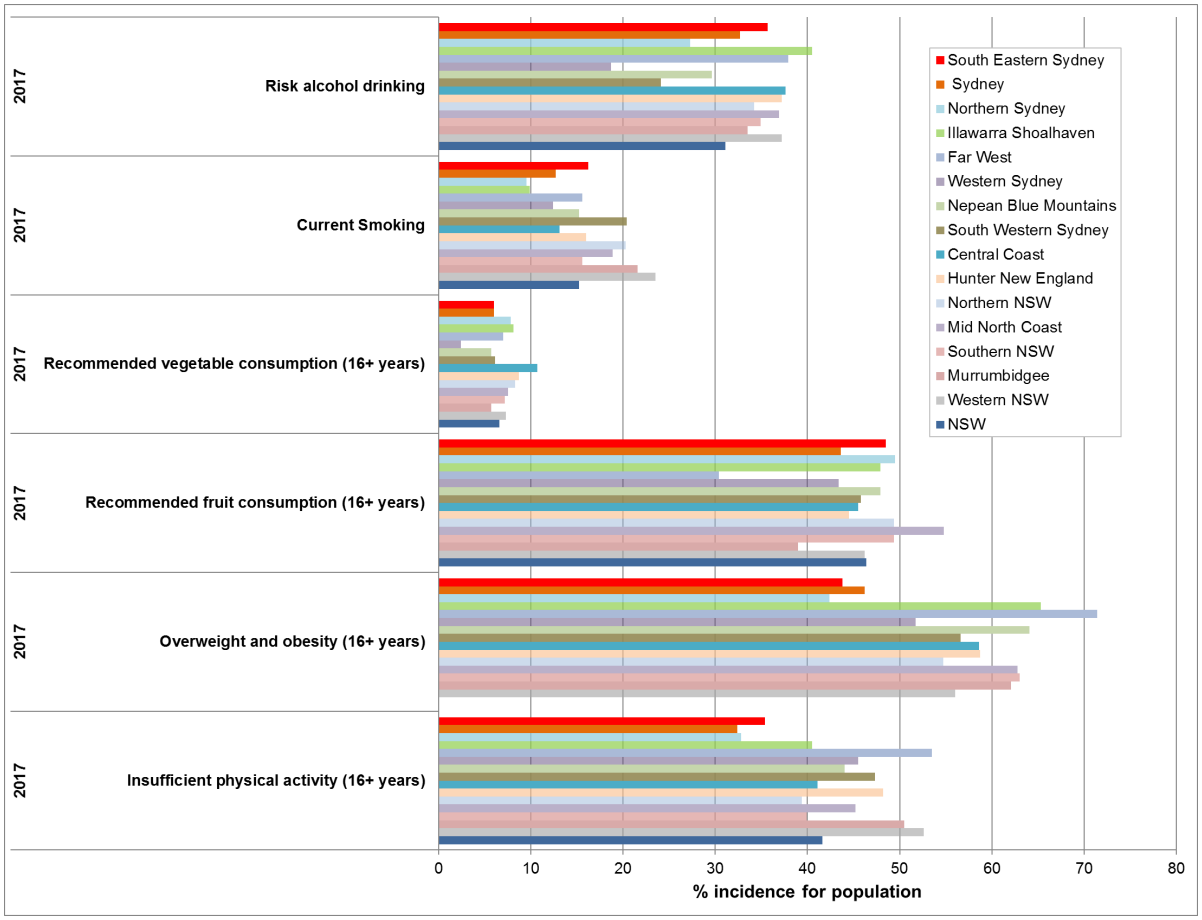
Most of the health indicators presented in this report are not available for each of the smaller suburbs/statistical areas surrounding the site. Health indicators are only available from a mix of larger areas (that incorporate the study area), namely the South Eastern Sydney Local Health District and the Sydney Local Health District. There are few health statistics that are reported for the smaller LGAs relevant to this project. The health statistics for these larger areas (and in some cases data for the Greater Sydney area) are assumed to be representative of the smaller population located within these districts and areas.

4.5.2 Health related behaviours

Health related behaviours that are linked to poorer health status and chronic disease, including cardiovascular and respiratory diseases, cancer, and other conditions, account for much of the burden of morbidity and mortality in later life.

Information in relation to health related behaviours is available for the larger populations within the local health districts in Sydney and NSW. This includes risky alcohol drinking, smoking, consumption of fruit and vegetables, being overweight or obese, and adequate physical activity. The study population is located within the South Eastern Sydney Local Health District and the Sydney Local Health District. The incidence of these health-related behaviours in these districts, compared with other districts in NSW, and the state of NSW (based on NSW Health data from 2017) is illustrated in **Figure 4.2.**

Review of this data indicates the population in the South Eastern Sydney and Sydney local health districts (that include the study area) have lower rates of physical inactivity and of being overweight and obese compared with NSW.



Note: these health related behaviours include those where the behaviour/factor may adversely affect health (eg alcohol drinking, smoking, being overweight/obese and inadequate physical activity) and others where the behaviour/factor may positively affect (enhance) health (eg adequate fruit and vegetable consumption).
Study area is located in the South Eastern Sydney Local Health District (red) and Sydney Local Health District (orange).

Figure 4.2: Summary of incidence of health-related behaviours (Source: HealthStats NSW 2019)

4.5.3 Health indicators

Figure 4.3 presents a comparison of the rates of the key mortality indicators based on data from 2011 to 2016 (depending on the available data) for all causes, potentially avoidable, cardiovascular disease, lung cancer and chronic obstructive pulmonary disease (COPD), reported in the larger South Eastern Sydney and Sydney local health districts, with comparison to other NSW local health districts (in urban and regional areas) as well as NSW as a whole.

Figure 4.4 present a comparison of the rates of the hospitalisations for key health effects based on data from 2015-2016 for diabetes, cardiovascular disease, asthma (5–34 years) and COPD (65+ years) reported in the larger South Eastern Sydney and Sydney local health districts, with comparison to other NSW local health districts (in urban and regional areas) as well as NSW as a whole.

It is noted that the data reported in these figures is based on statistics that are publicly available from NSW Health. Hence some of the statistics for mortality and hospitalisations relate to slightly different health endpoints and/or different age groups. The statistics are included for general comparison and discussion. Actual health statistics considered in the characterisation of risk are presented in **Table 4.5**.

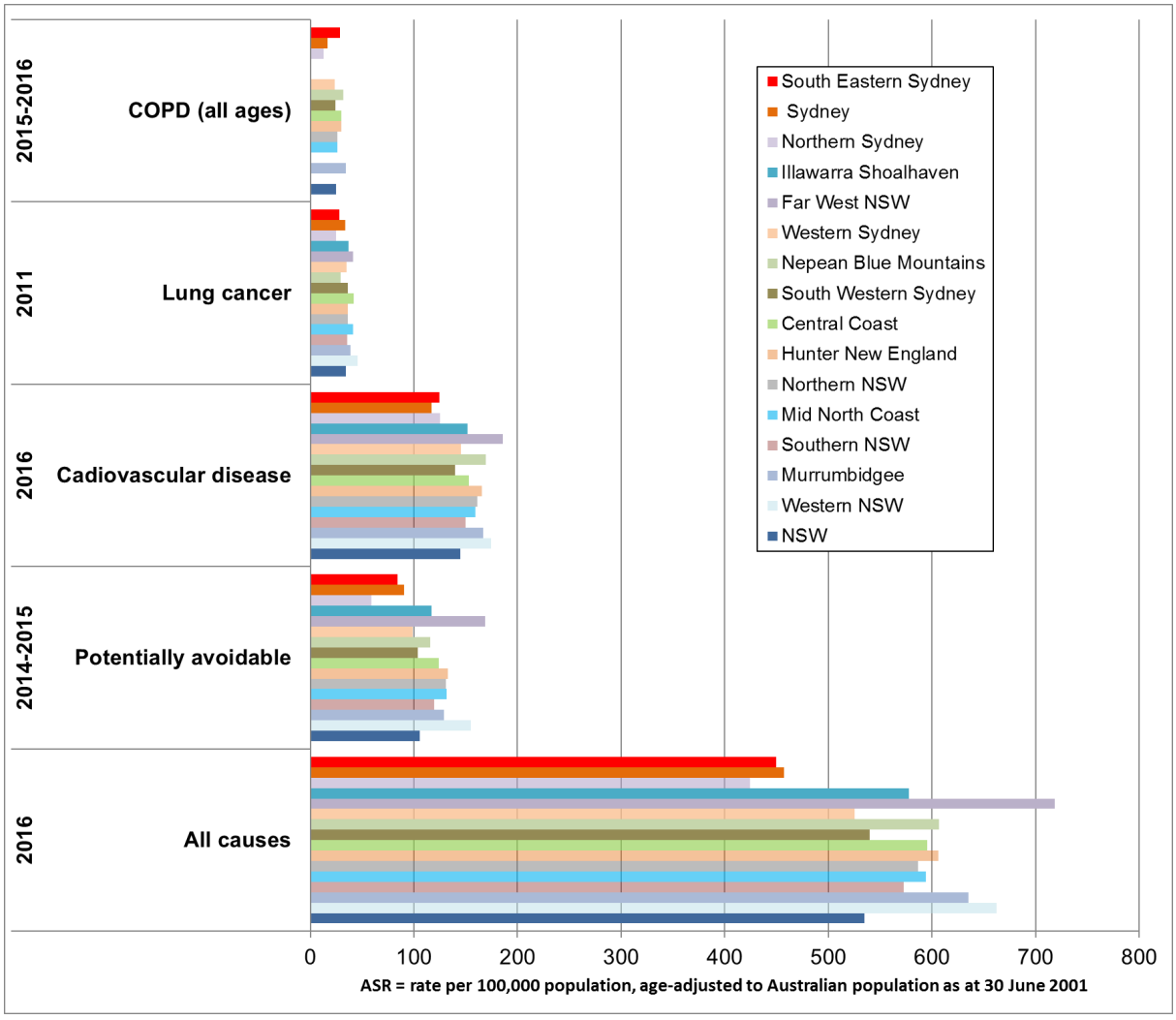


Figure 4.3: Summary of mortality data 2011 - 2016 (Source: HealthStats NSW 2019)

Review of the figure presented above indicate that the rate of mortality for the indicators presented in the South Eastern Sydney and Sydney local health districts are significantly lower than that reported for NSW, except for COPD and lung cancer which were not significant for Sydney Local Health District.

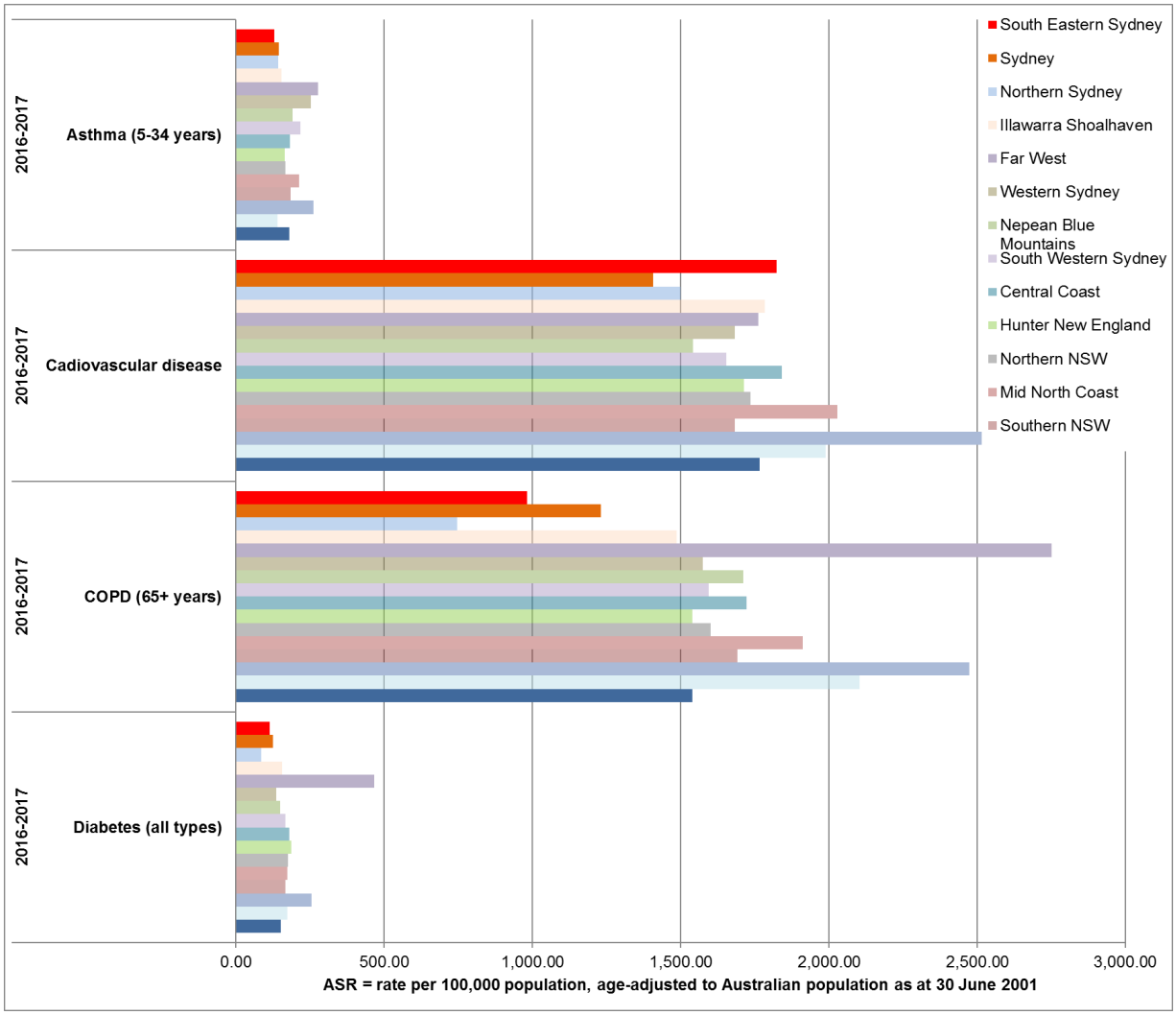


Figure 4.4: Summary of hospitalisation data 2016 - 2017 (Source: HealthStats NSW 2019)

Review of the figure presented above indicate that the rate of hospitalisations for the indicators presented in the South Eastern Sydney and Sydney local health districts is significantly lower than that reported for NSW, with the exception for cardiovascular disease hospitalisations in South Eastern Sydney, which is similar to the rate for NSW.

In relation to mental health, data from NSW Health indicates the following for adults:

- The rate of high or very high psychological distress reported in 2017 in the South Eastern Sydney local health district (11.2 per cent) is a little lower than the state average (15.1 per cent). The rate for the Sydney local health district (15.3 per cent) is essentially the same as the state average.
- The rate of high or very high psychological distress in Sydney Local Health District has varied between 10.9 and 15.3 per cent between 2003 and 2017. In the South Eastern Sydney Local Health District, the rate has generally declined from around 14.1 per cent in 2003 to less than 10 per cent in 2015 and 11.2 per cent in 2017.

In relation to some more specific health indicators **Table 4.5** presents the available data for the slightly smaller population areas in the LGAs in the study area. These have been compared with available data for the South Eastern Sydney Local Health District, Sydney Local Health District, Sydney and NSW. It is noted that health statistics are not available for the LGAs for all the health endpoints considered in this assessment. Where available, they have been presented for the purpose of comparison with statistics from Sydney and NSW.

Table 4.5: Summary of key health indicators

Health indicator	Data available for population areas (rate per 100,000 population)										
	Botany LGA	Rockdale LGA	Randwick LGA	Sydney LGA	Inner West LGA	Canterbury-Bankstown LGA	Georges River LGA	South Eastern Sydney	Sydney LHD	Sydney (wider metro	NSW
Mortality											
All causes – all ages	559.7 C	488.2 C	492.2 C	453.8 C	521.8 C	508.3 C	450.7 C	**449.4 c**	**457.0 c**	--	537.7 C
All causes (non-trauma) ≥30 years	--	--		--	--	--	--	--	--	**976.5**	--
All causes ≥30 years	--	--		--	--	--	--	--	--	**1026**	--
Cardiopulmonary ≥30 years	--	--		--	--	--	--	--	--	**412**	
Cardiovascular – all ages	133.8 C	140.6 C	132.3 C	113.2 C	136.7 C	143.6 C	132.0 C	**127.3 c**	**120.8 c**	191.8	147.9 C
Respiratory – all ages	--	--		--	--	--	--	**36.7 A**	**41.3A**	51.5	48.2 **A**
Hospitalisations											
Coronary heart disease	840.7 B	495.5 B	674.5 B	386.2 B	262.1 B	438.3 B	426.8 B	655.0 E	328.3 E	--	536.0 E
COPD >65 years	--	--		--	--	--	--	981.7 E	1230.5 E	--	1538.9 E
COPD All ages	187.6 B	170.9 B	165.6 B	220.4 B	202.9 B	208.8 B	137.5 B	145.3 E	195.8 E	--	253.1 E
Cardiovascular disease											
All ages	2026.5 B	1583.6 B	1869.9 B	1418.1 B	1314.6 B	1646.3 B	1362.4 B	1407.9 E	1512.8 E	1976	1787.2 E
>65 years	--	--		--	--	--	--	--	--	**9235**	
Respiratory disease											
All ages	--	--		--	--	--	--	1407.9 E	1512.8 E	**2003**	1787.2 E
>65 years	--	--		--	--	--	--	--	--	**3978**	
Asthma											
Asthma hospitalisations (ages 5–34 years)	--	--		--	--	--	--	129.4 E	144.2 E	--	180.5 E
Asthma emergency department hospitalisations (1–14 years)	--	--		--	--	--	--	--	--	**1209**	--

Health indicator	Data available for population areas (rate per 100,000 population)										
	Botany LGA	Rockdale LGA	Randwick LGA	Sydney LGA	Inner West LGA	Canterbury-Bankstown LGA	Georges River LGA	South Eastern Sydney	Sydney LHD	Sydney (wider metro	NSW
Asthma prevalence (current) for children aged 2–15 years	--	--		--	--	--	--	9.3% E	11.7% E	--	12.9% E
Current asthma for ages 16 and over	--	--		--	--	--	--	8.0% D	8.5% D	--	10.9% D

[1] Data for Sydney Metropolitan area for 2010 based on hospital statistics as reported for 2010 and population data from the ABS for 2011 (relevant to each age group considered) used in review of exposure and risks to inform recommendations for updating the National Environment Protection Measure (NEPM) Ambient Air Quality (Golder 2013)

All other data has been obtained from Health Statistics New South Wales, where:

A: 2014-2016 data B: 2015-2016 to 2016-2017 data

C: 2015-2016 or 2016 data D: 2017 data E: 2016-2017 data

-- No data available Bold and shaded: Data used in the characterisation of risk

The health indicators presented in **Table 4.5** include those that are specifically relevant to the quantification of exposure to nitrogen dioxide and particulate matter presented in **sections 6.7 and 6.8**.

Review of the data presented in **Table 4.5** generally indicates that for the population in the project area, the health statistics (including mortality rates and hospitalisation rates for most of these categories) are variable but generally similar to those reported in the larger local health districts of South Eastern Sydney, Sydney and the wider Sydney metropolitan area and slightly lower than the whole of NSW.

For the assessment of potential health impacts from the project, where specific health statistics for the smaller populations within the project area is not available (and not reliable due to the small size of the population), adopting health statistics from the whole of NSW is considered to provide a representative, if not cautious (eg over estimating existing health issues), summary of the existing health of the population of interest.

The rate of antidepressant medication prescriptions is an indicator that can be used to review changes in stress and anxiety levels within a community, and these are presented in **Table 4.6**. While this data was not directly used in the HIA to evaluate specific impacts, the data is relevant to assist in ongoing monitoring of potential indicators of changes that increase or decrease stress and anxiety in the community. In relation to the rate of medication prescriptions for antidepressants it is noted that all LGAs have lower rates of prescription, for all age groups, than the state average.

Table 4.6: Summary of key health indicators: Mental health

Age group	Number of prescriptions for antidepressants per 100,000 people, by LGA in 2014-2015					
	Botany	Sydney Inner City	Marrickville – Sydenham-Petersham	Canterbury	Kogarah - Rockdale	NSW average
17 years and under	4,988	7,284	6,531	3,294	3,502	8,187
18 to 64 years	65,100	76,303	79,279	54,776	58,780	90,959
65 years and over	149,818	159,584	158,224	143,705	152,210	179,771

Source: Australian Atlas of Healthcare Variation, Atlas 2015 (note that the Atlas 2017 did not include mental health data)

5 Community concerns

Community and stakeholder consultation has been undertaken as part of the project, which is reported in the Sydney Gateway Community and stakeholder consultation report, prepared by Roads and Maritime Services (July 2019).

Engagement with the community and key stakeholders was carried out as part of two formal periods of consultation for the project including:

- preliminary design (September to October 2018); and
- concept design (May to June 2019).

The purpose of this consultation was to raise awareness of the project, understand community and stakeholder concerns and obtain important feedback to help shape the design of the project and the environmental assessment.

The engagement focused on four stakeholder groups (government organisations, directly impacted landowners, peak bodies, local businesses and interest groups and general public/local community) who raised seven key concerns about the proposal:

- Environment
- Traffic and Road Safety
- Shared cycle and pedestrian pathways (active transport)
- Socio-economic impacts
- Property, access and parking
- Freight industry
- Public transport.

Based on feedback received at the early stages of engagement, the concept design was refined to provide a shared cycle and pedestrian pathway on the northern side of Alexandra Canal, ensured construction vehicles parking was provided within the construction sites and not on local streets and have committed to improving open space on the former Tempe landfill after construction.

While no specific health issues were raised during the consultation activities to date, a number of the key concerns are addressed, in terms of community health in the HIA report. This includes the impact of changes in air quality (section 8), noise (section 9), land contamination (section 8.4) and access/use of green space (section 9.5) on community health, as well as consideration of public safety (section 8), active transport (section 9.3.5) and public transport (section 9.3.4).

A range of consultation activities are proposed to support to public exhibition of the EIS/preliminary draft MDP.

6 Impacts to human health: Changes in air quality

6.1 Summary of key findings

This section presents the assessment of health impacts within the community in relation to changes in air quality, where impacts from construction and operation are considered. The assessment of health impacts has determined the following:

- Construction
  - The focus of the assessment of construction impacts relates to the generation of dust. Provided the proposed dust mitigation measures are implemented, the potential for dust from the project to be of concern to the health of the community is low
  - While health impacts are expected to be low with the implementation of proposed mitigation measures there may still be some nuisance dust that is noticeable by the community on occasions.
- Operations
  - The assessment of operational impacts involved a quantitative assessment of exposure and risk. The assessment has considered short-term (acute) exposures as well as long-term (chronic) exposures to pollutants derived from vehicle emissions. In some cases, the assessment has evaluated the total exposure that may occur in the community (ie existing air quality plus the project) as well as the change in air quality as a result of the project, which may increase or decrease
  - Where there were increases in pollutant concentrations, these were low and were not considered to be of significance (ie measurable) or of concern in relation to community health
  - Where the whole population is considered, there is a small (ie unmeasurable) benefit to health.

6.2 Existing air quality

When predicting the impact of any new or modified source of air pollution, it is necessary to take into account the way in which the emissions from the source would interact with existing pollutant levels. Defining these existing levels and the interactions can be challenging, especially in a large urban area such as Sydney where there is a complex mix of sources. It is important to consider both the temporal and spatial variation in pollutant concentrations; these fluctuate a great deal on short time scales, but also show cyclical variations. Moreover, in large urban areas there is usually a complex mix of pollution sources, and substantial concentration gradients. Short-term meteorological conditions and local topography are also important.

Air quality in the Sydney region has improved over the last few decades. The improvements have been attributed to initiatives to reduce emissions from industry, motor vehicles, businesses and residences.

Historically, elevated levels of carbon monoxide were generally only encountered near busy roads, but concentrations have fallen as a result of improvements in motor vehicle technology. Since the introduction of unleaded petrol and catalytic converters in 1985, peak carbon monoxide concentrations in central Sydney have significantly reduced, and the last exceedance of the air quality standard for carbon monoxide in NSW was recorded in 1998 (NSW DECCW 2010).

While levels of nitrogen dioxide, sulfur dioxide (SO_2) and carbon monoxide continue to be below national standards, levels of ozone and particulate matter (PM) can exceed the standards adopted in NSW (NSW EPA 2016) from time to time.

Ozone and PM levels are affected by:

- The annual variability in the weather
- Natural events such as bushfires and dust storms, as well as hazard reduction burns
- The location and intensity of local emission sources, such as wood heaters, transport and industry (NSW OEH 2015).

The project lies within an urbanised area of Sydney and hence it is important that the background air quality considered is representative of existing conditions in the local area.

Data relevant to characterising existing air quality in the *Technical Working Paper 4 – Air Quality* was obtained from a number of long-term air monitoring stations operated by the Office of Environment and Heritage (OEH) (in Chullora, Earlwood, Randwick and Rozelle) and Roads and Maritime (M5 East urban background stations [four locations] and M5 East roadside stations [two locations]).

6.3 Construction impacts

6.3.1 Overview of air quality impact assessment: construction

Technical Working Paper 4 – Air Quality evaluated impacts on air that may occur during construction. The assessment considered impacts that may occur during various surface works and involved a semi quantitative assessment approach, focusing on emissions to air of dust. This approach has been summarised with the outcomes reviewed in terms of potential impacts to human health.

The assessment identified the range of activities during construction, potential emissions from these activities and the location of these activities in relation to community receptors. **Figure 6.1** illustrates the location of the community receptors considered during construction works.

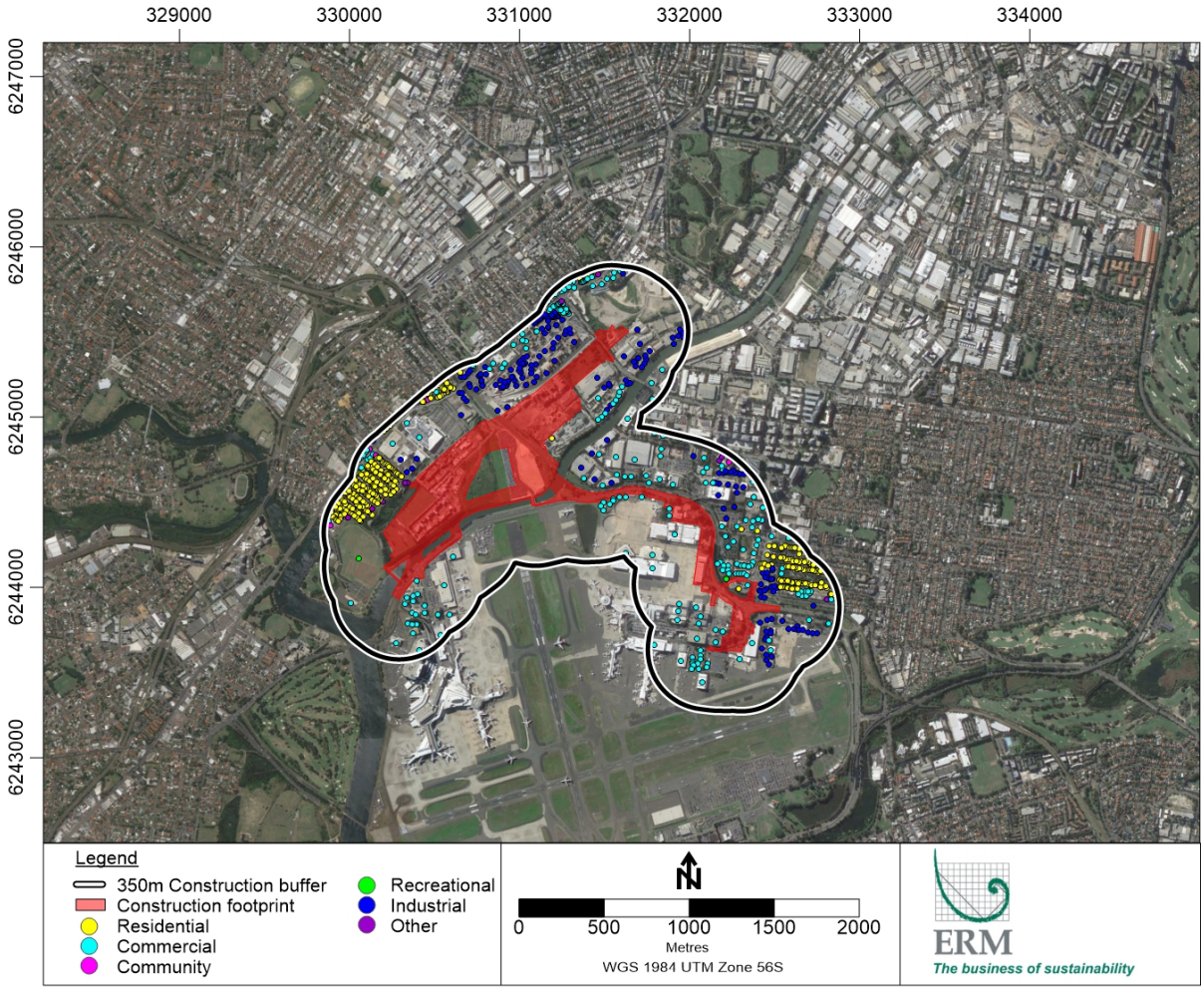


Figure 6.1: Receptors near the construction footprint of the Sydney Gateway road project

It is noted that for demolition activities, the *Work Health and Safety Regulation 2011* (NSW) requires that all hazardous materials are properly removed from buildings prior to any demolition works occurring. This is to prevent workers and the public from being exposed these materials and contaminants during the demolition and other construction works. Hence there is no need to further assess the presence of hazardous building materials during construction activities.

This approach then allocated a risk associated with the generation of dust and impacts on human health in the adjacent community. This approach considered the proximity to the source area and the number and type of receptors present. Impacts associated with nuisance dust and community health impacts were evaluated. For all demolition, earthworks, construction and track-out activities, where no mitigation measures are implemented, the risk of impacts on human health were evaluated and considered in terms of the location of community receptors.

The sensitivity of human receptors in all areas evaluated, relevant to all activities evaluated, was determined to be “High”. In relation to the risk ranking relevant to the impact of dust during construction on human health, this was determined to be “High”.

In relation to Commonwealth land within the project footprint, while most of the land is either commercial or industrial, there remains a high risk of potential dust impacts to receptors in this area.

On this basis, appropriate mitigation measures are required to minimise impacts on the local community (including Commonwealth land) during construction.

6.3.2 Dust mitigation and health impacts

For almost all construction activities, the aim should be to prevent significant impacts on receptors through the use of effective mitigation. Experience from similar construction projects shows that this is normally possible. Hence, where mitigation measures are appropriately implemented, the assessment of construction dust impacts presented in *Technical Working Paper 4 – Air Quality* concluded that the residual risk level would normally be “not significant”.

However, it is not possible to guarantee that the dust mitigation measures would be effective all the time. There is the risk that nearby residences, commercial buildings, hotel, cafés and schools in the immediate vicinity of the construction zone might experience some occasional dust soiling impacts. This does not imply that impacts are likely, or that if they do occur, that they would be frequent or persistent. Overall construction dust is unlikely to represent a serious ongoing problem. Any effects would be temporary and relatively short-lived, and would only arise during dry weather with the wind blowing towards a receptor, at a time when dust is being generated and mitigation measures are not being fully effective. The likely scale of this would not normally be considered sufficient to change the conclusion that with mitigation the effects would be ”not significant”.

A Construction Environmental Management Plan would be prepared to cover all construction stages of the project. Measures to manage potential dust impacts would include site management, monitoring, preparing and maintaining the construction sites, maintenance and controls on vehicles and machinery and construction. Chapter 8 of *Technical Working Paper 4 – Air Quality* provides additional details on the dust management measures proposed.

Where the above are implemented, the potential for health impacts to occur as a result of dust generated during construction is considered to be low. This assessment outcome does not preclude the deposition of nuisance dust (ie large dust particles) during the works or the presence of short-duration noticeable dust during some works.

Where impacts are considered in conjunction with other major projects, there is potential for nuisance dust impacts to occur for an extended period of time. The management of these impacts and associated construction fatigue is further discussed in **section 9.9**.

6.4 Overview of air quality impact assessment: operations

The assessment of changes in air quality associated with the operation of the project has been undertaken on the basis of the road traffic emissions related to the project as well as other sources that include existing and proposed tunnel ventilation outlets (seven outlets) as well as other road traffic.

Surface roads (ie project roads and other major roadways in the study area) have also been considered for the relevant stages of the project. This involved assessment of between 2,522 and 2,644 separate surface road links within the study area (depending on the scenario). These road links included residential roads, arterial roads as well as highway/freeway roads.

The mix of passenger vehicles (petrol and diesel), light commercial vehicles (petrol or diesel), petrol heavy commercial vehicles, diesel rigid or articulates heavy vehicles, diesel bus and motorcycles was estimated for the different road types and years of modelling.

Emissions from these sources were considered within an air modelling domain. A description of the GRAMM-GRAL model system can be found in *Technical Working Paper 4 – Air Quality*. The air modelling domain (ie the study area – or GRAL domain) is presented in **Figure 3.1** (which also includes boundaries of the Commonwealth land). The modelling considered meteorology relevant to a larger area (red box shown on **Figure 3.1**) that includes the study area, local terrain, and project-specific emission sources.

Emissions to air from the different types of vehicles relevant to the project and surrounding road network were based on traffic estimates from the Strategic Motorway Planning Model and emissions calculated using an emission model developed by NSW EPA, relevant to the Sydney area. This emissions inventory uses a base year of 2008, with projections for 2011, 2016, 2021, 2026, 2031 and 2036. Emission estimates relevant to the project assessment years 2026 and 2036 were utilised.

The assessment of operational air quality impacts related to the project was undertaken in accordance with the NSW EPA Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW EPA 2016).

In general the outcome of the air quality assessment, related to the operation of the project, indicates the following:

- For mostly criteria pollutants, the predicted air concentrations are dominated by background (existing) air quality. For some pollutants such as nitrogen dioxide, the project was found to be a significant contributor to the total concentration. In some cases, such as for particulate matter, background concentrations already exceed the relevant criteria
- In relation to the distribution of increases in pollutant concentrations, these were mostly small, with a very small number of receptors where larger increases were predicted.

The modelling undertaken to assess air quality impacts has been relied on and used in the HIA. The data used to evaluate health impacts relates to key pollutants derived from vehicle emissions, which are volatile organic compounds and polycyclic aromatic hydrocarbons (evaluated further in **section 6.5**), carbon monoxide (evaluated further in **section 6.6**), nitrogen dioxide (evaluated further in **section 6.7**) and particulates (evaluated further in **section 6.8**).

6.5 Assessment of health impacts - volatile organic compounds and polycyclic aromatic hydrocarbons

6.5.1 General

Technical Working Paper 4 – Air Quality has considered emissions of volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) to air from the project. Both VOCs and PAHs refer to a group of compounds with a mix of different proportions and toxicities. It is the individual compounds within the group that are of importance for evaluating adverse health effects. The composition of individual compounds in the VOCs and PAHs evaluated would vary depending on the source of the emissions. Hence it is important that the key individual compounds present in emissions considered for this project are speciated (ie identified and quantified as a percentage of the total VOCs or total PAHs) to ensure that potential impacts associated with exposure to these compounds can be adequately assessed.

Most of the volatile organic compounds (VOCs) emitted from vehicles comprise a range of hydrocarbons of low toxicity (such as methane, ethylene, ethane, butenes, butanes, pentenes, pentanes and heptanes) (EPA 2012). From a toxicity perspective, the key VOCs considered for the vehicle emissions are BTEX (benzene, toluene, ethylbenzene and total xylenes), 1,3-butadiene and formaldehyde (consistent with those identified and targeted in studies conducted in Australia on vehicle emissions (DEH 2003; EPA 2012)). The emission rate of these VOCs is based on the traffic mix assumed for the project and emission rates relevant to the Australian vehicle fleet.

PAHs are predominantly derived from diesel exhausts, with the composition and concentrations dependent on the fuel and type of vehicle. The emission rate of PAHs from vehicles related to the project is based on the traffic mix relevant to the project, and the Australian vehicle fleet using Australian fuel. More specifically the speciation of PAHs into carcinogenic PAHs, which have been assessed on the basis of a benzo(a)pyrene toxicity equivalent (TEQ, defined as per Canadian Council of Ministers of the Environment (CCME) (CCME 2010)) and non-carcinogenic PAHs is based on data from light and heavy duty diesel vehicles under congested conditions (DEH 2003).

The modelling of air emissions relevant to VOCs and PAHs has grouped these together as total hydrocarbons (THC). The weighted percentage of the key VOCs and PAHs within the THCs relevant to this project, for the years 2026 and 2036, based on the speciation profiles for the various classes of vehicles and the fleet mix evaluated are summarised in **Table 6.1**.

Table 6.1: Weighted speciation profiles for 2026 and 2036

Pollutant	Weighted % of THC for traffic	
	2026	2036
VOCs		
Benzene	4.0	3.5
Toluene	7.3	6.0
Ethylbenzene	1.3	1.1
Xylenes	6.0	5.0
Formaldehyde	3.3	4.5
1,3-Butadiene	1.1	0.94
PAHs		
Total PAHs	0.77	0.94
Individual PAHs (as proportion of total PAHs)		
Carcinogenic PAHs as Benzo(a)pyrene TEQ	0.046	0.046
Naphthalene	70	70
Acenaphthylene	4.9	4.9
Acenaphthene	2.0	2.0
Fluorene	5.0	5.0
Phenanthrene	3.4	3.4
Anthracene	0.49	0.49
Fluoranthene	0.45	0.45
Pyrene	0.71	0.71

6.5.2 Assessment of health impacts

6.5.2.1 Approach

The assessment of inhalation exposures associated with VOCs and PAHs has considered the following:

- Health based air guidelines and inhalation toxicity reference values (TRVs) for carcinogenic compounds have been selected on the basis of guidance provided by enHealth (enHealth 2012b). It is noted that there is no one individual agency/organisation that provides the most robust and current guidelines and TRVs for the compounds considered in this assessment, as the relevant agencies/organisations do not necessarily review all the chemicals and do not update assessments on a regular basis. As a result, the guidelines and TRVs adopted in this assessment come from a number of different sources. The guidelines and TRVs adopted are based on consideration of the available information and reviews provided by relevant key organisations that undertake detailed evaluations of toxicity and determine quantitative values for the assessment of inhalation exposures. This information has been evaluated to determine the most appropriate value that can be used to quantify acute and chronic inhalation exposures. This requires consideration of the hazards identified and the mechanisms for action particularly in relation to the assessment of carcinogenic effects, transparency of the review (ie is all the information presented and the derivation of the guideline transparent), robustness of the evaluation (ie critical review and evaluation of all available and relevant studies), currency of the evaluation (including

whether more recent key studies were considered) and the application of uncertainty factors

- For VOCs and PAHs which are considered genotoxic carcinogens (consistent with guidance provided by enHealth (enHealth 2012b)) an incremental lifetime carcinogenic risk has been calculated. For the VOCs and PAHs evaluated in this assessment a carcinogenic risk calculation has been adopted for the assessment of maximum potential (incremental) increase in benzene, 1,3-butadiene and PAHs assessed as a benzo(a)pyrene toxicity equivalent (TEQ). The assessment undertaken has adopted the calculation methodology outlined in **Annexure B**, adopting the inhalation unit risk values presented in **Table 6.3**, and assuming the maximum impacts occur at a residential home where individuals are at home 24 hours per day, 365 days of the year and they live at the same house for 35 years (enHealth 2012a)
- For other VOCs and non-carcinogenic PAHs, where the health effects are associated with a threshold (ie a level below which there are no effects), the maximum predicted concentration of individual VOCs and non-carcinogenic PAHs (background plus the change due to the project) associated with the project have been compared against published peer-reviewed health-based guidelines relevant to acute and chronic exposures (where relevant). The health-based guidelines adopted (identified on the basis of guidance from enHealth 2012) are relevant to exposures that may occur to all members of the general public (including sensitive individuals) with no adverse health effects. The guidelines available relate to inhalation exposures from all sources and reflect duration of exposure where:
  - Acute guidelines are based on exposures that may occur for a short period of time (typically for one-hour to be consistent with the air data, but may be up to 14 days). These guidelines are available to assess peak exposures (based on the modelled one-hour maximum concentration) that may be associated with VOCs in the air and are presented in **Table 6.2**
  - Chronic guidelines are based on exposures that may occur all day, every day for a lifetime. These guidelines are available to assess long-term exposures (based on the modelled annual average concentration) that may be associated with VOCs and PAHs in the air and are presented in **Table 6.3**. Use of these values assumes the maximum impact occurs at a residential home where individuals are at home 24 hours per day for 365 days of the year.

Table 6.2: Adopted acute inhalation guidelines based on protection of public health

Compound assessed	Acute health based guideline (µg/m^3)	Basis
Benzene	580	Acute 1-hour health-based guideline, based on depressed peripheral lymphocytes from the Texas Commission on Environmental Quality (TCEQ) evaluation (TCEQ 2013d).
Toluene	15,000	Acute 1-hour health-based guideline, based on eye and nose irritation, increased occurrence of headache and intoxication in human male volunteers from TCEQ evaluation (TCEQ 2013c).
Ethylbenzene	22,000	Acute inhalation guideline, relevant to exposures up to 14 days, based on auditory threshold changes in rats, with conversion to a value relevant to humans from the Agency for Toxic Substances and Disease Registry (ATSDR 2010). This is more conservative than the acute 1 hour health based guideline of 86000 µg/m^3 (based on the same health effect in rats) available from TCEQ (TCEQ 2010).
Xylenes	7,400	Acute 1-hour health-based guideline, based on mild respiratory effects and subjective symptoms of neurotoxicity in human volunteers from TCEQ evaluation (TCEQ 2013a).
1,3-Butadiene	660	Acute 1-hour health-based guideline, based on developmental effects derived by the California Office of Environmental Health Hazard Assessment (OEHHA 2013). The guideline developed is lower than developed by TCEQ (TCEQ 2007) based on the same critical study.
Formaldehyde	100	Acute health-based guideline, based on changes in blink eye response in human volunteers (WHO 2000a, 2010).

Table 6.3: Adopted chronic guidelines and carcinogenic unit risk values based on protection of public health

Compound assessed	Chronic health based guideline	Basis
Threshold guidelines		
Benzene	30 µg/m^3	The most significant chronic health effect associated with exposure to benzene is the increased risk of cancer, specifically leukaemia, which is assessed separately (below). The assessment of other health effects (other than cancer) has been undertaken using a chronic guideline derived by the United States Environmental Protection Agency (USEPA) (USEPA 2002) based on haematological effects in an occupational inhalation study (converted to public health value using safety factors). This is the most current evaluation of effects associated with chronic inhalation exposure to benzene and is consistent with the value used to derive the NEPM (NEPC 1999 amended 2013) health based guidelines.
Toluene	5,000 µg/m^3	Chronic guideline derived by the USEPA (USEPA 2005) based on neurological effects in an occupational study (converted to public health value using safety factors). This is the most current evaluation of effects associated with chronic inhalation exposure to toluene and is consistent with the value used to derive the NEPM (NEPC 1999 amended 2013) health based guidelines.
Ethylbenzene	260 µg/m^3	Chronic guideline derived by ATSDR (ATSDR 2010) based on nephropathy in rats in an inhalation study, with conversion to a value relevant to humans. This is the most current evaluation of effects associated with chronic inhalation exposure to ethylbenzene.

Compound assessed	Chronic health based guideline	Basis
Xylenes	220 µg/m^3	Chronic guideline derived by ATSDR (ATSDR 2007) based on mild subjective respiratory and neurological symptoms in an occupational study (converted to public health value using safety factors).
Formaldehyde	100 µg/m^3	Formaldehyde is classified by International Agency for Research on Cancer (IARC) as carcinogenic to humans. The guideline developed by the WHO (WHO 2000a, 2010) is considered to be protective of both short and long-term exposures, for non-carcinogenic and carcinogenic health effects. Some lower guidelines are available from the United States, however these are based on approaches to the assessment of carcinogenic effects inconsistent with that adopted by enHealth (enHealth 2012b) and the WHO (WHO 2010).
Carcinogenic inhalation unit risk values adopted for carcinogenic risk calculation		
Benzene	$6x10^{-6}$ $(µg/m^3)^{-1}$	Benzene is classified as a known human carcinogen by IARC. Inhalation unit risk value is from the WHO (WHO 2000a, 2010) and is based on excess risk of leukaemia from epidemiological studies.
1,3-Butadiene	$5x10^{-7}$ $(µg/m^3)^{-1}$	1,3-Butadiene is classified as a known human carcinogen by IARC. Inhalation unit risk values are available from a number of agencies, including the WHO, USEPA and TCEQ. The most current evaluation has been undertaken by TCEQ (TCEQ 2013b). This has considered the same studies as WHO and USEPA, but included more recent studies and more relevant dose-response modelling.
Benzo(a)pyrene TEQ	0.087 $(µg/m^3)^{-1}$	Benzo(a)pyrene (BaP) is classified by IARC as a known human carcinogen, which relates to BaP as well as all the other carcinogenic PAHs assessed as a BaP toxicity equivalent (TEQ) value. Inhalation unit risk value is from the WHO (WHO 2010) and is based on protection from lung cancer for an occupational study associated with coke oven emissions. It is noted that carcinogenic risks associated with lung cancer from diesel particulate matter (which is dominated by the presence of carcinogenic PAHs) is also assessed separately.

6.5.2.2 Calculated health impacts

Tables 6.4 to 6.7 presents a summary of the maximum predicted 1-hour or annual average concentrations of VOCs and non-carcinogenic PAHs assessed by comparison against acute and chronic health based guidelines (developed using a threshold approach). The tables also present a Hazard Index (HI) which is the ratio of the maximum predicted concentration to the guideline (ie maximum concentration/guideline). Each individual HI is added up to obtain a total HI for all the threshold chemicals considered. The total HI is a sum of the potential hazards associated with all the threshold chemicals together assuming the health effects are additive, and is evaluated as follows (enHealth 2012b):

- A total HI less than or equal to one means that all the maximum predicted concentrations are below the health based guidelines and there are no additive health impacts of concern
- A total HI greater than one means that the predicted concentrations (for at least one individual compound) are above the health based guidelines, or that there are at least a few individual chemicals where the maximum predicted concentrations are close to the health based guidelines such that there is the potential for the presence of all these together (as a sum) to result in adverse health effects.

The assessment of acute exposures, presented in **Tables 6.4 and 6.5**, has compared the maximum predicted total (background plus existing roads and project) one-hour average concentration against the relevant acute guidelines. This is the maximum one-hour average concentration reported anywhere in the project area, regardless of land use.

The assessment of chronic exposures, presented in **Tables 6.6 and 6.7**, has compared the maximum predicted total annual average concentration against the relevant chronic guidelines. This is the maximum anywhere, regardless of land use, which has been assumed to be residential (as the worst case scenario). For other potential maximum exposures, **Tables 6.6 and 6.7** also presents the maximum calculated HI assuming the maximum occurs in a commercial/industrial area. In this case, the calculated HI takes into account that these exposures occur for eight hours per day over 240 days per year.

Tables 6.8 and 6.9 present a summary of the calculated incremental lifetime carcinogenic risk associated with exposure to the maximum predicted change in concentrations of benzene, 1,3-butadiene and carcinogenic PAHs (as benzo(a)pyrene TEQ). The calculation presented assumes residents are exposed to the maximum change in pollutant concentrations all day, every day for a lifetime. The calculated carcinogenic risk for these compounds has been summed, in accordance with enHealth guidance (enHealth 2012b). The table also presents the calculated total carcinogenic risk assuming maximum exposures occur in commercial/industrial areas. This calculation assumes workers are exposed eight hours per day, 240 days per year for 30 years. The calculated risks are considered in conjunction with what are considered negligible, tolerable/acceptable and unacceptable risks as outlined in **Annexure C**.

The HI values presented in the tables have been rounded to two significant figures reflecting the level of uncertainty in the calculations presented.

The following evaluation is based on the maximum predicted concentration in air for the relevant assessment scenarios for 2026 and 2036 as modelled in *Technical Working Paper 4 – Air Quality*. Concentrations in all other areas of the surrounding community are lower than the maximum as evaluated in this assessment. In many locations, the change due to the project is a lowering of VOC and PAH concentrations in air (ie a benefit).

Table 6.4: Assessment of acute exposures to VOCs – maximum impacts in community associated with project: 2026

Key VOC	Maximum predicted 1 hour average concentration associated with project (background plus project) and calculated HI					
	2026: Without project		2026: With project		2026: Cumulative	
	Maximum concentration (µg/m^3)	HI	Maximum concentration (µg/m^3)	HI	Maximum concentration (µg/m^3)	HI
Benzene	7.8	0.014	8.6	0.015	8.0	0.014
Toluene	14.3	0.0010	15.7	0.00105	14.6	0.0010
Ethylbenzene	2.6	0.00012	2.8	0.00013	2.6	0.0001
Xylenes	11.8	0.0016	12.9	0.0017	12.1	0.0016
1,3-Butadiene	2.1	0.0032	2.3	0.0035	2.1	0.0032
Formaldehyde	6.5	0.065	7.1	0.071	6.6	0.066
Total HI		0.084	0.092		0.086	
Unacceptable HI		>1	>1		>1	

Table 6.5: Assessment of acute exposures to VOCs – maximum impacts in community associated with project: 2036

Key VOC	Maximum predicted 1 hour average concentration associated with project (background plus project) and calculated HI					
	2036: Without project		2036: With project		2036: Cumulative	
	Maximum concentration ($\mu g/m^3$)	HI	Maximum concentration ($\mu g/m^3$)	HI	Maximum concentration ($\mu g/m^3$)	HI
Benzene	5.0	0.0087	4.6	0.0080	4.3	0.0074
Toluene	8.8	0.00058	8.1	0.00054	7.5	0.00050
Ethylbenzene	1.6	0.000073	1.5	0.000067	1.4	0.000062
Xylenes	7.2	0.0010	6.7	0.0009	6.2	0.0008
1,3-Butadiene	1.4	0.0021	1.3	0.0019	1.2	0.0018
Formaldehyde	6.5	0.13	6.0	0.12	5.6	0.11
Total HI		0.14	0.13		0.12	
Unacceptable HI		>1	>1		>1	

Table 6.6: Assessment of chronic exposures to VOCs and PAHs – maximum impacts in community associated with project: 2026

Key VOCs and PAHs	Maximum predicted annual average concentration associated with project (background plus project) and calculated HI – Residential exposures					
	2026: Without project		2026: With project		2026: Cumulative	
	Max concentration ($\mu g/m^3$)	HI	Max concentration ($\mu g/m^3$)	HI	Max concentration ($\mu g/m^3$)	HI
Benzene	0.52	0.017	0.47	0.016	0.48	0.016
Toluene	0.95	0.00019	0.86	0.00017	0.87	0.00017
Ethylbenzene	0.17	0.00065	0.15	0.00059	0.16	0.00060
Xylenes	0.78	0.0035	0.71	0.0032	0.72	0.0033
Formaldehyde	0.43	0.0043	0.39	0.0039	0.39	0.0039
Naphthalene	0.070	0.023	0.063	0.021	0.064	0.021
Acenaphthylene	0.0049	2.5×10^{-5}	0.0044	2.2×10^{-5}	0.0045	2.3×10^{-5}
Acenaphthene	0.00200	1.0×10^{-5}	0.00181	9.1×10^{-6}	0.00184	9.2×10^{-6}
Fluorene	0.0050	3.6×10^{-5}	0.0045	3.2×10^{-5}	0.0046	3.3×10^{-5}
Phenanthrene	0.0034	2.4×10^{-5}	0.0031	2.2×10^{-5}	0.0031	2.2×10^{-5}
Anthracene	0.00049	4.9×10^{-7}	0.00044	4.4×10^{-7}	0.00045	4.5×10^{-7}
Fluoranthene	0.00045	3.2×10^{-6}	0.00041	2.9×10^{-6}	0.00041	3.0×10^{-6}
Pyrene	0.00071	7.1×10^{-6}	0.00064	6.4×10^{-6}	0.00065	6.5×10^{-6}
Total HI – Residential		0.032		0.029		0.030
Max HI – Commercial/Industrial		0.007		0.006		0.006
Unacceptable HI		>1		>1		>1

Table 6.7: Assessment of chronic exposures to VOCs and PAHs – maximum impacts in community associated with project: 2036

Key VOCs and PAHs	Maximum predicted annual average concentration associated with project (background plus project) and calculated HI – Residential exposures					
	2036: Without Project		2036: With project		2036: Cumulative	
	Max concentration ($\mu g/m^3$)	HI	Max concentration ($\mu g/m^3$)	HI	Max concentration ($\mu g/m^3$)	HI
Benzene	0.32	0.011	0.31	0.010	0.29	0.010
Toluene	0.56	0.00011	0.53	0.00011	0.51	0.00010
Ethylbenzene	0.10	0.00039	0.10	0.00037	0.09	0.00036
Xylenes	0.46	0.0021	0.44	0.0020	0.42	0.0019
Formaldehyde	0.42	0.0042	0.40	0.0040	0.38	0.0038
Naphthalene	0.020	0.058	0.019	0.055	0.018	0.020
Acenaphthylene	0.061	0.020	0.058	0.019	0.055	0.018
Acenaphthene	0.0043	2.1×10^{-5}	0.0040	2.0×10^{-5}	0.0039	1.9×10^{-5}
Fluorene	0.0017	8.7×10^{-6}	0.0017	8.3×10^{-6}	0.0016	7.9×10^{-6}
Phenanthrene	0.0044	3.1×10^{-5}	0.0041	3.0×10^{-5}	0.0039	2.8×10^{-5}
Anthracene	0.0030	2.1×10^{-5}	0.0028	2.0×10^{-5}	0.0027	1.9×10^{-5}
Fluoranthene	0.00043	4.3×10^{-7}	0.00040	4.0×10^{-7}	0.00039	3.9×10^{-7}
Pyrene	0.00039	2.8×10^{-6}	0.00037	2.7×10^{-6}	0.00035	2.5×10^{-6}
Total HI – Residential		0.027		0.026		0.025
Max HI – Commercial/Industrial		0.006		0.006		0.005
Unacceptable HI		>1		>1		>1

Table 6.8: Assessment of incremental lifetime carcinogenic risk – maximum impacts in community associated with project: 2026

Key VOC	Maximum predicted change in annual average concentration associated with project and cancer risk – Residential			
	2026: With project		2026: Cumulative	
	Maximum change in concentration (µg/m^3)	ILCR	Maximum change in concentration (µg/m^3)	ILCR
Benzene	0.13	3×10^{-7}	0.1	2×10^{-7}
1,3-Butadiene	0.035	7×10^{-9}	0.028	5×10^{-9}
Benzo(a)pyrene TEQ	0.0012	4×10^{-5}	0.00093	3×10^{-5}
Total carcinogenic risk – Residential		4×10^{-5}	3×10^{-5}	
Maximum carcinogenic risk – Commercial/Industrial		1×10^{-5}	7×10^{-6}	
Unacceptable carcinogenic risk		$>1 \times 10^{-4}$	$>1 \times 10^{-4}$	

Note: ILCR = incremental lifetime carcinogenic risk (refer to **Annexure B** for calculation methodology and **Table 6.3** for inhalation unit risk values)

Table 6.9: Assessment of incremental lifetime carcinogenic risk – maximum impacts in community associated with project: 2036

Key VOC	Maximum predicted change in annual average concentration associated with project and cancer risk – Residential			
	2036: With project		2036: Cumulative	
	Maximum change in concentration (µg/m^3)	ILCR	Maximum change in concentration (µg/m^3)	ILCR
Benzene	0.09	2×10^{-7}	0.097	2×10^{-7}
1,3-Butadiene	0.025	5×10^{-9}	0.026	5×10^{-9}
Benzo(a)pyrene TEQ	0.0011	4×10^{-5}	0.0012	4×10^{-5}
Total carcinogenic risk – Residential		4×10^{-5}	4×10^{-5}	
Maximum carcinogenic risk – Commercial/Industrial		9×10^{-6}	1×10^{-5}	
Unacceptable carcinogenic risk		$>1 \times 10^{-4}$	$>1 \times 10^{-4}$	

Note: ILCR = incremental lifetime carcinogenic risk (refer to **Annexure B** for calculation methodology and **Table 6.3** for inhalation unit risk values)

For the assessment of acute exposures to VOCs (**Tables 6.4 and 6.5**), the calculated HI associated with exposure to the maximum concentrations predicted is less than one for all the project scenarios. On this basis, there are no acute risk issues in the local community associated with the project.

For the assessment of chronic exposures to VOCs and non-carcinogenic PAHs (**Tables 6.6 and 6.7**), the calculated HI associated with exposure to the maximum concentrations predicted is less than or equal to one for 2026, 2036 and the cumulative scenarios. The calculated lifetime cancer risks (**Tables 6.8 and 6.9**) associated with the maximum change in benzene, 1,3-butadiene and carcinogenic PAHs (as benzo(a)pyrene TEQ) are less than or equal to $4x10^{-5}$ and are considered to be tolerable. It is noted that the calculations undertaken for PAHs is based on a conservative estimate of the fraction of emissions from vehicles that comprises PAHs (as a percentage of total VOCs). The approach adopted is expected to overestimate concentrations of PAHs in air. Hence the calculations presented are considered to be a conservative upper limit estimate.

On this basis, there are no chronic risk issues in the local community associated with the project.

6.6 Assessment of health impacts – carbon monoxide

Motor vehicles are the dominant source of carbon monoxide in air (DECCW, 2009). Adverse health effects of exposure to carbon monoxide are linked with carboxyhaemoglobin in blood. In addition, an association between exposure to carbon monoxide and cardiovascular hospital admissions and mortality, especially in the elderly for cardiac failure, myocardial infarction and ischemic heart disease; and some birth outcomes (such as low birth weights) have been identified (NEPC 2010).

Guidelines are available from the NEPC (as standards) (NEPC 2016) that are based on the protection of adverse health effects associated with carbon monoxide. The air standards currently available from NEPC are consistent with health based guidelines currently available from the WHO (WHO 2005, 2010) and the USEPA (2011[2], specifically listed to be protective of exposures by sensitive populations including asthmatics, children and the elderly). On this basis, the current NEPC standards are considered appropriate for the assessment of potential health impacts associated with the project.

The NEPC ambient air quality standard for the assessment of exposures to carbon monoxide has considered the lowest observed adverse effect level (LOAEL) and the no observed adverse effect level (NOAEL) associated with a range of health effects in healthy adults, with people with ischemic heart disease and with foetal effects.

In relation to these data, a level of carbon monoxide of nine parts per million (ppm) by volume (or 10 milligrams per cubic metre or 10,000 micrograms per cubic metre) over an 8-hour period was considered to provide protection (for both acute and chronic health effects) for most members of the population (NEPC 2016). An additional 1.5-fold uncertainty factor to protect more susceptible groups in the population was included. On this basis, the NEPC standard is protective of adverse health effects in all individuals, including sensitive individuals.

The 1-hour criteria of 30 mg/m^3 (WHO 2000c) is consistent with the more recent update from the WHO (WHO 2010).

Table 6.10 summarises the maximum predicted cumulative (ie project plus background) 1-hour average and 8-hour average concentrations of carbon monoxide for the assessment years 2026 and 2036, in relation to emissions to air from the project.

[2] Most recent review of the Primary National Ambient Air Quality Standards for Carbon Monoxide published by the USEPA in the Federal Register Volume 76, No. 169, 2011, available from: http://www.gpo.gov/fdsys/pkg/FR-2011-08-31/html/2011-21359.htm

Table 6.10: Review of potential acute and chronic health impacts – carbon monoxide (CO)

Scenario	Maximum 1-hour average concentration of CO (mg/m^3) Background plus project	Maximum 8-hour average concentration of CO (mg/m^3) Background plus project
2026: Without project	5.3	3.7
2026: With project	5.5	3.8
2026: Cumulative	5.6	3.9
2036: Without project	4.7	3.3
2036: With project	4.7	3.3
2036: Cumulative	4.7	3.2
Relevant health based standard/ guideline	**30**	**10**

NA – it is not applicable or relevant to assess chronic exposures for the maximum emissions scenario

All the concentrations of carbon monoxide presented in **Table 6.10** are below the relevant health based standards/guidelines listed at the base of the table.

6.7 Assessment of health impacts – nitrogen dioxide

6.7.1 Health effects associated with exposure

Nitrogen oxides (NOx) refer to a collection of highly reactive gases containing nitrogen and oxygen, most of which are colourless and odourless. Nitrogen oxide gases form when fuel is burnt. Motor vehicles, along with industrial, commercial and residential (eg gas heating or cooking) combustion sources, are primary producers of nitrogen oxides. The main source of nitrogen oxides in urban areas is from on-road vehicles.

In terms of health effects, nitrogen dioxide is the only oxide of nitrogen that is of concern (WHO 2000d). Nitrogen dioxide is a colourless and tasteless gas with a sharp odour. Nitrogen dioxide can cause inflammation of the respiratory system and increase susceptibility to respiratory infection. Exposure to elevated levels of nitrogen dioxide has also been associated with increased mortality, particularly related to respiratory disease, and with increased hospital admissions for asthma and heart disease patients (WHO 2013). Asthmatics, the elderly and people with existing cardiovascular and respiratory disease are particularly susceptible to the effects of nitrogen dioxide (Morgan, Broom & Jalaludin 2013; NEPC 2010). The health effects associated with exposure to nitrogen dioxide depend on the duration of exposure as well as the concentration.

Guidelines are available from the NEPC (as standards) (NEPC 2016) which indicate acceptable concentrations of nitrogen dioxide. These guidelines are based on protection from adverse health effects following both short-term (acute) and longer-term (chronic) exposure for all members of the population including sensitive populations like asthmatics, children and the elderly.

When reviewing the available literature on the health effects associated with exposure to nitrogen dioxide it is important to consider the following:

- Whether the evidence suggests that associations between exposure to nitrogen dioxide concentrations and effects on health are causal. The most current review undertaken by the USEPA (USEPA 2015) specifically evaluated evidence of causation. The review identified that a causal relationship existed for respiratory effects (for short-term exposure with long-term exposures also likely to be causal). All other associations related to

exposure to nitrogen dioxide (specifically cardiovascular effects, mortality and cancer) were considered to be suggestive.

- Whether the reported associations are distinct from, and additional to, those reported and assessed for exposure to particulate matter. Co-exposures to nitrogen dioxide and particulate matter complicates review and assessment of many of the epidemiology studies as both these air pollutants occur together in urban areas. There is sufficient evidence (epidemiological and mechanistic) to suggest that some of the health effect associations identified relate to exposure to nitrogen dioxide after adjustment/correction for co-exposures with particulate matter (COMEAP 2015).
- Whether the assessment of potential health effects associated with exposure to different levels of nitrogen dioxide can be undertaken on the basis of existing guidelines, or whether specific risk calculations are required to be undertaken. The current guidelines in Australia for the assessment of nitrogen dioxide in air relate to cumulative (total) exposures, and adopt criteria that are considered to be protective of short and long-term exposures. It is thus relevant that these guidelines be considered in this assessment.
- In addition, the current standards relate to regional air quality, not localised sources and hence use of such standards for the assessment of localised exposures is of limited value.

For these situations, it is relevant to also evaluate the impact on community health of the change in nitrogen dioxide concentration in the local community using appropriate risk calculations. For the conduct of risk assessments in relation to exposure to nitrogen dioxide, the WHO (WHO 2013) identified that the strongest evidence of health effects related to respiratory hospitalisations and to a lesser extent mortality (associated with short-term exposures) and recommend that these health endpoints should be considered in any core assessment of health impacts associated with exposure.

On the basis of the above, potential health effects associated with exposure to nitrogen dioxide would be undertaken for the project using both comparison with guidelines (assessing cumulative/total exposures) and an assessment of incremental impacts on health (associated with changes in air quality from the project).

6.7.2 Assessment of cumulative/total exposures

The NEPC ambient air quality guideline for the assessment of acute (short-term) exposures to nitrogen dioxide relates to the maximum predicted total (cumulative) 1-hour average concentration in air. The guideline of 246 micrograms per cubic metre (or 120 parts per billion by volume) is based on a LOAEL of 409–613 micrograms per cubic metre derived from statistical reviews of epidemiological data suggesting an increased incidence of lower respiratory tract symptoms in children and aggravation of asthma. An uncertainty factor of two to protect susceptible people (ie asthmatic children) was applied to the LOAEL (NEPC 1998). On this basis, the NEPC acute guideline is protective of adverse health effects in all individuals, including sensitive individuals.

The NEPC ambient air quality standard for the assessment of chronic (long-term) exposures to nitrogen dioxide relates to the maximum predicted total (cumulative) annual average concentration in air. The standard of 62 micrograms per cubic metre (or 30 parts per billion by volume) is based on a LOAEL of the order of 40–80 parts per billion by volume (around 75–150 micrograms per cubic metre). This relates to the early and middle childhood years when exposure can lead to the development of recurrent upper and lower respiratory tract symptoms, such as recurrent ‘colds’, a productive cough and an increased incidence of respiratory infection with resultant absenteeism from school.

An uncertainty factor of two was applied to the LOAEL to account for susceptible people within the population resulting in a guideline of 20-40 parts per billion by volume (38–75 micrograms per cubic metre) (NEPC 1998). On this basis, the NEPC standard is protective of adverse health effects in all individuals, including sensitive individuals.

Table 6.11 summarises the maximum predicted cumulative/total 1-hour average and annual average concentrations of nitrogen dioxide for the years 2026 and 2036.

The maximum annual average concentration is the annual average concentration at the maximally affected receptor, regardless of land use.

Table 6.11: Review of potential acute and chronic health impacts – nitrogen dioxide (NO_2)

Scenario	Maximum 1-hour average concentration of NO_2 ($\mu g/m^3$) Background plus project	Maximum annual average concentration of NO_2 ($\mu g/m^3$) Background plus project
2026: Without project	232.7	36.4
2026: With project	225.6	35.2
2026: Cumulative	258.9	35.1
2036: Without project	220.5	35.1
2036: With project	217.4	34.5
2036: Cumulative	214.6	34.5
Relevant health based standard	**246**	**62**

With the exception of the 2026 cumulative scenario the concentrations of nitrogen dioxide presented in the above table, relevant to the assessment of total acute and chronic exposures, are below the NEPC guidelines. In addition, for these scenarios, the maximum concentrations of nitrogen dioxide are lower with the project, compared to the situation without the project.

For the 2026 cumulative scenario, there was only one exceedance, for one hour only, of the health based standard, which was located within the car park of Sydney Airport. At this location the project results in an increase in nitrogen dioxide exposures. Given how close the maximum predicted concentration is to the guideline, and the range of responses noted in the underlying studies, it is unlikely that such an exceedance would result in any adverse health effects in people present in the car park, should the worst case conditions occur.

To further address potential risks to human health that may be associated with population exposures and localised changes in nitrogen dioxide that relate to the project, incremental risk calculations have been undertaken and are presented in **section 6.7.3**.

6.7.3 Assessment of incremental exposures

The evidence base supports quantification of effects of short-term (acute) exposure, using the same averaging time as in the relevant studies. The strongest evidence is for respiratory effects, particularly exacerbation of asthma (particularly within children), with some support also for all-cause mortality. These health endpoints have been evaluated in relation to changes in nitrogen dioxide concentrations in air associated with the project, within the local community in 2026 and 2036.

Table 6.12 summarises the health endpoints considered in this assessment, the β coefficient relevant to the calculation of a relative risk (refer to **Annexure A** for details on the calculation of a β coefficient from published studies). The coefficients adopted for the assessment of impacts on mortality and asthma emergency department admissions are derived from the detailed assessment undertaken for the current review of health impacts of air pollution undertaken by NEPC (Golder 2013) and are considered to be robust.

Table 6.12: Adopted exposure-response relationships for assessment of changes in nitrogen dioxide concentrations

Health endpoint	Exposure period	Age group	Adopted β coefficient (also as %) for 1 µg/m^3 increase in NO_2	Reference
Mortality, all causes (non-trauma)	Short-term	All ages	0.00188 (0.19%)	Relationship derived for from modelling undertaken for 5 cities in Australia and 1 day lag (EPHC 2010; Golder 2013)
Mortality, respiratory	Short-term	All ages*	0.00426 (0.43%)	Relationship derived for from modelling undertaken for 5 cities in Australia and 1 day lag (EPHC 2010; Golder 2013)
Asthma emergency department admissions	Short-term	1–14 years	0.00115 (0.11%)	Relationship established from review conducted on Australian children (Sydney) for the period 1997 to 2001 (Golder 2013; Jalaludin et al. 2008)

* Relationships established for all ages, including young children and the elderly

Table 6.13 presents the change in localised risk associated with changes in nitrogen dioxide at the maximum impacted receptors relevant to the various land use in the community, as well as the community receptors, for the operational years 2026 and 2036, including the cumulative scenarios (refer to **Annexure A** for methodology for the calculation of localised risks). The assessment assumes an individual, at a specific location, is exposed at each maximum impacted location over all hours of the day, regardless of the land use. Risks for all other receptors (including other community receptors) are lower than the maximums presented.

All risks are presented to one significant figure, reflecting the level of uncertainty associated with the calculations presented.

Figure 6.2 presents a summary of the calculated change in localised risk associated with changes in nitrogen dioxide concentrations at each community receptor location evaluated.

Annexure C presents a discussion on levels of the levels of risk that are considered to be negligible, tolerable/acceptable and unacceptable. A summary of these risk levels is included in **Table 6.13**.

Calculations relevant to the characterisation of risks associated with changes in nitrogen dioxide concentrations in the community are presented in **Annexure D**.

Table 6.14 presents a summary of the calculated change in incidence of the relevant health effects for the population living in the LGAs within the study area, associated with changes in nitrogen dioxide concentrations for 2026 and 2036. All calculations relevant to the LGAs, including calculation for each individual suburb considered in the LGAs, are presented in **Annexure E**.

Table 6.13: Maximum calculated risks associated with exposure to changes in nitrogen dioxide concentrations with operation of the project

Scenario and receptor	Maximum change in localised risk from exposure to nitrogen dioxide for the following health endpoints		
	Mortality: All causes (all ages)	Mortality: Respiratory (all ages)	Asthma ED Admissions (1–14 years)
2026 – with project			
Maximum from all receptors	4×10^{-5}	8×10^{-6}	6×10^{-5}
Maximum residential	3×10^{-5}	7×10^{-6}	6×10^{-5}
Maximum workplace	4×10^{-5}	8×10^{-6}	6×10^{-5}
Maximum childcare and schools	5×10^{-6}	1×10^{-6}	8×10^{-6}
Maximum aged care	7×10^{-7}	1×10^{-7}	1×10^{-6}
Maximum hospitals/medical	4×10^{-6}	8×10^{-7}	7×10^{-6}
Maximum open space	2×10^{-6}	5×10^{-7}	4×10^{-6}
Maximum from community receptors	3×10^{-6}	7×10^{-7}	6×10^{-6}
2026 – cumulative			
Maximum from all receptors	4×10^{-5}	7×10^{-6}	6×10^{-5}
Maximum residential	3×10^{-5}	7×10^{-6}	6×10^{-5}
Maximum workplace	4×10^{-5}	7×10^{-6}	6×10^{-5}
Maximum childcare	3×10^{-6}	5×10^{-7}	4×10^{-6}
Maximum aged care	3×10^{-7}	6×10^{-8}	5×10^{-7}
Maximum hospitals/medical	3×10^{-6}	6×10^{-7}	5×10^{-6}
Maximum open space	4×10^{-6}	8×10^{-7}	6×10^{-6}
Maximum from community receptors	4×10^{-6}	7×10^{-7}	6×10^{-6}
2036 – with project			
Maximum from all receptors	5×10^{-5}	9×10^{-6}	7×10^{-5}
Maximum residential	5×10^{-5}	9×10^{-6}	7×10^{-5}
Maximum workplace	5×10^{-5}	9×10^{-6}	7×10^{-5}
Maximum childcare and schools	4×10^{-6}	7×10^{-7}	6×10^{-6}
Maximum aged care	-4×10^{-8}	-9×10^{-9}	-7×10^{-8}
Maximum hospitals/medical	3×10^{-6}	6×10^{-7}	4×10^{-6}
Maximum open space	3×10^{-6}	6×10^{-7}	5×10^{-6}
Maximum from community receptors	3×10^{-6}	7×10^{-7}	5×10^{-6}

Scenario and receptor	Maximum change in localised risk from exposure to nitrogen dioxide for the following health endpoints		
	Mortality: All causes (all ages)	Mortality: Respiratory (all ages)	Asthma ED Admissions (1–14 years)
2036 – cumulative			
Maximum from all receptors	5×10^{-5}	9×10^{-6}	7×10^{-5}
Maximum residential	4×10^{-5}	9×10^{-6}	7×10^{-5}
Maximum workplace	5×10^{-5}	9×10^{-6}	7×10^{-5}
Maximum childcare	3×10^{-6}	7×10^{-7}	5×10^{-6}
Maximum aged care	-8×10^{-7}	-2×10^{-7}	-1×10^{-6}
Maximum hospitals/medical	4×10^{-6}	8×10^{-7}	6×10^{-6}
Maximum open space	3×10^{-6}	6×10^{-7}	5×10^{-6}
Maximum from community receptors	3×10^{-6}	5×10^{-7}	4×10^{-6}
Negligible risks	$<1 \times 10^{-6}$		
Tolerable/acceptable risks	$\geq 1 \times 10^{-6}$ and $\leq 1 \times 10^{-4}$		
Unacceptable risks	$>1 \times 10^{-4}$		

Note: Negative values mean a decrease in exposure and some health benefit

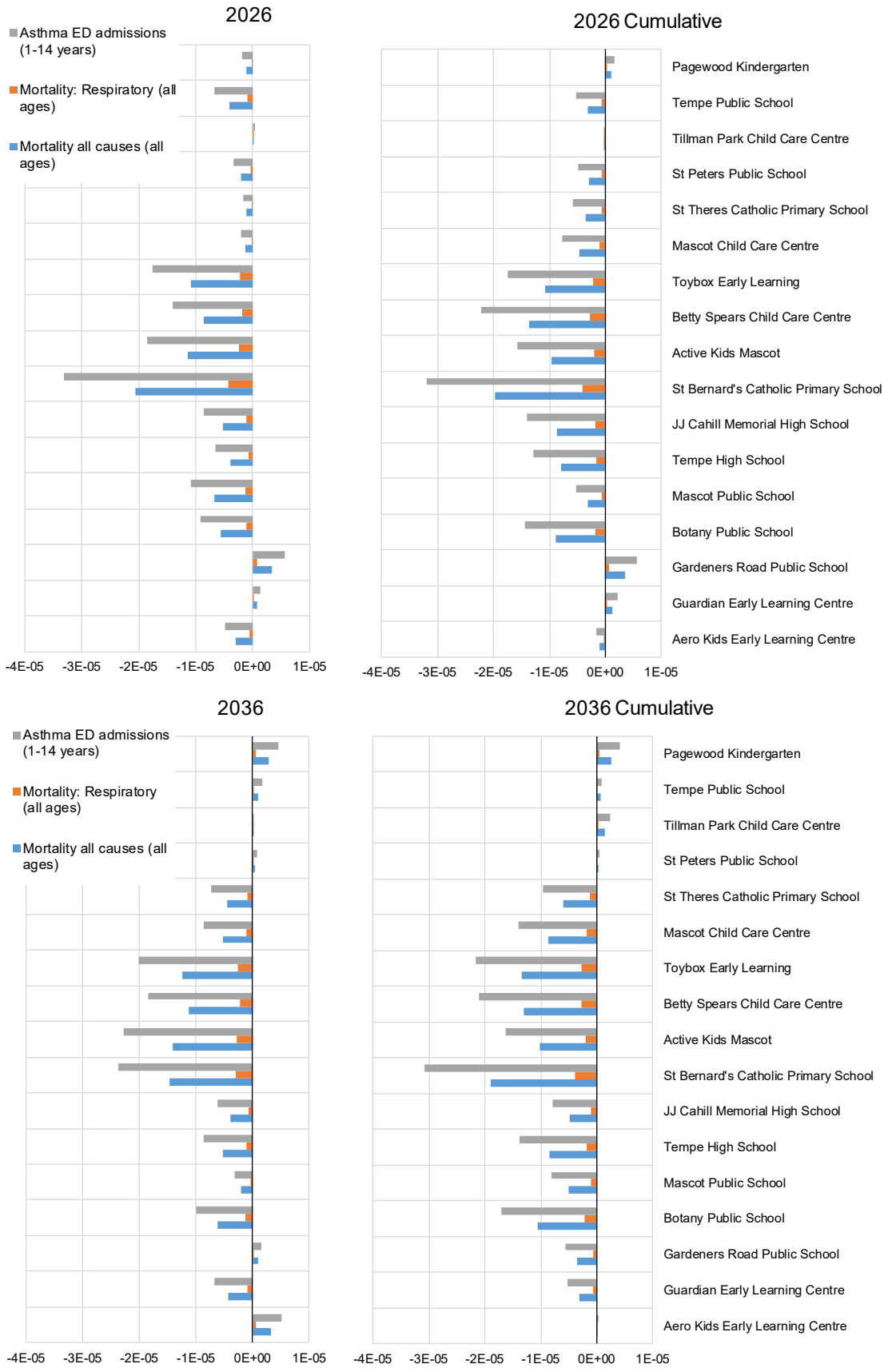


Figure 6.2: Change in calculated risk for key health endpoints associated with total changes in nitrogen dioxide concentrations at community receptors (2026 and 2036) (negative values mean a decrease in exposure and some health benefit)

Table 6.14: Calculated changes in population incidence of health effects associated with changes in NO_2 concentrations

LGA	Change in population incidence – number of cases					
	2026			2036		
	Mortality – All Causes	Mortality – Resp.	Morbidity – Asthma ED	Mortality – All Causes	Mortality – Resp.	Morbidity – Asthma ED
	All ages	All ages	1-14 years	All ages	All ages	1–14 years
With Project						
Inner West	-0.03	-0.006	-0.006	-0.03	-0.005	-0.005
Sydney Inner City	-0.06	-0.01	-0.006	-0.065	-0.01	-0.006
Canterbury	-0.003	-0.0006	-0.001	-0.004	-0.0008	-0.001
Botany	-0.23	-0.04	-0.049	-0.23	-0.04	-0.05
Kogarah - Rockdale	-0.012	-0.003	-0.0035	-0.02	-0.004	-0.005
Eastern Suburbs (Randwick)	-0.05	-0.009	-0.01	-0.045	-0.009	-0.009
Total for all LGAs	**-0.4**	**-0.07**	**-0.08**	**-0.4**	**-0.07**	**-0.075**
Cumulative						
Inner West	-0.03	-0.006	-0.007	-0.04	-0.008	-0.0086
Sydney Inner City	-0.08	-0.02	-0.0076	-0.1	-0.02	-0.01
Canterbury	-0.005	-0.0009	-0.001	-0.006	-0.001	-0.002
Botany	-0.25	-0.04	-0.05	-0.31	-0.05	-0.06
Kogarah - Rockdale	-0.02	-0.003	-0.004	-0.1	-0.02	-0.025
Eastern Suburbs (Randwick)	-0.06	-0.01	-0.01	-0.08	-0.015	-0.016
Total for all LGAs	**-0.4**	**-0.08**	**-0.08**	**-0.65**	**-0.1**	**-0.1**

Negative value indicates that there is a decrease in incidence associated with the project

Assessment of the localised risks calculated for changes in nitrogen dioxide levels associated with the project, indicates the following:

- The maximum risks calculated for exposures in residential areas are less than $1x10^{-4}$ and are therefore considered to be tolerable/acceptable
- The maximum risks calculated for exposures in commercial/industrial areas are less than $1x10^{-4}$ and are therefore considered to be tolerable/acceptable
- All maximum risks calculated for continuous exposures in childcare centres, schools, aged care homes and open space areas are below $1x10^{-4}$ and considered to be tolerable/acceptable
- All risks calculated for exposures at community receptors are below $1x10^{-4}$ and considered to be tolerable/acceptable. It is noted that for most community receptors the impact of the project is a lowering of risk (negative risk values presented in **Figure 6.2**).

Assessment of the calculated impacts in terms of the change in incidence of the relevant health effects associated with exposure to nitrogen dioxide in the community, indicates the following:

- The total change in the number of cases relevant to the health effects evaluated, for both 2026 and 2036, including the cumulative scenarios is negative, meaning a decrease in incidence as a result of the project. The number of cases, however is small, with a decrease of less than one case. These changes would not be measurable within the community
- The incidence calculations presented in **Table 6.14** are the totals for each LGA. Within these LGAs are a number of smaller suburbs. The calculated change in incidence relevant to each of these suburbs has also been evaluated, as presented in **Annexure E**. Review of the incidence calculated for the individual suburbs indicates that these predominantly relate to small decreases in health incidence with some suburbs showing a small increase. There are no individual suburbs within the LGAs where there is a change incidence that is of significance or would be measurable.

6.8 Assessment of health impacts – particulates

6.8.1 Particle size

Particulate matter is a widespread air pollutant with a mixture of physical and chemical characteristics that vary by location (and source). Unlike many other pollutants, particulates comprise a broad class of diverse materials and substances, with varying morphological, chemical, physical and thermodynamic properties, with sizes that vary from less than 0.005 microns to greater than 100 microns. Particulates can be derived from natural sources such as crustal dust (soil), pollen and moulds, and other sources that include combustion and industrial processes. Secondary particulate matter is formed via atmospheric reactions of primary gaseous emissions. The gases that are the most significant contributors to secondary particulates include nitrogen oxides, ammonia, sulfur oxides, and certain organic gases (derived from vehicle exhaust, combustion sources, agricultural, industrial and biogenic emissions).

Numerous epidemiological studies[3] have reported significant positive associations between particulate air pollution and adverse health outcomes, particularly mortality as well as a range of adverse cardiovascular and respiratory effects.

The potential for particulate matter to result in adverse health effects is dependent on the size and composition of the particulate matter. The common measures of particulate matter that are considered in the assessment of air quality and health risks are:

- Total suspended particulates: This refers to all particulates with an equivalent aerodynamic particle[4] size below about 50 microns in diameter[5]. It is a fairly gross indicator of the presence of dust with a wide range of sizes. Larger particles (termed 'inspirable', comprise particles around 10 microns and larger) are more of a nuisance as they would deposit out of the air (measured as deposited dust) close to the source and, if inhaled, are mostly trapped in the upper respiratory system[6] and do not reach the lungs. Finer particles

[3] Epidemiology is the study of diseases in populations. Epidemiological evidence can only show that this risk factor is associated (correlated) with a higher incidence of disease in the population exposed to that risk factor. The higher the correlation the more certain the association. Causation (ie that a specific risk factor actually causes a disease) cannot be proven with only epidemiological studies. For causation to be determined a range of other studies need to be considered in conjunction with the epidemiology studies.

[4] The term equivalent aerodynamic particle is used to reference the particle to a particle of spherical shape and particle of density one gram per cubic metre.

[5] The size, diameter, of dust particles is measured in micrometers (microns).

[6] The upper respiratory tract comprises the mouth, nose, throat and trachea. Larger particles are mostly trapped by the cilia and mucosa and swept to the back of the throat and swallowed.

(smaller than 10 microns, termed 'respirable') tend to be transported further from the source and are of more concern with respect to human health as these particles can penetrate into the lungs (see following point). Not all of the dust characterised as total suspended particulates is thus relevant for the assessment of health impacts, and total suspended particulates as a measure of impact, has not been further evaluated in this assessment. The assessment has only focused on particulates of a size where significant associations have been identified between exposure and adverse health effects.

- PM_{10} (particulate matter below 10 microns (µm)_ in diameter), $PM_{2.5}$ (particulate matter below 2.5 µm in diameter) and PM_1 (particulate matter below one µm in diameter, often termed very fine particles) and ultrafines (particulate matter below 0.1 µm in diameter), as illustrated in **Figure 6.3.** These particles are small and have the potential to penetrate beyond the body's natural clearance mechanisms of cilia and mucous in the nose and upper respiratory system, with smaller particles able to further penetrate into the lower respiratory tract[7] and lungs. Once in the lungs adverse health effects may result (OEHHA 2002).

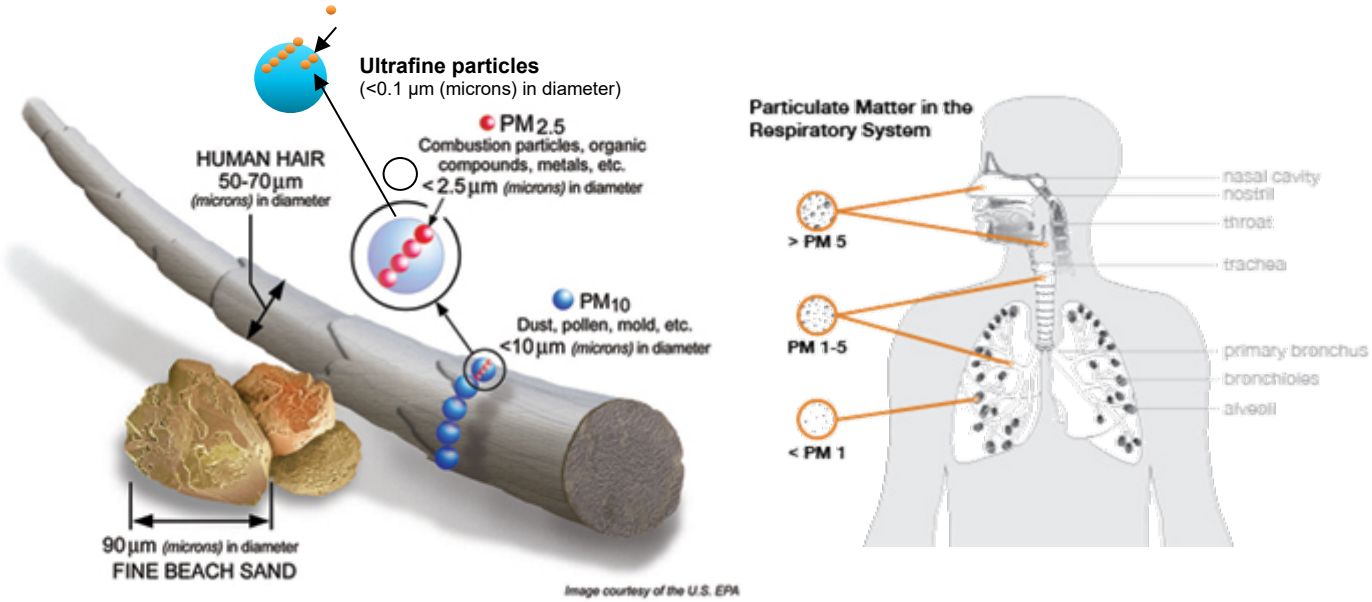


Figure 6.4: Illustrative representation of particle sizes and penetration into the lungs

Evaluation of size alone as a single factor in determining the potential for particulate toxicity is difficult since the potential health effects are not independent of chemical composition. There are certain particulate size fractions that tend to contain certain chemical components. Metals are commonly found attached to fine particulates (less than $PM_{2.5}$) while crustal materials (like soil) are usually larger and are present as PM_{10} or larger. In addition, different sources of particulates have the potential to result in the presence of other pollutants in addition to particulate matter. For example, combustion sources, prevalent in urban areas, result in the emission of particulate matter (more dominated by $PM_{2.5}$) as well as gaseous pollutants (such as nitrogen dioxide and carbon monoxide). This results in what is referred to as co-exposure and is an issue that has to be accounted for when evaluating studies that come from studying health effects in large populations exposed to pollution from many sources (as is the case in urban air).

[7] The lower respiratory tract comprises the smaller bronchioles and alveoli, the area of the lungs where gaseous exchange takes place. The alveoli have a very large surface area and absorption of gases occurs rapidly with subsequent transport to the blood and the rest of the body. Small particles can reach these areas, be dissolved by fluids and absorbed.

Where co-exposure is accounted for, the available science supports that exposure to fine particulate matter (less than 2.5 μm, $PM_{2.5}$) is associated (and shown to be causal in some cases) with health impacts in the community (USEPA 2012). A more limited body of evidence suggests an association between exposure to larger particles, PM_{10} and adverse health effects (USEPA 2009, 2018; WHO 2003).

It is noted that when assessing potential health impacts associated with changes in particulate matter concentrations the studies relied upon for establishing associations (between changes in concentrations in air and health effects) are large epidemiological studies. These studies relate changes in health indicators with changes in measured concentrations of particulate matter. As a result, the particle size fractions addressed in these studies relate to the fractions measured in the urban air environment studies.

In relation to measuring particulate matter in urban air, the following should be noted:

- The measurement of particulate matter in urban air most commonly reports PM_{10}. This is the concentration of particulate matter less than or equal to 10 μm in diameter (and includes the smaller fractions of $PM_{2.5}$ and very fine particles). The measurement techniques for PM_{10} are well established and provide stable, robust, verifiable data that is considered to be consistently reported across all countries. This means this data on PM_{10} collected in different parts of a city, in different parts of a country and by different countries can be compared against each other. This is the key reason why many of the epidemiological studies have looked at associations between PM_{10} and various health effects.
- The measurement of $PM_{2.5}$ is becoming more common in urban environments. This is the concentration of particulate matter less than or equal to 2.5 μm in diameter (and includes the smaller fractions of very fine particles and ultrafines). The measurement techniques used for $PM_{2.5}$ are less well established resulting in data that varies depending on the type of equipment used and how it is set-up and maintained. Due to either a lack of monitoring data or the inconsistency of monitoring data some epidemiology studies have assessed associations between $PM_{2.5}$ and health effects by using PM_{10} data and assuming that a certain percentage of PM_{10} comprises $PM_{2.5}$. Some studies have directly used measurements of $PM_{2.5}$ in urban air. Even where these measurement issues are considered, the studies still clearly show strong relationships between changes in $PM_{2.5}$ concentrations and health effects.
- The measurement of very fine and ultrafine particles is difficult (using equipment that is less robust/stable and provides variable data) and has not been undertaken in most urban air environments. As a result, there are no robust epidemiological studies that relate changes in ultrafine particle levels and health effects that can be used in a risk assessment. There is sufficient data available to confirm that motor vehicles are a key source of ultrafine particles. Available studies in animals and humans have identified a range of adverse health effects associated with exposure to ultrafine particulates, however the studies do not show that short-term exposure to ultrafine particulates have effects that are significantly different from those associated with exposure to $PM_{2.5}$ (HEI 2013).

When assessing health impacts from fine particulates, the robust associations of effects (that are based on large epidemiology studies primarily from the US and Europe) have been determined on the basis of $PM_{2.5}$, as $PM_{2.5}$ which is what is commonly measured in urban air. No robust associations (that can be used in a quantitative assessment) are available for PM_1 and the current science is inconclusive in relation to ultrafine particulates. The associations developed for $PM_{2.5}$ would include a significant contribution from PM_1 (as $PM_{2.5}$ comprises a significant proportion of PM_1) and so health effects observed for PM_1 would be captured in the studies that have been conducted on the basis of $PM_{2.5}$. It is important that the quantitative evaluation of potential health impacts adopts robust health effects associations and utilises particulate matter measures that are collected in the urban air environment. The further assessment of exposure to fine particulate matter has thus focused on particulates reported/evaluated as $PM_{2.5}$.

6.8.2 Health effects

Adverse health effects associated with exposure to particulate matter have been well studied and reviewed by Australian and International agencies. Most of the studies and reviews have focused on population-based epidemiological studies in large urban areas in North America, Europe and Australia, where there have been clear associations determined between health effects and exposure to $PM_{2.5}$ and to a lesser extent, PM_{10}. These studies are complemented by findings from other key investigations conducted in relation to: the characteristics of inhaled particles; deposition and clearance of particles in the respiratory tract; animal and cellular toxicity studies; and studies on inhalation toxicity by human volunteers (NEPC 2010).

Particulate matter has been linked to adverse health effects after both short-term exposure (days to weeks) and long-term exposure (months to years). The health effects associated with exposure to particulate matter vary widely (with the respiratory and cardiovascular systems most affected) and include mortality and morbidity effects.

In relation to mortality, for short-term exposures in a population this relates to the increase in the number of deaths due to existing (underlying) respiratory or cardiovascular disease; for long-term exposures in a population this relates to mortality rates over a lifetime, where long-term exposure is considered to accelerate the progression of disease or even initiate disease.

In relation to morbidity effects, this refers to a wide range of health indicators used to define illness that have been associated with (or caused by) exposure to particulate matter. In relation to exposure to particulate matter, effects are primarily related to the respiratory and cardiovascular system and include (Morawska, Moore & Ristovski 2004; USEPA 2009, 2018):

- Aggravation of existing respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits)
- Changes in cardiovascular risk factors such as blood pressure
- Changes in lung function and increased respiratory symptoms (including asthma)
- Changes to lung tissues and structure
- Altered respiratory defence mechanisms.

The most recent review of the available studies (USEPA 2018) have also indicated that effects on the nervous system and carcinogenic effects are likely to have a causal relationship with long-term exposures to $PM_{2.5}$. IARC (2013) has classified particulate matter as carcinogenic to humans based on data relevant to lung cancer.

These effects are commonly used as measures of population exposure to particulate matter in community epidemiological studies (from which most of the available data in relation to health effects is derived) and are more often grouped (through the use of hospital codes) into the general categories of cardiovascular morbidity/effects and respiratory morbidity/effects. The available studies provide evidence for increased susceptibility for various populations, particularly older populations, children and those with underlying health conditions (USEPA 2009).

There is consensus in the available studies and detailed reviews that exposure to fine particulates, $PM_{2.5}$, is associated with (and causal to) cardiovascular and respiratory effects and mortality (all causes) (USEPA 2012). While similar relationships have also been determined for PM_{10}, the supporting studies do not show relationships as clear as shown with $PM_{2.5}$ (USEPA 2012).

There are a number of studies that have been undertaken where other health effects have been evaluated. These studies have a large degree of uncertainty or a limited examination of the relationship and are generally only considered to be suggestive or inadequate (in some cases) of an association with exposure to $PM_{2.5}$ (USEPA 2018). This includes long-term exposures and metabolic effects, male and female reproduction and fertility, pregnancy and birth outcomes; and short-term exposures and nervous system effects (USEPA 2018).

In relation to the key health endpoints relevant to evaluating exposures to $PM_{2.5}$, there are some associated health measures or endpoints where the exposure-response relationships are not as strong or robust as those for the key health endpoints and are considered to be a subset of the key health endpoints. This includes mortality (for different age groups), chronic bronchitis, medication use

by adults and children with asthma, respiratory symptoms (including cough), restricted work days, work days lost, school absence and restricted activity days (Anderson et al. 2004; EC 2011b; Ostro 2004; WHO 2006).

6.8.3 Approach to the assessment of particulate exposures

In relation to the assessment of exposures to particulate matter there is sufficient evidence to demonstrate that there is an association between exposure to $PM_{2.5}$ (and to a lesser extent PM_{10}) and effects on health that are causal.

The available evidence does not suggest a threshold below which health effects do not occur. Accordingly, there are likely to be health effects associated with background levels of $PM_{2.5}$ and PM_{10}, even where the concentrations are below the current guidelines. Standards and goals are currently available for the assessment of $PM_{2.5}$ and PM_{10} in Australia (NEPC 2016). These standards and goals are not based on a defined level of risk that has been determined to be acceptable, rather they are based on balancing the potential risks due to background and urban sources to lower impacts on health in a practical way.

The air quality standards and goals relate to average or regional exposures by populations from all sources, not to localised 'hot-spot' areas such as locations near industry, busy roads or mining. They are intended to be compared against ambient air monitoring data collected from appropriately sited regional monitoring stations. In some cases, there may be local sources (including busy roadways and industry) that result in background levels of PM_{10} and $PM_{2.5}$ that are close to, equal to, or in exceedance of, the air quality standards and goals. Where impacts are being evaluated from a local source it is important to not only consider cumulative/total impacts associated with the project (undertaken using the current air quality goals) but also evaluate the impact of changes in air quality within the local community.

This assessment has therefore been undertaken to consider both cumulative/total exposure impacts (refer to **section 6.8.4**) and incremental exposure impacts associated with changes in $PM_{2.5}$ and PM_{10} concentrations that are associated with the project (refer to **section 6.8.5**). Incremental changes are those due to the project alone while cumulative/total changes are those where background air quality in addition to those due to the project alone are considered.

6.8.4 Assessment of cumulative/total exposures

The assessment of cumulative/total exposures to $PM_{2.5}$ and PM_{10} is based on a comparison of the cumulative/total concentrations predicted with the current air quality standards and goals presented in the National Environment Protection Council (NEPC) (Ambient Air Quality) Measures (NEPM) (NEPC 2016). These standards and goals are total concentrations in ambient air, within the community, that are based on the most current science in relation to health effects. The most current standards and goals, based on the protection of community health presented by the NEPC, have been further considered in this HIA report.

In relation to the current NEPM PM_{10} standard, the following is noted (NEPC 1998, 2010, 2014, 2016):

- The standard was derived through a review of appropriate health studies by a technical review panel of the NEPC where short-term exposure-response relationships for PM_{10} and mortality and morbidity health endpoints were considered
- Mortality health impacts were identified as the most significant and were the primary basis for the development of the standard
- On the basis of the available data for key air sheds in Australia, the criterion of 50 micrograms per cubic metre was based on analysis of the number of premature deaths that would be avoided and associated cost savings to the health system (using data from the US). The development of the standard is not based on any acceptable level of risk

- The assessment undertaken considered exposures and issues relevant to urban air environments that are expected to also be managed through the PM_{10} standard. These issues included emissions from vehicles and wood heaters.

A similar approach has been adopted by NEPC (Burgers & Walsh 2002; NEPC 2002, 2014) in relation to the derivation of the $PM_{2.5}$ air quality standards, with specific studies related to $PM_{2.5}$ and mortality and morbidity indicators considered. Goals for lower $PM_{2.5}$ standards to be met by 2025 are also outlined by NEPC (NEPC 2016).

Table 6.15 presents a comparison of the current NEPC standards and goals with those established by the WHO (WHO 2005), the European Union (EU) and the USEPA (2012). The 2025 goals established by the NEPM for $PM_{2.5}$ (and adopted in this assessment) are similar to but slightly more conservative (health protective) than those provided by the WHO, EU and the USEPA. The NEPM PM_{10} guidelines are also similar to those established by the WHO and EU, however the guidelines are significantly lower than the 24-hour average guideline available from the USEPA.

Table 6.15: Comparison of particulate matter air quality goals

Pollutant	Averaging period	Criteria/guidelines/goals			
		NEPC (2016)	WHO (2005)	EU*	USEPA (2012)
PM_{10}	24-hour	50 µg/m^3	50 µg/m^3	50 µg/m^3 as limit value with 35 exceedances permitted each year	150 µg/m^3 (not to be exceeded more than once per year on average over 3 years)
	Annual	25 µg/m^3	20** µg/m^3	40 µg/m^3 as limit value	N/A
$PM_{2.5}$	24-hour	25 µg/m^3 20 µg/m^3 (goal for 2025)	25 µg/m^3	N/A	35 µg/m^3 (98th percentile, averaged over 3 years)
	Annual	8 µg/m^3 7 µg/m^3 (goal for 2025)	10** µg/m^3	25 µg/m^3 as target value from 2010 and limit value from 2015. 20 µg/m^3 as a 3 year average (average exposure indicator) from 2015 with requirements for ongoing percentage reduction and target of 18 µg/m^3 as 3 year average by 2020	12 µg/m^3 (annual mean averaged over 3 years)

* Current EU Air Quality Standards available from http://ec.europa.eu/environment/air/quality/standards.htm

** The WHO Air Quality guidelines are based on the lowest levels at which total, cardiopulmonary and lung cancer mortality have been shown to increase with more than 95 per cent confidence in response to $PM_{2.5}$ in the ACS study (Pope et al. 2002). The use of a $PM_{2.5}$ guideline is preferred by the WHO (WHO 2005).

The air quality standards and goals for $PM_{2.5}$ and PM_{10} relate to total concentrations in the air (from all sources including the project). The background air quality data used in this project is outlined in the *Technical Working Paper 4 – Air Quality*. The background data includes a contribution of PM that is derived from vehicles that utilise the existing road network, but is not a background for properties adjacent to existing major roadways. Use of this background data would result in some double counting of the contribution of vehicle emissions to air quality in the local area, as the project has assumed emissions from vehicles using the project (or changes in surface road vehicles) are in addition to those currently using roads in the local area. This is a conservative approach.

Table 6.16 summarises the maximum 24-hour average and annual average concentrations of $PM_{2.5}$ and PM_{10} relevant to the assessment of emissions in 2026 and 2036. The maximum annual average concentration is the annual average concentration at the maximally affected grid location or individual community receptor.

Table 6.16: Review of cumulative/total PM concentrations

Location and scenario	Maximum 24-hour average concentration (µg/m³)		Maximum annual average concentration (µg/m³)	
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}
2026: Without project	51.5	73.8	13.6	25.7
2026: With project	51.1	74.0	13.5	25.6
2026: Cumulative	51.2	73.3	13.4	25.4
2036: Without project	52.1	74.2	13.7	25.8
2036: With project	52.0	74.8	13.6	25.7
2036: Cumulative	51.4	72.2	13.1	24.9
Standards and goals	**25** **(20 as goal for 2025)**	**50**	**8** **(7 as goal by 2025)**	**25**

Note: Data as provided for the surface roads. Where cumulative/total (ie background plus emissions from surface roads) are required to be considered, a conservative approach would be to add the background (30 µg/m³ for 24-hour averages and 8.9 µg/m³ for annual averages) to the no project and project estimates. This would result in some double counting of road emissions as the existing background included existing road emissions which are also counted in the no project and project calculations.

Review of **Table 6.16** indicates:

- The maximum total/cumulative concentrations of $PM_{2.5}$ are above the relevant standard and goal for the 24-hour and annual average, regardless of the project. This is due to existing levels (ie background levels) of $PM_{2.5}$ in the local urban environment.
- The maximum total/cumulative concentrations of PM_{10} are at or above the relevant standard and goal for the 24-hour and annual average, regardless of the project. This is due to existing levels (ie background levels) of PM_{10} in the local urban environment.

Concentrations of $PM_{2.5}$ and PM_{10} are essentially unchanged within the local community with the operation of the project.

To further address potential risks to human health that may be associated with localised changes (or redistribution) in exposures to $PM_{2.5}$ and PM_{10} that relate to the project, an assessment of incremental impacts has been undertaken and are presented in **section 6.8.5**.

6.8.5 Assessment of incremental exposures

A detailed assessment of potential health effects associated with exposure to changes in air quality as a result of the project has been undertaken. As no threshold has been determined for exposure to $PM_{2.5}$ or PM_{10} the assessment of impacts on health has utilised robust, published, quantitative relationships (exposure-response relationships) that relate a change in $PM_{2.5}$ or PM_{10} concentration with a change in a health indicator. **Annexure A** presents an overview of the methodology adopted for using exposure-response relationships for the assessment of health impacts in a community.

For the assessment of potential exposures to changes in particulate matter, the assessment focused on health effects and exposure-response relationships that are robust and relate to $PM_{2.5}$, being the

more important particulate fraction size relevant for emissions from combustion sources. Assessment of PM_{10} has also been included.

The specific health effects (or endpoints) evaluated in this assessment include:

- Primary health endpoints:
  - Long-term exposure to $PM_{2.5}$ and changes in all-cause mortality (equal or greater than 30 years of age)
  - Short-term exposure and changes to the rate of hospitalisations with cardiovascular and respiratory disease (equal or greater than 65 years of age).
- Secondary health endpoints (to supplement the primary assessment):
  - Short-term exposure to PM_{10} and changes in all-cause mortality (all ages)
  - Long-term exposure to $PM_{2.5}$ and changes in cardiopulmonary mortality (equal or greater than 30 years of age)
  - Short-term exposure to $PM_{2.5}$ and changes in cardiovascular and respiratory mortality (all ages)
  - Short-term exposure to $PM_{2.5}$ and changes in emergency department admissions for asthma in children aged 1–14 years.

Table 6.17 summarises the health endpoints considered in this assessment, the relevant health impact functions (from the referenced published studies) and the associated β coefficient relevant to the calculation of a relative risk (refer to **Annexure A** for details on the calculation of a β coefficient from published studies).

The health impact functions presented in this table are the most current and robust values and are appropriate for the quantification of potential health effects for the health endpoints considered in this assessment.

Table 6.17: Adopted health impact functions and exposure-responses relationships

Health endpoint	Exposure period	Age group	Published relative risk [95 confidence interval] per 10 $\mu g/m^3$	Adopted β coefficient (as %) for 1 $\mu g/m^3$ increase in PM	Reference
Primary assessment health endpoints					
$PM_{2.5}$: Mortality, all causes	Long-term	≥30yrs	1.06 [1.04-1.08]	0.0058 (0.58)	Relationship derived for all follow-up time periods to the year 2000 (for approx. 500,000 participants in the US) with adjustment for seven ecologic (neighbourhood level) covariates (Krewski et al. 2009). This study is an extension (additional follow-up and exposure data) of the work undertaken by Pope (2002), is consistent with the findings from California (1999-2002) (Ostro et al. 2006) and is more conservative than the relationships identified in a more recent Australian and New Zealand study (EPHC 2010)

Health endpoint	Exposure period	Age group	Published relative risk [95 confidence interval] per 10 µg/m^3	Adopted β coefficient (as %) for 1 µg/m^3 increase in PM	Reference
$PM_{2.5}$: Cardiovascular hospital admissions	Short-term	≥65yrs	1.008 [1.0059-1.011]	0.0008 (0.08)	Relationship established for all data and all seasons from US data for 1999 to 2005 for lag 0 (exposure on same-day) (strongest effect identified) (Bell 2012; Bell et al. 2008)
$PM_{2.5}$: Respiratory hospital admissions	Short-term	≥65yrs	1.0041 [1.0009-1.0074]	0.00041 (0.041)	Relationship established for all data and all seasons from US data for 1999 to 2005 for lag 2 (exposure 2 days previous) (strongest effect identified) (Bell 2012; Bell et al. 2008)
Secondary assessment health endpoints					
PM_{10}: Mortality, all causes	Short-term	All ages*	1.006 [1.004-1.008]	0.0006 (0.06)	Based on analysis of data from European studies from 33 cities and includes panel studies of symptomatic children (asthmatics, chronic respiratory conditions) (Anderson et al. 2004)
$PM_{2.5}$: Mortality, all causes	Short-term	All ages*	1.0094 [1.0065-1.0122]	0.00094 (0.094)	Relationship established from study of data from 47 US cities for the years 1999 to 2005 (Zanobetti & Schwartz 2009)
$PM_{2.5}$: Cardio-pulmonary mortality	Long-term	≥30yrs	1.14 [1.11-1.17]	0.013 (1.3)	Relationship derived for all follow-up time periods to the year 2000 (for approx. 500,000 participants in the US) with adjustment for seven ecologic (neighbourhood level) covariates (Krewski et al. 2009)
$PM_{2.5}$: Cardiovascular mortality	Short-term	All ages*	1.0097 [1.0051-1.0143]	0.00097 (0.097)	Relationship established from study of data from 47 US cities for the years 1999 to 2005 (Zanobetti & Schwartz 2009)
$PM_{2.5}$: Asthma (emergency department admissions)	Short-term	1-14 years	--	0.00148 (0.148)	Relationship established from review conducted on Australian children (Sydney) for the period 1997 to 2001 (Jalaludin et al. 2008)
$PM_{2.5}$: Respiratory mortality (including lung cancer)	Short-term	All ages*	1.0192 [1.0108-1.0278]	0.0019 (0.19)	Relationship established from study of data from 47 US cities for the years 1999 to 2005 (Zanobetti & Schwartz 2009)

* Relationships established for all ages, including young children and the elderly

Tables 6.18 and 6.19 presents the change in localised risk associated with changes in PM_{10} and $PM_{2.5}$ at the maximum impacted receptors relevant to the various land use in the community, as well as the community receptors, for the operational years 2026 and 2036, including the cumulative scenarios (refer to **Annexure A** for methodology for the calculation of localised risks). The assessment assumes an individual is exposed at each maximum impacted location over all hours of the day, regardless of the land use. This has been undertaken to address any future changes in land use that may occur. Risks for all other receptors (including other community receptors) are lower than the maximums presented.

All risks are presented to one significant figure, addressing the level of uncertainty associated with the calculations presented.

Figure 6.4 presents a summary of the calculated change in localised risk associated with changes in PM_{10} and $PM_{2.5}$ concentrations at each community receptor location evaluated.

Annexure C presents a discussion on levels of the levels of risk that are considered to be negligible, tolerable/acceptable and unacceptable. A summary of these risk levels is included in **Tables 6.18 and 6.19**.

Calculations relevant to the characterisation of risks associated with changes in PM_{10} and $PM_{2.5}$ concentrations in the community are presented in **Annexure F**.

Tables 6.20 and 6.21 present a summary of the calculated change in incidence of the relevant health effects for the population living in the LGAs within the study area, associated with changes in PM_{10} and $PM_{2.5}$ concentrations for 2026 and 2036. All calculations relevant to the LGAs, including calculation for each individual suburb considered in the LGAs, are presented in **Annexure G**.

6.8.5.1 Assessing exposure to diesel particulate matter

In addition to the above exposure-response relationships, potential exposure to diesel particulate matter (DPM) derived from the project has been evaluated.

Diesel exhaust (DE) is emitted from 'on-road' diesel engines (vehicle engines) and can be formed from the gaseous compounds emitted by diesel engines (secondary particulate matter). After emission from the exhaust pipe, diesel exhaust undergoes dilution and chemical and physical transformations in the atmosphere, as well as dispersion and transport in the atmosphere. The atmospheric lifetime for some compounds present in diesel exhaust ranges from hours to days.

Available evidence indicates that there are human health hazards associated with exposure to diesel particulate matter. The hazards include acute exposure-related symptoms, chronic exposure related non-cancer respiratory effects, and lung cancer. The non-cancer health effects associated with exposure to DPM are adequately addressed on the basis of the current $PM_{2.5}$ and PM_{10} guidelines. However, the potential for exposure to DPM to result in an increased risk of lung cancer in the community requires further consideration. **Annexure B** presents the methodology adopted for the assessment of lung cancer risks associated with exposure to DPM. In summary, the following has been assumed/undertaken:

- It has been conservatively assumed that 100 per cent of $PM_{2.5}$ predicted in the local community is derived from diesel vehicles and comprises DPM
- An incremental lifetime risk of lung cancer has been calculated (refer to **Annexure B** for methodology) on the basis of the inhalation toxicity value available from the World Health Organization (WHO 1996).

Table 6.18: Calculated localised risk associated with changes in $PM_{2.5}$ and PM_{10} concentrations – project operations in 2026

Receptor	Change in annual average concentration (µg/m³)		Calculated risks for health endpoints									
			$PM_{2.5}$: Mortality, all causes	$PM_{2.5}$: CV hosp.	$PM_{2.5}$: Resp. hosp.	PM_{10}: Mortality, all causes	$PM_{2.5}$: Mortality, all causes	$PM_{2.5}$: Mortality, CP	$PM_{2.5}$: Mortality, CV	$PM_{2.5}$: Mortality, Resp.	$PM_{2.5}$: Asthma ED Hosp.	DPM Lung cancer
	PM_{10}	$PM_{2.5}$	long-term	short-term	short-term	short-term	short-term	long-term	short-term	short-term	short-term	long-term
			≥30 yrs	≥65 yrs	≥65 yrs	all	all	≥30 yrs	all	all	1–14 yrs	all
2026 with project												
Maximum residential	1.50	1.00	6×10^{-5}	7×10^{-5}	2×10^{-5}	4×10^{-6}	4×10^{-6}	5×10^{-5}	1×10^{-6}	8×10^{-7}	2×10^{-5}	3×10^{-5}
Maximum childcare	0.10	0.09	5×10^{-6}	7×10^{-6}	1×10^{-6}	3×10^{-7}	4×10^{-7}	5×10^{-6}	1×10^{-7}	7×10^{-8}	2×10^{-6}	3×10^{-6}
Maximum schools	0.04	0.05	3×10^{-6}	3×10^{-6}	8×10^{-7}	1×10^{-7}	2×10^{-7}	3×10^{-6}	6×10^{-8}	4×10^{-8}	8×10^{-7}	2×10^{-6}
Maximum aged care	-0.01	-0.02	-1×10^{-6}	-1×10^{-6}	-3×10^{-7}	-3×10^{-8}	$^{-8} \times 10^{-8}$	-1×10^{-6}	-2×10^{-8}	-1×10^{-8}	-3×10^{-7}	-6×10^{-7}
Maximum hospital	0.19	0.08	5×10^{-6}	6×10^{-6}	1×10^{-6}	5×10^{-7}	3×10^{-7}	4×10^{-6}	1×10^{-7}	6×10^{-8}	1×10^{-6}	3×10^{-6}
Maximum commercial/ industrial	1.40	0.85	5×10^{-5}	6×10^{-5}	1×10^{-5}	4×10^{-6}	4×10^{-6}	5×10^{-5}	1×10^{-6}	7×10^{-7}	2×10^{-5}	3×10^{-5}
Maximum open space	0.12	0.06	4×10^{-6}	4×10^{-6}	1×10^{-6}	3×10^{-7}	3×10^{-7}	3×10^{-6}	7×10^{-8}	5×10^{-8}	1×10^{-6}	2×10^{-6}
Maximum community receptors	0.06	0.17	1×10^{-5}	1×10^{-5}	3×10^{-6}	2×10^{-7}	7×10^{-7}	9×10^{-6}	2×10^{-7}	1×10^{-7}	3×10^{-6}	6×10^{-6}
2026 with project – Cumulative												
Maximum residential	1.55	1.00	6×10^{-5}	7×10^{-5}	2×10^{-5}	4×10^{-6}	4×10^{-6}	5×10^{-5}	1×10^{-6}	8×10^{-7}	2×10^{-5}	3×10^{-5}
Maximum childcare	0.10	0.08	5×10^{-6}	6×10^{-6}	1×10^{-6}	3×10^{-7}	3×10^{-7}	4×10^{-6}	1×10^{-7}	6×10^{-8}	1×10^{-6}	3×10^{-6}
Maximum schools	0.08	0.10	6×10^{-6}	7×10^{-6}	2×10^{-6}	2×10^{-7}	4×10^{-7}	5×10^{-6}	1×10^{-7}	8×10^{-8}	2×10^{-6}	3×10^{-6}
Maximum aged care	-0.06	-0.02	-1×10^{-6}	-1×10^{-6}	-3×10^{-7}	-2×10^{-7}	$^{-8} \times 10^{-8}$	-1×10^{-6}	-2×10^{-8}	-1×10^{-8}	-3×10^{-7}	-6×10^{-7}
Maximum hospital	0.16	0.08	5×10^{-6}	6×10^{-6}	1×10^{-6}	4×10^{-7}	4×10^{-7}	4×10^{-6}	1×10^{-7}	7×10^{-8}	1×10^{-6}	3×10^{-6}
Maximum commercial/ industrial	1.40	0.87	5×10^{-5}	6×10^{-5}	1×10^{-5}	4×10^{-6}	4×10^{-6}	5×10^{-5}	1×10^{-6}	7×10^{-7}	2×10^{-5}	3×10^{-5}
Maximum open space	0.17	0.09	5×10^{-6}	7×10^{-6}	2×10^{-6}	5×10^{-7}	4×10^{-7}	5×10^{-6}	1×10^{-7}	7×10^{-8}	2×10^{-6}	3×10^{-6}
Maximum community receptors	0.11	0.05	3×10^{-6}	4×10^{-6}	8×10^{-7}	3×10^{-7}	2×10^{-7}	3×10^{-6}	6×10^{-8}	4×10^{-8}	9×10^{-7}	2×10^{-6}

Negligible risks	**$<1 \times 10^{-6}$**
Tolerable/acceptable risks	**$\geq 1 \times 10^{-6}$ and $\leq 1 \times 10^{-4}$**
Unacceptable risks	**$>1 \times 10^{-4}$**

Negative values mean a decrease in exposure and some health benefit

CV = cardiovascular, CP = cardiopulmonary, Resp = respiratory, hosp. = hospitalisations, DPM = diesel particulate matter

Table 6.19: Calculated localised risk associated with changes in $PM_{2.5}$ and PM_{10} concentrations – project operations in 2036

Receptor	Change in annual average concentration (µg/m³)		Calculated risks for health endpoints									
			$PM_{2.5}$: Mortality, all causes	$PM_{2.5}$: CV hosp.	$PM_{2.5}$: Resp. hosp.	PM_{10}: Mortality, all causes	$PM_{2.5}$: Mortality, all causes	$PM_{2.5}$: Mortality, CP	$PM_{2.5}$: Mortality, CV	$PM_{2.5}$: Mortality, Resp.	$PM_{2.5}$: Asthma ED Hosp.	DPM Lung cancer
	PM_{10}	$PM_{2.5}$	long-term	short-term	short-term	short-term	short-term	long-term	short-term	short-term	short-term	long-term
			≥30 yrs	≥65 yrs	≥65 yrs	all	all	≥30 yrs	all	all	1–14 yrs	all
2036 with project												
Maximum residential	1.70	1.15	7×10^{-5}	8×10^{-5}	2×10^{-5}	5×10^{-6}	5×10^{-6}	6×10^{-5}	1×10^{-6}	9×10^{-7}	2×10^{-5}	4×10^{-5}
Maximum childcare	0.12	0.10	6×10^{-6}	7×10^{-6}	2×10^{-6}	3×10^{-7}	4×10^{-7}	5×10^{-6}	1×10^{-7}	8×10^{-8}	2×10^{-6}	3×10^{-6}
Maximum schools	0.20	0.09	5×10^{-6}	7×10^{-6}	1×10^{-6}	5×10^{-7}	4×10^{-7}	5×10^{-6}	1×10^{-7}	7×10^{-8}	2×10^{-6}	3×10^{-6}
Maximum aged care	0.05	-0.01	-7×10^{-7}	-8×10^{-7}	-2×10^{-7}	1×10^{-7}	-5×10^{-8}	-6×10^{-7}	-1×10^{-8}	-9×10^{-9}	-2×10^{-7}	-4×10^{-7}
Maximum hospital	0.17	0.11	7×10^{-6}	8×10^{-6}	2×10^{-6}	5×10^{-7}	5×10^{-7}	6×10^{-6}	1×10^{-7}	9×10^{-8}	2×10^{-6}	4×10^{-6}
Maximum commercial/ industrial	1.70	1.20	7×10^{-5}	9×10^{-5}	2×10^{-5}	5×10^{-6}	5×10^{-6}	6×10^{-5}	1×10^{-6}	9×10^{-7}	2×10^{-5}	4×10^{-5}
Maximum open space	0.18	0.11	7×10^{-6}	8×10^{-6}	2×10^{-6}	5×10^{-7}	5×10^{-7}	6×10^{-6}	1×10^{-7}	9×10^{-8}	2×10^{-6}	4×10^{-6}
Maximum community receptors	0.13	0.10	6×10^{-6}	8×10^{-6}	2×10^{-6}	4×10^{-7}	4×10^{-7}	5×10^{-6}	1×10^{-7}	8×10^{-8}	2×10^{-6}	3×10^{-6}
2036 with project – Cumulative												
Maximum residential	1.82	1.20	7×10^{-5}	9×10^{-5}	2×10^{-5}	5×10^{-6}	5×10^{-6}	6×10^{-5}	1×10^{-6}	9×10^{-7}	2×10^{-5}	4×10^{-5}
Maximum childcare	0.12	0.08	5×10^{-6}	6×10^{-6}	1×10^{-6}	3×10^{-7}	3×10^{-7}	4×10^{-6}	1×10^{-7}	6×10^{-8}	1×10^{-6}	3×10^{-6}
Maximum schools	0.15	0.08	5×10^{-6}	6×10^{-6}	1×10^{-6}	4×10^{-7}	4×10^{-7}	4×10^{-6}	1×10^{-7}	7×10^{-8}	1×10^{-6}	3×10^{-6}
Maximum aged care	-0.03	-0.02	-1×10^{-6}	-1×10^{-6}	-3×10^{-7}	-7×10^{-8}	-9×10^{-8}	-1×10^{-6}	-2×10^{-8}	-2×10^{-8}	-4×10^{-7}	-7×10^{-7}
Maximum hospital	0.20	0.07	4×10^{-6}	5×10^{-6}	1×10^{-6}	5×10^{-7}	3×10^{-7}	4×10^{-6}	9×10^{-8}	6×10^{-8}	1×10^{-6}	3×10^{-6}
Maximum commercial/ industrial	1.90	1.26	7×10^{-5}	9×10^{-5}	2×10^{-5}	5×10^{-6}	5×10^{-6}	7×10^{-5}	2×10^{-6}	1×10^{-6}	2×10^{-5}	4×10^{-5}
Maximum open space	0.22	0.16	1×10^{-5}	1×10^{-5}	3×10^{-6}	6×10^{-7}	7×10^{-7}	9×10^{-6}	2×10^{-7}	1×10^{-7}	3×10^{-6}	5×10^{-6}
Maximum community receptors	0.09	0.09	5×10^{-6}	7×10^{-6}	1×10^{-6}	3×10^{-7}	4×10^{-7}	5×10^{-6}	1×10^{-7}	7×10^{-8}	2×10^{-6}	3×10^{-6}

Negligible risks	**$<1 \times 10^{-6}$**
Tolerable/acceptable risks	**$\geq 1 \times 10^{-6}$ and $\leq 1 \times 10^{-4}$**
Unacceptable risks	**$>1 \times 10^{-4}$**

Negative values mean a decrease in exposure and some health benefit

CV = cardiovascular, CP = cardiopulmonary, Resp = respiratory, hosp. = hospitalisations, DPM = diesel particulate matter

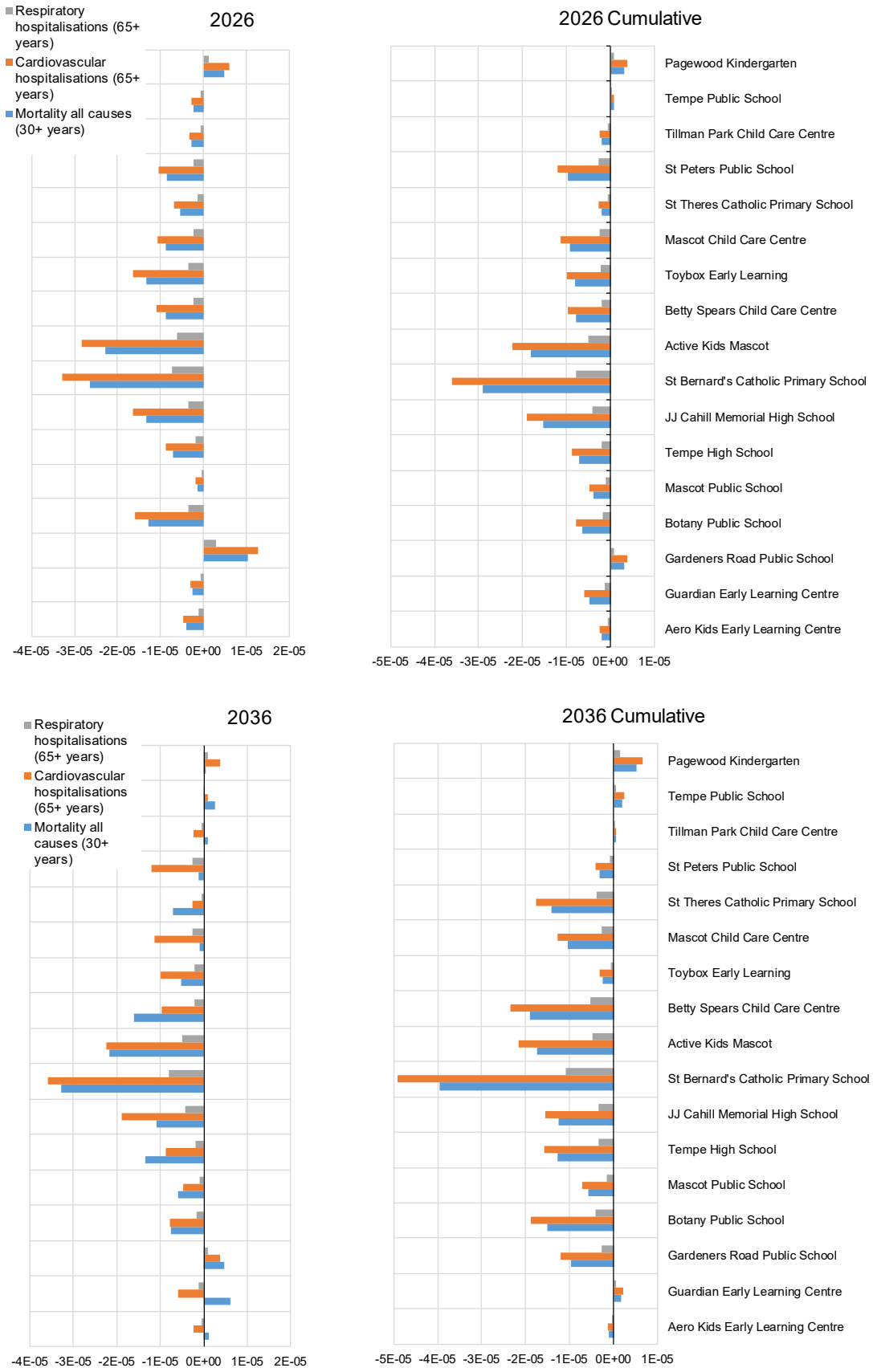


Figure 6.5: Change in calculated risk for key health endpoints associated with total changes in $PM_{2.5}$ concentrations at community receptors (2026 and 2036) (negative values mean a decrease in exposure and some health benefit)

Table 6.20: Calculated change in population incidence of health effects associated with changes in $PM_{2.5}$ concentrations – project operations in 2026

LGA	Change in population incidence – number of cases							
	Primary Indicators			Secondary Indicators				
	Mortality – All Causes	Hospitalisations – Cardiovascular	Hospitalisations – Respiratory	Mortality – All causes	Mortality – Cardiopulmonary	Mortality – Cardiovascular	Mortality – Respiratory	Morbidity – Asthma ED Admissions
	≥30 years	≥65 years	≥65 years	All ages	≥30 years	All ages	All ages	1–14 years
With Project								
Inner West	-0.023	-0.0054	-0.0012	-0.0029	-0.020	-0.00079	-0.00047	-0.0015
Sydney Inner City	-0.056	-0.0099	-0.0022	-0.0069	-0.050	-0.0018	-0.0013	-0.0017
Canterbury	-0.0021	-0.00061	-0.00013	-0.00028	-0.0018	-0.000082	-0.000046	-0.00020
Botany LGA	-0.17	-0.047	-0.010	-0.026	-0.16	-0.0063	-0.0038	-0.014
Kogarah - Rockdale	-0.022	-0.0068	-0.0015	-0.0028	-0.020	-0.00082	-0.00047	-0.0016
Eastern Suburbs (Randwick)	-0.036	-0.010	-0.0022	-0.0047	-0.032	-0.0013	-0.00080	-0.0025
Total for all LGAs	**-0.31**	**-0.079**	**-0.018**	**-0.043**	**-0.28**	**-0.011**	**-0.0069**	**-0.021**
Cumulative								
Inner West	-0.025	-0.0059	-0.0013	-0.0032	-0.022	-0.00087	-0.00052	-0.0017
Sydney Inner City	-0.063	-0.011	-0.0025	-0.0078	-0.057	-0.0020	-0.0014	-0.0019
Canterbury	-0.0032	-0.00094	-0.00021	-0.00044	-0.0029	-0.00013	-0.000072	-0.00032
Botany LGA	-0.18	-0.048	-0.011	-0.026	-0.16	-0.0065	-0.0039	-0.014
Kogarah - Rockdale	0.031	0.0097	0.0021	0.0039	0.028	0.0012	0.00067	0.0022
Eastern Suburbs (Randwick)	-0.030	-0.0086	-0.0019	-0.0040	-0.027	-0.0011	-0.00068	-0.0021
Total for all LGAs	**-0.27**	**-0.065**	**-0.014**	**-0.038**	**-0.24**	**-0.0095**	**-0.0060**	**-0.018**

Negative value indicates that there is a decrease in incidence associated with the project

Table 6.21: Calculated change in population incidence of health effects associated with changes in $PM_{2.5}$ concentrations – project operations in 2036

LGA	Change in population incidence – number of cases							
	Primary Indicators			Secondary Indicators				
	Mortality – All Causes	Hospitalisations – Cardiovascular	Hospitalisations – Respiratory	Mortality – All causes	Mortality – Cardiopulmonary	Mortality – Cardiovascular	Mortality – Respiratory	Morbidity – Asthma ED Admissions
	≥30 years	≥65 years	≥65 years	All ages	≥30 years	All ages	All ages	1–14 years
With Project								
Inner West	-0.021	-0.0050	-0.0011	-0.0027	-0.019	-0.00074	-0.00044	-0.0014
Sydney Inner City	-0.057	-0.010	-0.0022	-0.0072	-0.052	-0.0018	-0.0013	-0.0018
Canterbury	-0.0044	-0.0013	-0.00029	-0.00060	-0.0039	-0.00018	-0.000099	-0.00043
Botany LGA	-0.15	-0.041	-0.0090	-0.022	-0.14	-0.0055	-0.0033	-0.012
Kogarah - Rockdale	-0.014	-0.0042	-0.00093	-0.0017	-0.012	-0.00051	-0.00029	-0.0010
Eastern Suburbs (Randwick)	-0.041	-0.012	-0.0025	-0.0054	-0.037	-0.0015	-0.00091	-0.0029
Total for all LGAs	**-0.29**	**-0.073**	**-0.016**	**-0.040**	**-0.26**	**-0.010**	**-0.0064**	**-0.019**
Cumulative								
Inner West	-0.028	-0.0066	-0.0015	-0.0036	-0.025	-0.00098	-0.00058	-0.0019
Sydney Inner City	-0.094	-0.017	-0.0036	-0.012	-0.084	-0.0030	-0.0021	-0.0029
Canterbury	-0.0033	-0.00098	-0.00022	-0.00046	-0.0030	-0.00013	-0.000075	-0.00033
Botany LGA	-0.20	-0.055	-0.012	-0.030	-0.18	-0.007	-0.0045	-0.016
Kogarah - Rockdale	-0.017	-0.0053	-0.0012	-0.0021	-0.015	-0.00063	-0.00036	-0.0012
Eastern Suburbs (Randwick)	-0.053	-0.015	-0.0033	-0.0070	-0.048	-0.0019	-0.0012	-0.0037
Total for all LGAs	**-0.40**	**-0.099**	**-0.022**	**-0.055**	**-0.36**	**-0.014**	**-0.0088**	**-0.026**

Negative value indicates that there is a decrease in incidence associated with the project

Review of the calculated changes in risk indicates the following in relation to impacts associated with the expected operation of the project in 2026 and 2036, including the cumulative scenarios:

- A number of the calculated localised risks as shown in **Figure 6.4** for the community receptors are negative, meaning that the operation of the project would result in lower levels of risk, when compared with the situation where the project is not operating
- The maximum risks calculated for exposures in residential areas are less than $1x10^{-4}$ and considered to be tolerable/acceptable
- The maximum risks calculated for exposures in commercial/industrial areas are less than $1x10^{-4}$ and considered to be tolerable/acceptable
- All maximum risks calculated for continuous exposures in childcare centres, schools, aged care homes and open space areas are below $1x10^{-4}$ and considered to be tolerable/ acceptable.

Review of the calculated impacts in terms of the change in incidence of the relevant health effects for $PM_{2.5}$ in the community, as shown in **Tables 6.18 and 6.19**, indicates the following:

- The total change in the number of cases relevant to the health effects evaluated, for both 2026 and 2036 is negative, meaning an overall decrease in incidence as a result of the project. The number of cases, however is very small, less than one for all health effects considered. As a result, these changes would not be measurable within the community. It is noted that the overall decrease in incidence throughout the population is consistent with the observed distribution of impacts presented in *Technical Working Paper 4 - Air Quality*. This is illustrated in **Figure 6.5** that shows the change in annual average $PM_{2.5}$ concentrations as a result of the project in 2036. This shows the localised increases close to the project (where there are fewer residents present) and decreases in a number of other areas adjacent to other key roadways.
- Most individual LGAs show a total decrease in health incidence. Only the Kogarah-Rockdale LGA shows and increase, and only for the 2026 cumulative scenario. These increases are also very small, less than one for all health effects considered. As a result, these changes would not be measurable in the community.
- Within these LGAs are a number of smaller suburbs. The calculated change in incidence relevant to each of these suburbs has also been evaluated, as presented in **Annexure G**. Review of the incidence calculated for the individual suburbs indicates that these predominantly relate to small decreases in health incidence with some suburbs showing an increase. The largest increase in health incidence for any individual suburb is less than 0.1 case. Hence there are no individual suburbs within the LGAs where there is a change incidence that is of significance or would be measurable.

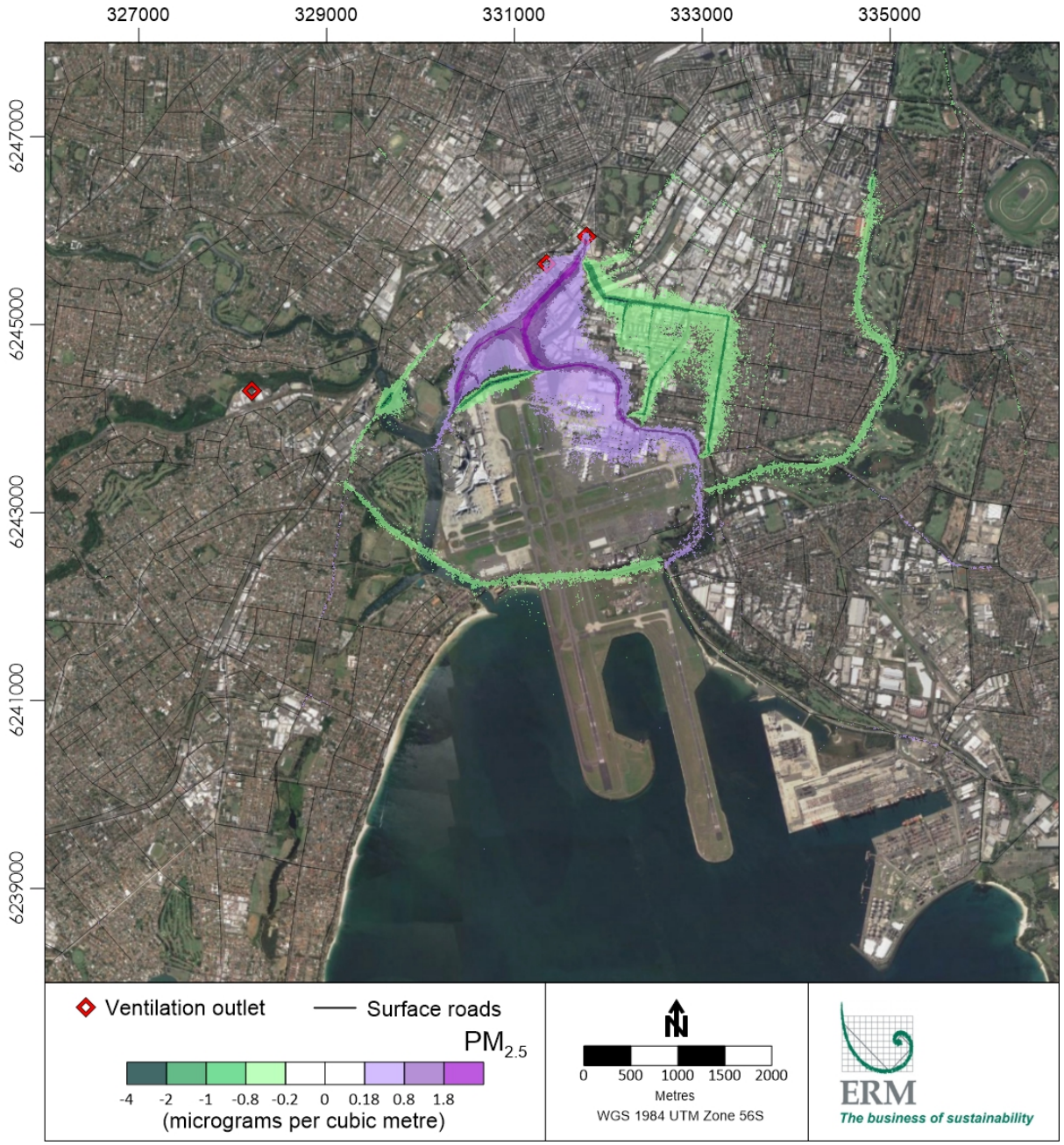


Figure 6.6: Contour plot of change in annual mean $PM_{2.5}$ concentration in the 2036 With Project scenario

6.9 Valuing particulate impacts

The SEARs (as outlined in **section 1.3**) requires the assessment of health impacts to also evaluate costs to the community. More specifically the SEARs have indicated that health costs should be evaluated on the basis of the following guidance document:

- Methodology for Valuing the Health Impacts of Changes in Particle Emissions (EPA 2013).

This guideline has developed an approach for use in Australia that is based on the approach developed in the UK. The approach adopted is simplistic, relating health costs in the community to changes in total tonnes of $PM_{2.5}$ emitted. This calculation has generalised the health impacts associated with changes in $PM_{2.5}$ exposures as emitted to air and does not specifically address how people are exposed to these emissions (this is assumed to occur). *Technical Working Paper 4 – Air*

Quality has calculated the tonnes of $PM_{2.5}$ relevant to each of the scenarios evaluated for this project. This relates to the total tonnes of $PM_{2.5}$ emitted to air and this shows a small decrease in $PM_{2.5}$ with the project in both 2026 and 2036.

The assessment of potential health effects associated with the change in $PM_{2.5}$ concentrations the community are exposed to, as discussed in **section 6.8.5**, **Tables 6.20 and 6.21**, is consistent with this outcome, where the project is associated with a decrease in incidence, or the number of cases, relevant to mortality and hospitalisations (ie a health benefit). These impacts (ie the change in number of cases) ideally should be those that are considered in valuing the health impacts. Where this is considered a reduction in health, costs should be calculated. However, that is not the case with the methodology outlined by NSW EPA (2013) which is only based on the change in total tonnes of $PM_{2.5}$ emitted. As a result, the calculations presented are not considered representative of health costs related to the project.

When applying the NSW EPA (2013) methodology, the project area has been assumed to be "urban large" (noting there are no definitions in the guidance in relation to determining this), where the damage costs listed are $280,000 per tonne of $PM_{2.5}$ in for Sydney for the 2011 population density and in 2011 prices. For the current built urban population density, this increases to $350,000 per tonne of $PM_{2.5}$ in 2011 prices (rounded to 2 significant figures). In today's (2018) prices, based on the inflation calculator from the Reserve Bank of Australia[8] the damage cost is $400,000 per tonne of $PM_{2.5}$ (rounded to 2 significant figures). Following this approach, the damage costs / saving associated with changes in $PM_{2.5}$ are calculated to range from be minus $40,000 (saving) in 2036 cumulative scenario to minus $240,000 (saving) in 2026.

All project scenarios evaluated result in a damage saving (ie lowering of health costs from $PM_{2.5}$).

6.10 Cumulative impacts

Cumulative impacts related to the construction and operation of the project along with the Botany Rail Duplication and other major infrastructure projects has been considered in *Technical Working Paper 4 – Air Quality*.

In relation to the Botany Rail Duplication project, construction impacts would need to be managed and mitigated in a manner consistent with the measures identified for the Sydney Gateway road project. Where this occurs, health impacts would also be managed. No operational impacts were modelled or quantified for both projects, hence no quantitative assessment of health impacts can be undertaken. In relation to the operation of both projects, health impacts associated with the Botany Rail Duplication are significantly lower than for the Sydney Gateway road project and the cumulative impacts on health are not expected to be different to those predicted for Sydney Gateway road project alone.

Future developments in the area such as the F6 Extension and the WestConnex project (in particular the New M5 and the M4-M5 Link) have already been accounted for in the modelling of air quality impacts, and hence health impacts have been addressed in this assessment (refer to the cumulative scenario presented in this report). Similarly, there are also two other major developments existing in the area, namely Sydney Airport and Port Botany. These have been taken into account within the air quality assessment and are, therefore, addressed in this assessment.

6.11 Summary of impacts relevant to Commonwealth land

Assessment of dust impacts during construction considered receptors located within Commonwealth land. This identified high risk dust impacts at a number of receptors, where mitigation measures need to be implemented to mitigate these impacts and protect health.

The assessment of impacts relevant to changes in air quality on Commonwealth land involved consideration of 162 individual receptors located on Commonwealth land (included in the assessment

[8] http://www.rba.gov.au/calculator/annualDecimal.html

presented above), as shown on **Figure 6.6**. These comprise commercial/industrial receptors (92 per cent) with the remainder listed as other (7.4 per cent) and park/sport/recreational. Changes in $PM_{2.5}$ for 2036, as presented in **Figure 6.5,** include changes relevant to Commonwealth land, which shows that some of the maximum increases are within this area, as well as decreases along Airport Drive to the north of Terminal 1.

The assessment of health impacts associated with the change in air quality considered these receptors and the outcomes presented relevant to maximum impacts, also apply to Commonwealth land. On this basis, all health impacts from the changes in air quality within Commonwealth land are considered to be low and not measurable within the community.

Figure 6.7: Location of receptors within Commonwealth land boundaries

6.12 Uncertainties

Any assessment of potential human health risks or impacts needs to consider the uncertainties inherent in the information and data relied upon for undertaking such an assessment as well as the methodology and assumptions adopted in the quantification of risk or impact. **Annexure H** presents a detailed review of the uncertainties relevant to the assessment of health impacts from changes in air quality. Overall, the approach adopted is expected to overestimate exposures and risks (ie health impacts) within the community.

7 Impacts to human health: Changes in noise

7.1 Summary of key findings

The assessment of health impacts associated with changes in noise as a result of the project has been undertaken on the basis of a qualitative assessment, where the following has been determined:

- Construction
  - Where the proposed management measures are implemented, the potential for construction noise and vibration to adversely impact community health would be minimised.
  - It should be noted that even where mitigation measures are implemented, some noise impacts may occur where works occur close to sensitive receivers. These impacts are expected to be of short duration, where annoyance and potentially sleep disturbance may occur on occasions.
- Operations
  - Without mitigation, 247 buildings (231 residential buildings) which includes 360 individual floors of multi-storey buildings (278 residential floors) have been identified where road noise exceeds the health based criteria. These impacts are of significance in Noise Catchment Areas (NCA) NCA02 and NCA03. Increases in noise levels at some locations in these areas have the potential to result in unacceptable risks to human health in terms of cardiovascular health, noise annoyance and sleep-disturbance.
  - To ensure health impacts are effectively mitigated, mitigation measures would be required to be designed and implemented as outlined in *Technical Working Paper 2 – Noise and Vibration.* The mitigation of operational noise impacts should consider treatment at or near the noise sources prior to the implementation of at-property treatments as at-property treatments are less certain (in terms of acceptance and use) and their presence at a property has the potential to also affect the wellbeing of residents.

7.2 Health effects associated with environmental noise

7.2.1 General

Environmental noise has been identified (enHealth 2018; I-INCE 2011; WHO 2011, 2018) as a growing concern in urban areas because it has negative effects on quality of life and wellbeing and has the potential for causing harmful physiological health effects. With increasingly urbanised societies, impacts of noise on communities have the potential to increase over time.

Sound is a natural phenomenon that only becomes noise when it has some undesirable effect on people or animals. Unlike chemical pollution, noise energy does not accumulate either in the body or in the environment, but it can have both short-term and long-term adverse effects on people. These health effects include (WHO 1999, 2011, 2018):

- Sleep disturbance (sleep fragmentation that can affect psychomotor performance, memory consolidation, creativity, risk-taking behaviour and risk of accidents)
- Cardiovascular health
- Annoyance
- Hearing impairment and tinnitus
- Cognitive impairment (effects on reading and oral comprehension, short and long-term memory deficits, attention deficit).

Other effects for which evidence of health impacts exists, and are considered to be important, but for which the evidence is weaker, include:

- Effects on quality of life, wellbeing and mental health (usually in the form of exacerbation of existing issues for vulnerable populations rather than direct effects)
- Adverse birth outcomes (pre-term delivery, low birth weight and congenital abnormalities)
- Metabolic outcomes (type 2 diabetes and obesity).

Within a community the severity of the health effects of exposure to noise and the number of people who may be affected are schematically illustrated in **Figure 7.1**.

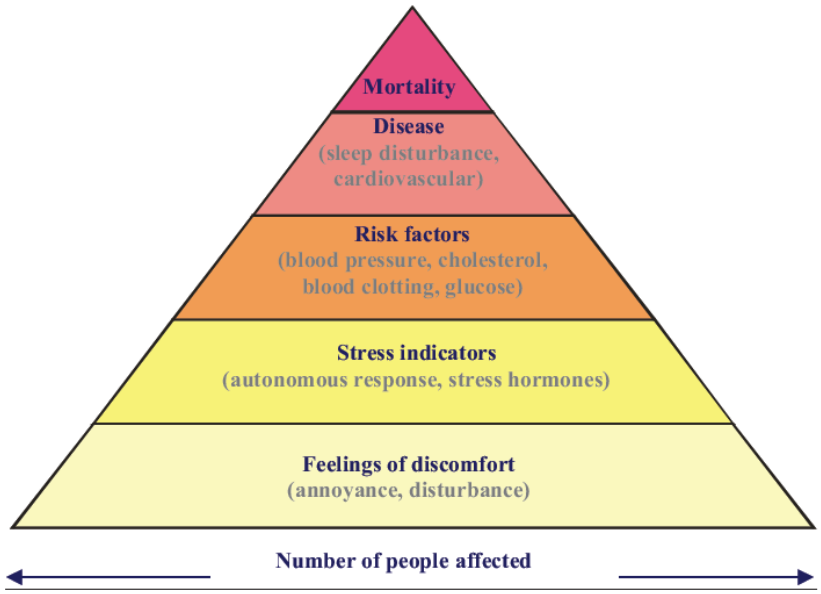


Figure 7.1: Schematic of severity of health effects of exposure to noise and the number of people affected (WHO 2011)

Often, annoyance is the major consideration because it reflects the community's dislike of noise and their concerns about the full range of potential negative effects, and it affects the greatest number of people in the population (I-INCE 2011; WHO 2011, 2018).

There are many possible reasons for noise annoyance in different situations. Noise can interfere with speech communication or other desired activities. Noise can contribute to sleep disturbance which has the potential to lead to other long-term health effects. Sometimes noise is just perceived as being inappropriate in a particular setting without there being any objectively measurable effect at all. In this respect, the context in which sound becomes noise can be more important than the sound level itself (I-INCE 2011; WHO 2011, 2018).

Different individuals have different sensitivities to types of noise and this reflects differences in expectations and attitudes more than it reflects any differences in underlying auditory physiology. A noise level that is perceived as reasonable by one person in one context (e.g. in their kitchen when preparing a meal) may be considered completely unacceptable by that same person in another context (e.g. in their bedroom when they are trying to sleep). In this case the annoyance relates, in part, to the intrusion from the noise. Similarly, a noise level considered to be completely unacceptable by one person, may be of little consequence to another even if they are in the same room. In this case, the annoyance depends almost entirely on the personal preferences, lifestyles and attitudes of the listeners concerned (I-INCE 2011; WHO 2011, 2018).

Perceptible vibration (e.g. from construction activities) also has the potential to cause annoyance or sleep disturbance and so adverse health outcomes in the same way as airborne noise. However, the health evidence available relates to occupational exposures or the use of vibration in medical

treatments. No data is available to evaluate health effects associated with community exposures to perceptible vibrations (I-INCE 2011; WHO 2011, 2018).

It is against this background that an assessment of potential noise impacts of the project on health was undertaken.

7.2.2 Health impacts from road traffic noise

Road traffic noise is caused by the combination of rolling noise (noise from tyres on the roadway) and propulsion noise (from engine, exhaust and transmission).

A number of large international studies are available that have specifically evaluated health impacts associated with exposure to road traffic noise. Where exposure to road traffic noise is associated with, or can be shown to be causal, adverse health effects an exposure-response relationship is often established. The main health effects that have been studied in these types of investigations in relation to road traffic noise are annoyance, sleep disturbance, cardiovascular disease, stroke and memory/concentration (cognitive) effects. The most recent review of noise and impacts on health, presented by the WHO (WHO 2018) included a detailed review of the available literature, including impacts specifically related to road noise.

7.2.2.1 Cardiovascular effects

Cardiovascular diseases are the class of diseases that involve the heart or blood vessels, both arteries and veins. These diseases can be separated by end target organ and health outcomes. Strokes reflecting cerebrovascular events and ischaemic heart disease (IHD) or Coronary Heart disease (CHD) are the most common representation of cardiovascular disease.

High-quality epidemiological evidence on cardiovascular and metabolic effects of environmental noise indicates that exposure to road traffic noise increases the risk of IHD (enHealth 2018; WHO 2018).

A link between noise and hypertension is relatively well established in the relevant literature. Whilst there is not a consensus on the precise causal link between the two, there are a number of credible hypotheses. A leading hypothesis is that exposure to noise could lead to triggering of the nervous system (autonomic) and endocrine system which may lead to increases in blood pressure, changes in heart rate, and the release of stress hormones. Depending on the level of exposure to excess noise, the duration of the exposure and certain attributes of the person exposed, this can cause an imbalance in the person's normal state (including blood pressure and heart rate), which may make a person hypertensive (consistently increased blood pressure) which can then lead to other cardiovascular diseases (DEFRA 2014). This hypothesis is illustrated in **Figure 7.2**.

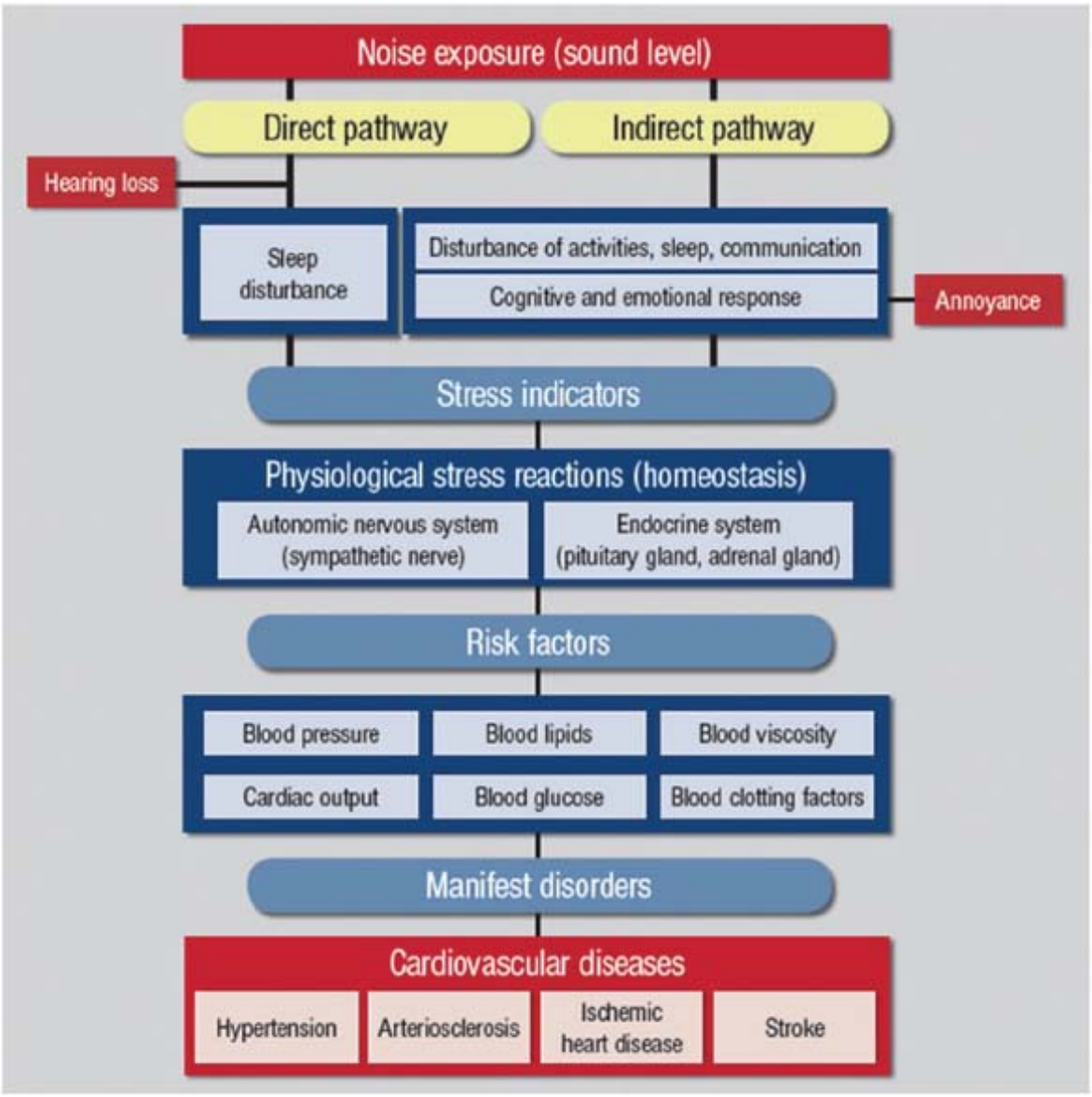


Figure 7.2: Noise reaction model/hypothesis (Babisch 2014)

The available studies regarding road traffic noise and cardiovascular disease risk largely involve meta-analysis (ie statistical analysis that combines the results of multiple scientific studies). A number of studies have been published by Babisch (Babisch 2002, 2006, 2008, 2014; van Kempen & Babisch 2012) and others (WHO 2018) have provided the basis for a number of exposure-response relationships adopted for the assessment of cardiovascular health effects associated with road-traffic noise.

In relation to hypertension the most relevant recent study (van Kempen & Babisch 2012) involved analysis of 27 studies between 1970 and 2010, where a relationship between road traffic noise and hypertension was determined. This relates to the incidence of hypertension in the population and has been adopted by the European Commission for the assessment of health impacts of road noise in Europe (EEA 2014). Review by the WHO (2018) considered that the available studies on the incidence of hypertension and road noise provided evidence that was rated very low quality. The relationship recommended by the WHO relates to a non-statistically significant outcome in relation to hypertension.

For the assessment of IHD, the WHO (WHO 2018) has undertaken a meta-analysis of three cohort studies and four case-control studies that investigated a relationship between road noise and the

incidence of IHD. The meta-analysis involved 67 224 participants (from 7033 cases). The relationship established was considered to be based on high quality evidence.

Review of the incidence of stroke and road noise by the WHO (2018) determined that the available cohort studies and cross-sectional studies showed mixed outcomes, with the evidence rated very low to moderate quality. In relation to the risk of stroke from exposure to noise, there are limited meta-analysis type studies available and the studies available combine the risks from noise from road and air transport. A more specific study that just investigated the link between road traffic noise and cardiovascular disease/mortality has been undertaken in London (Halonen et al. 2015). This was a large epidemiological study that identified statistically significant associations between road traffic noise (as modelled to residential dwellings) and hospital admissions for stroke and all-cause mortality. The relationships identified related to exposure to day and evening noise as $L_{Aeq,16h}$. The study corrected for confounders such as $PM_{2.5}$ and NO_2 exposures and has been considered suitable for use in an assessment of noise impacts. The relative risk identified for hospital admissions for stroke is equivalent to that identified from a meta-analysis of air and road noise (Houthuijs et al. 2014).

The relationships determined in the above studies relate to noise exposures in excess of a threshold. The threshold for where these effects are of significance are generally equal to or above the noise criteria adopted for the assessment of operational noise impacts. It is noted, however that in areas already affected by noise at levels above these thresholds, the guidelines relate to an increase in noise attributed to the project, with a guideline of 2 dB(A) adopted. An increase in noise by 2 dB would not be associated with unacceptable cardiovascular risks (where the above exposure-response relationships were considered). In areas where noise levels (as L_{den}) are 55 dB(A) and higher, an increase of 5 dB(A) would result in an increase in mortality risks (all causes, all ages) that would be considered unacceptable (ie greater than $1x10^{-4}$).

7.2.2.2 Annoyance and sleep disturbance

Changes in annoyance and sleep disturbance associated with noise are considered to be pathways for the key health indicators listed above. However, these issues are of importance to the local community and so it is relevant to evaluate the changes in levels of annoyance and sleep disturbance as a result of noise from the operation of the project within the community.

Annoyance

Annoyance is a feeling of displeasure associated with any agent or condition known or believed by an individual or group to adversely affect them. Annoyance following exposure to prolonged high levels of environmental noise may also result in a variety of other negative emotions, for example feelings of anger, depression, helplessness, anxiety and exhaustion (EEA 2014).

Annoyance levels can be reliably measured by means of an ISO 15666 defined questionnaire, which has enabled the identification of relationships between annoyance and noise sources. The European Commission (EC 2002) conducted a review of the available data and provided recommendations on relationships that define the percentage of persons annoyed (%A) and the percentage of persons highly annoyed (%HA) to total levels of noise reported as L_{DEN} (ie average noise levels during the day, evening and night). These relationships were established for exposure to aircraft noise, road traffic noise and rail traffic noise, and have been adopted by the UK and European Environment Agency (DEFRA 2014; EEA 2010, 2014). These relationships have also been reviewed by the WHO (WHO 2018), where the key outcome of %HA relevant to road noise (Guski, Schreckenberg & Schuemer 2017) was considered most appropriate for determining actions and outcomes.

The available noise guidelines have been developed to address noise annoyance within the community. Hence the increase in noise permitted as a result of the project is small. In many cases the change in noise exposure is reduced as a result of the project. However where noise level changes of 2 dB occur, this has the potential to result in an increase in individuals highly annoyed by noise by 2 per cent, which is well below the level of annoyance of 5 per cent considered to be of concern (or likely to be perceived) by residents (Schomer 2005). For noise levels between 45 and 75 dB(A) (as L_{den}), an increase in noise by 4.5 dB(A) results in the increase in individuals that are highly annoyed by noise to exceed the criteria of 5 per cent and may be considered unacceptable.

Sleep disturbance

It is relatively well-established that night time noise exposure can have an impact on sleep (enHealth 2018; WHO 2009, 2011, 2018). Noise can cause difficulty in falling asleep, awakening and alterations to the depth of sleep, especially a reduction in the proportion of healthy rapid eye movement sleep. Other primary physiological effects induced by noise during sleep can include increased blood pressure, increased heart rate, vasoconstriction, changes in respiration and increased body movements (WHO 2011). Exposure to night-time noise also may induce secondary effects, or so-called after-effects. These are effects that can be measured the day following exposure, while the individual is awake, and include increased fatigue, depression and reduced performance.

Studies are available that have evaluated awakening by noise, increased mortality (ie increase in body movements during sleep), self-reported chronic sleep disturbances and medication use (EC 2004). The most easily measurable outcome indicator is self-reported sleep disturbance, where there are a number of epidemiological studies available. From these studies the WHO (WHO 2009, 2011, 2018) identified an exposure response relationship that relates to the percentage of persons sleep disturbed (%SD) and highly sleep disturbed (%HSD) to total levels of noise reported as L_{night} (ie average noise levels during night, which is an 8-hour time period, as measured outdoors). The relationship adopted relates to the assessment of road-traffic noise, with other relationships for air and rail traffic noise. These relationships have been adopted by the WHO (2009, 2011), UK and European Environment Agency (DEFRA 2014; EEA 2010, 2014). Review by the WHO (WHO 2018), considered that the key outcome of %HSD was considered most appropriate for determining actions and outcomes in relation to road noise. For night time noise levels between 45 and 65 dB(A), increases in noise levels at night time of 5, 10, 15 and 20 dB(A) may result in an approximate 3, 7, 12 and 18 per cent increase respectively in individuals who are highly sleep disturbed.

The available noise guidelines include criteria to address sleep disturbance that are based on the above studies and relationships. Hence compliance with these guidelines would address health impacts associated with sleep disturbance in the community.

7.2.2.3 Cognitive effects

There is evidence for effects of noise on cognitive performance in children such as lower reading performance (WHO 2011). A major study was undertaken in the EU – RANCH – and this study was reviewed in WHO (2011). The study found an exposure response relationship between noise and cognitive performance in children for aircraft noise but the relationship between performance and noise for road traffic was much less clear (Stansfeld et al. 2005a; Stansfeld et al. 2005b; WHO 2011, 2018). WHO (2011) used the aircraft noise relationships to assess the impact of noise on children's cognitive performance. For this project, it was not considered appropriate to use the relationships based on the impacts of aircraft noise. The same study showed that road traffic alone did not show an association between road traffic noise and adverse changes in children's cognitive functions studied (reading comprehension, episodic memory, working memory, prospective memory or sustained attention), nor with sustained attention, self-reported health, or mental health.

7.2.2.4 Individual road noise events

It is noted that noise impacts can also occur because of individual noise events, such as engine braking or loud exhausts. The noise measures adopted above for the assessment of the health effects of noise relate to an average/equivalent sound level over different time periods, which, when measured, would include individual noise events. This is the preferred approach for evaluating annoyance and other health effects related to noise (NSW DECCW 2011). Individual noise events are of most significance in relation to the assessment of sleep disturbance. The available research indicates that one or two individual noise events per night, with a maximum indoor noise level of $65^{-7}0$ dB(A) are not likely to affect health and wellbeing (NSW DECCW 2011). Criteria have been adopted to address maximum noise events, however it is noted that it is not possible to model all individual noise events as these relate to individual vehicles or trucks and individual driving behaviour that cannot be predicted.

7.3 Existing noise environment

The project is located in the suburbs of Tempe, St Peters and Mascot and is close to a number of major existing road and rail transportation corridors, including Sydney Kingsford Smith Airport. The suburbs of Tempe and Mascot have relatively large areas of suburban residential receivers, however they are mostly located at relatively far distances from the project. The nearest residential receivers are around 100 metres away from the project, to the north of the former Tempe Landfill. Various receivers types, including several hotels, are also close to the project near the intersection of Joyce Drive and O'Riordan Street. Commercial areas are located in the areas around Sydney Airport, with a number of hotels located on Sydney Airport Land.

To undertake the noise assessment required for the project, the existing background noise quality needed to be assessed as the guidelines that relate to noise impacts from a specific project are based on levels allowable above background.

The *Technical Working Paper 2 – Noise and Vibration* has identified a number of noise catchment areas (NCAs) located to the west and east of the project (NCA01 to NCA08) as shown **Figures 7.3 and 7.4**. These NCAs include a range of land uses as well as a number of other non-residential sensitive receivers (child care, school, hotels, medical, library, outdoor recreational areas and places of worship).

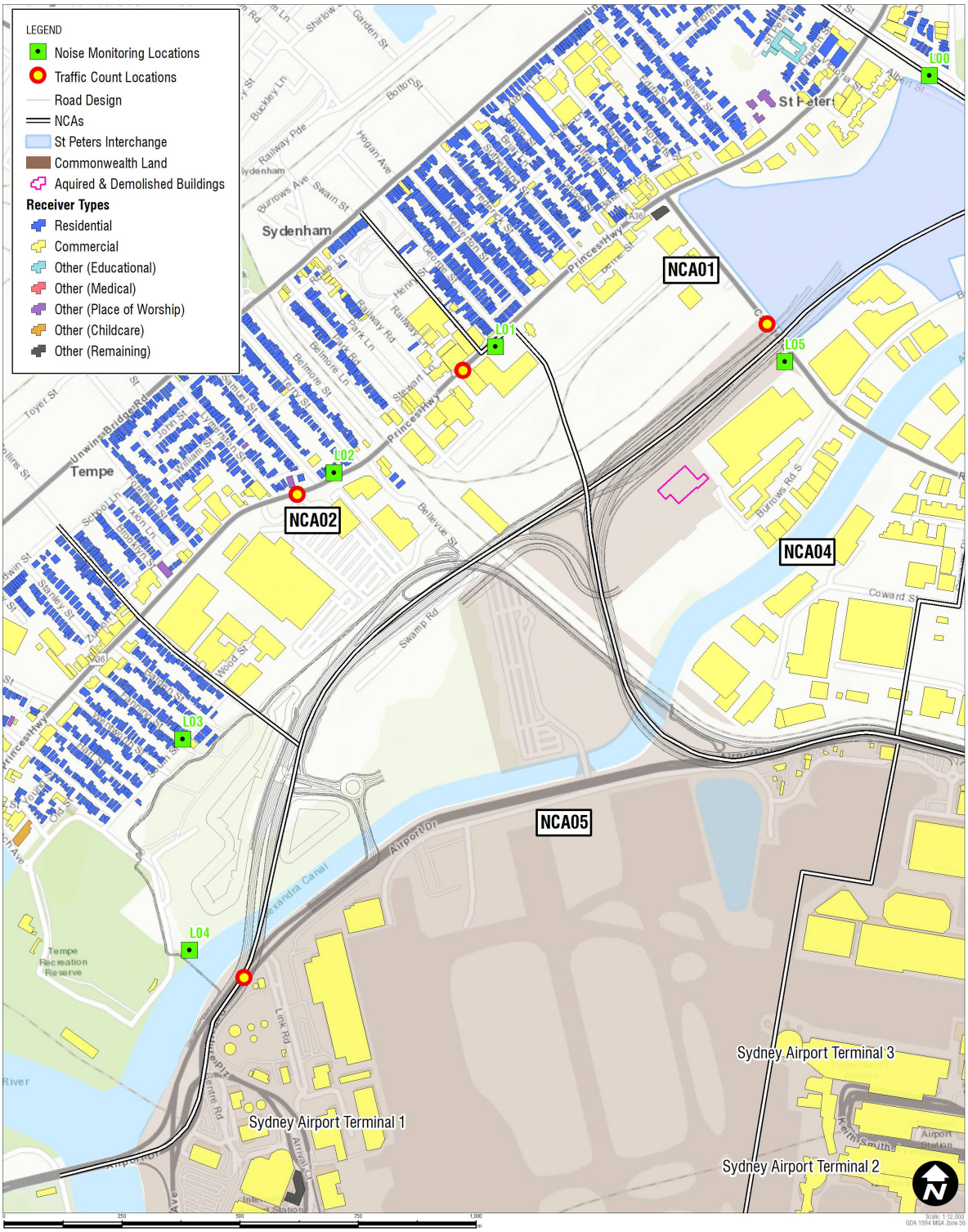


Figure 7.3: Noise catchment areas (including location of receivers) – West

Figure 7.4: Noise catchment areas (including location of receivers) – East

To determine existing or background noise levels in the project area, ambient noise surveys (including attended noise measurements) were conducted in September and October 2018. Monitoring was undertaken by a noise logger. A noise logger measures the noise level over the sample period and then determines L_{A1}, L_{A10}, L_{A90}, L_{Amax} and L_{Aeq} levels of the noise environment. The A-weighting is a frequency filter applied to represent how the human ear hears sound. The L_{A1}, L_{A10} and L_{A90} levels are the levels exceeded for 1 per cent, 10 per cent and 90 per cent of the sample period respectively. The L_{Amax} level is the maximum noise levels due to individual noise events. The L_{A90} level is taken as the background noise level also known as the rated background level. The L_{Aeq} level is the energy averaged noise level over a defined period and is known as Ambient Noise Level.

Rated background levels in the project area ranged from 54 to 65 dBA during the day (7 am to 6 pm), 45 to 62 dBA during the evening (6pm to 10 pm) and 38 to 53 dBA during the night (10 pm to 7 am).

7.4 Noise assessment criteria

7.4.1 General

Criteria adopted for the assessment of noise and vibration impacts of the project considered guidance specifically relevant to the Commonwealth-owned land as well as areas outside of these areas, where NSW guidelines are available.

Noise issues in NSW are managed by the NSW EPA. The NSW EPA has prepared a number of guidance documents with regard to the types of noise that are considered in relation to construction and operation of the project. The *NSW Noise Policy for Industry (NPfI)* (NSW EPA 2017), the *NSW Road Noise Policy* (NSW DECCW 2011), and the Interim Noise Construction Guideline (ICNG) (NSW DECC 2009) are all relevant to the assessment of noise generated by this project.

In the absence of more specific criteria the NPfI is considered appropriate for the assessment of ground-borne noise impacts on Commonwealth-land, specifically ground based aviation activities.

In all these policies, there is discussion of the need to balance the economic and social benefits of activities that may generate noise with the protection of the community from the adverse effects of noise. The noise assessment criteria adopted relate to levels of noise that can be tolerated or permitted above background before some adverse effect (annoyance, discomfort, sleep disturbance or complaints) occurs.

The Roads and Maritime *Construction Noise and Vibration Guideline,* August 2016 (CNVG) outlines Roads and Maritime's approach to assessing and mitigating construction noise. The Roads and Maritime *Noise Mitigation Guide* applies to the assessment and management of noise during operations. These guidelines are considered in addition to the other relevant policy and guidelines from the NSW EPA.

For the assessment of noise impacts from the project a range of guidelines and criteria have been adopted for the assessment of:

- Construction – including ground-borne noise, vibration and blasting
- Operations – relevant to road noise and fixed facilities.

The following sections provide an overview of the guidelines adopted for each of these aspects. In particular, the basis for the guidelines and relevance to the protection of health and wellbeing is noted.

7.4.2 Construction noise criteria

People are usually more tolerant to noise and vibration during the construction phase of projects than during normal operation. This response results from recognition that the construction emissions are of a temporary nature – especially if the most noise-intensive construction impacts occur during the less sensitive daytime period. For these reasons, acceptable noise and vibration levels are normally higher during construction than during operations.

Construction often requires the use of heavy machinery which can generate high noise and vibration levels at nearby buildings and receptors. For some equipment, there is limited opportunity to mitigate the noise and vibration levels in a cost-effective manner and hence the potential impacts should be minimised by using feasible and reasonable management techniques.

At any particular location, the potential impacts can vary greatly depending on factors such as the relative proximity of community receptors, the overall duration of the construction works, the intensity of the noise and vibration levels, the time at which the construction works are undertaken, and the character of the noise or vibration emissions.

The *Technical Working Paper 2 – Noise and Vibration* has considered construction noise impacts associated with construction activities for the project. There are some areas within the community were construction impacts from a number of road projects are proposed, with these works occurring over a longer period of time, potentially up to eight years. It is noted that the project areas where the community may be affected by these consecutive construction activities is small, and the noise impacts relevant to these areas from the project are low. Further discussion on issues related to these longer duration impacts (ie construction fatigue) are further addressed in the **section 0**.

The ICNG has been adopted for the assessment of noise during construction works (NSW DECC 2009). These guidelines require that noise impacts from the project be predicted at community receptors. These noise levels are then compared with the project specific criteria, referred to as noise management levels (NMLs), which are based on an increase above background levels. Where an exceedance occurs, the guidelines require that the proponent must apply all feasible and reasonable work practices to minimise impacts. The management levels are based on levels of noise above background that may result in reactions (or complaints) by the community. The levels are based on some reaction (noise affected) and a strong reaction (highly noise affected).

The Airports (Environment Protection) Regulations 1997 include a 75 dBA criteria for construction noise as L_{A10}. While this applies to commonwealth-land, the more conservative NSW guidelines have been applied to all areas for consistency across all areas.

Levels of noise allowable outside standard work hours, particularly at night, are lower than those permitted during normal work hours. Where construction works are planned to extend over more than two consecutive nights a sleep disturbance assessment is required to be undertaken. The noise assessment has adopted a guideline of existing background plus 15 dB for night-time works resulting in noise criteria in the range 53 to 68 dBA as $LA_{eq,15\text{-}minute}$. Based on the available information on the levels of noise that result in sleep disturbance the following should be noted:

- A maximum internal noise level below 50–55 dB(A) is considered unlikely to cause awakening
- External noise levels of 60–65 dB(A) are unlikely to result in awakening reactions, where it is assumed that an open window provides up to 10 dB(A) attenuation of noise from outdoors to indoors.

The night-time noise criteria adopted for this assessment generally sits in the range noted above, however there are some NCAs (NVA01, NCA05 [commercial area only] and NCA07 [Sydney Airport]) where the adopted criteria sit just above this range.

The assessment of noise impacts during construction has been undertaken based on 9 noise catchment areas (assumed to have background noise levels consistent with the background noise monitoring location within each catchment area).

The ICNG does not provide direct reference to an appropriate criterion to assess the noise arising from construction traffic on public roads. However, it does refer to the Road Noise Policy which presents a discussion on assessing feasible and reasonable mitigation measures. In assessing feasible and reasonable mitigation measures, an increase of up to 2 dB(A) represents a minor impact that is considered barely perceptible to the average person. Therefore, the noise goal applied to traffic movements on public roads generated during the construction phase of the project is an increase in existing road traffic noise levels of no more than 2 dB(A).

7.4.3 Ground-borne noise criteria

The ICNG provides residential noise management levels for ground-borne noise (ie vibration transmitted through the ground into buildings which results in an audible noise indoors), which are applicable when ground-borne noise levels are higher than the corresponding airborne construction noise levels. The ICNG provides ground-borne noise levels at residences for evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home. The following ground-borne noise levels are applicable for residences:

- Evening 40 dB(A) LAeq (15 minute)
- Night-time 35 dB(A) LAeq (15 minute).

7.4.4 Vibration criteria

The effects of vibration on buildings can be divided into three main categories:

- Human comfort: Those in which the occupants or users of the building are inconvenienced or possibly disturbed. These guidelines are of most relevance to the assessment of community health. Intermittent vibration has been evaluated on the basis of the NSW EPA guideline Assessing Vibration: A Technical Guideline (NSW DEC 2006), which is based on vibration dose values. The criteria for vibration dose values are based on the potential for annoyance (based on the level of vibration over the assessment period). Guidelines for continuous and impulsive vibration are dependent on the time of day they occur and the activity taking place that could be affected.
- Building contents: Those where the building contents may be affected. As people perceive floor vibration well before levels are likely to cause damage to building contents and structures, for most areas controlling vibration to manage human comfort would also address damage to building contents. No separate criteria are adopted to evaluate this aspect.
- Structural damage: Those in which the integrity of the building or the structure itself may be prejudiced (structural damage). Most commonly specified ‘safe’ structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have potential to cause damage to the main structure. The assessment of potential structural damage has been undertaken in accordance with Australian Standard AS2187, British Standard BS 7385 and German Standard DIN 4150:Part 3-1999 (DIN 1999). These guidelines include criteria relevant to addressing blasting activities.

7.4.5 Operational noise criteria

Operational noise impacts have been evaluated on the basis of the Road Noise Policy, with additional guidance and criteria provided within Roads and Maritime’s *Noise Criteria Guideline* (NCG) and *Noise Mitigation Guideline* (NSW DECCW 2011; NSW Roads and Maritime 2015). The principles underlying the guidance documents are:

- Criteria are based on the road development type a residence is affected by due to the road project
- Adjacent and nearby residences should not have significantly different criteria for the same road
- Criteria for the surrounding road network are assessed where a road project generates an increase in traffic noise greater than 2 dB(A) on the surrounding road network
- Existing quiet areas are to be protected from excessive changes in amenity due to traffic noise.

The project consists of both new and redeveloped roads or road sections according to the definitions in the guidance documents and so both road types need to be considered in developing project-specific limits.

For residential areas, criteria are established for properties near either freeway/arterial/sub-arterial roads or local roads. These criteria relate to noise levels during the daytime (7 am to 10 pm) and night-time (10 pm to 7 am). Night-time noise criteria are aimed at minimising sleep disturbance. Criteria are also available to assessed noise exposures in other types of buildings, including schools, places of worship, open space, childcare, aged care and hospital facilities.

Operational traffic noise from the surrounding road network also required some consideration, with criteria (eg noise criteria is exceeded and an increase by more than 2 dB(A) is predicted) established to determine if such impacts need to be further considered for mitigation measures.

The Airports (Environment Protection) Regulations 1997 include a 60 dBA $L_{Aeq(24hour)}$ and 55 dBA $L_{Aeq(8hour)}$ operational road noise guideline. While this applies to commonwealth-land, the more conservative NSW guidelines have been applied to all areas for consistency across all areas.

For ground based aviation noise impacts from Commonwealth land, project-specific noise triggers that are the lowest values from the NPfI (NSW EPA 2017) based on intrusiveness and amenity noise impacts has been adopted for the assessment of NCA03, NCA06 and NCA08.

Guidelines are also available to evaluate maximum noise levels from roadways, such as those from individual vehicles or trucks that have the potential to disturb sleep. While no specific criterion is set to address this specific issue, a number of guidance points may be used to qualify if the maximum noise level is likely to be an issue. These include calculation of maximum noise levels, the extent to which the maximum noise levels for individual vehicle pass-bys exceed the L_{Aeq} noise level for each hour of the night, and the number of times the maximum noise levels for individual vehicle pass-bys exceed the L_{Aeq} noise level for each hour of the night.

The assessment of maximum noise levels at night-time, has considered the following triggers:

- A maximum noise level of the event is greater than 65 dBA as L_{AFmax}
- The L_{AFmax} – $LA_{eq,1hour}$ is greater than or equal to 15 dB.

Exceedance of these triggers requires further evaluation. The further analysis should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period.

7.5 Overview of noise and vibration assessment and evaluation of health impacts

7.5.1 Construction impacts

7.5.1.1 Noise

Applicable legislation and guidelines have been used to inform the construction noise modelling and assessment presented in *Technical Working Paper 2 – Noise and Vibration*. Noise mitigation has been recommended in accordance with these guidelines. These guidelines have been developed taking into consideration current international practices, health impacts of noise and to protect vulnerable people.

Noise that may be generated during construction has been modelled based on the type of equipment to be used, where the equipment is to be used in relation to the community receptors, the hours of work, the duration of the activities undertaken and the local terrain. Modelling was undertaken at a number of construction sites within the project area.

The majority of construction is proposed to be undertaken during standard construction hours, however some night-time work would be required at times to minimise disruption to road, rail and air traffic and for safety reasons. Works that may occur outside of standard hours have been considered in the noise modelling.

The assessment has considered a range of standard noise mitigation measures, ie those that would be a standard requirement for a range of construction activities. In some situations, impacts from

construction noise and vibration may be unavoidable, particularly where works are undertaken in close proximity to the community. Where this occurs the Roads and Maritime *Construction Noise and Vibration Guideline* includes a range of additional mitigation measures to manage these impacts.

Overall, a likely worst case assessment has been used in accordance with the ICNG, assuming no additional mitigation measures are implemented. For each area assessed, the noise levels at the most affected receptor have been used to represent the whole noise catchment area.

The noise modelling identified noise impacts in excess of the criteria for standard and out of hours construction period (refer to *Technical Working Paper 2 – Noise and Vibration* for further detail).

Overall, given the distant location of the nearest residential or other sensitive receivers to the project in some areas, there are a number of locations where there are no exceedances of the relevant criteria. Construction noise impacts are generally limited to NCA03, NCA06 and NCA08. Impacts identified related to the use of noise intensive equipment such as rock breakers or concrete saws, which are only used for relatively short periods of time.

The highest impacted residential receivers are in NCA03 (to the north of the former Tempe landfill on South Street and Smith Street) where the nearest receivers are around 100 metres from the works at the former Tempe Tip site, and also in NCA08 (on Baxter Road) due to the proximity of receivers to the works near the intersection of Qantas Drive and Sir Reginald Ansett Drive. Only one residential receiver (in NCA08, Baxter Road) was identified as Highly Noise Affected during enabling works.

Sleep disturbance criteria is likely to be exceeded when night works occur near residential receivers. Where these works occur site-specific Construction Noise and Vibration Impact Statements would be developed before works commenced, which identify the relevant mitigation measures from *Construction Noise and Vibration Guideline* to implement during the work.

Exceedances of noise management limits for other non-residential receivers for both daytime and night-time periods (relevant to hotels only) were identified particularly during the use of noise intensive equipment.

Where construction works related to the Sydney Gateway road project are considered in conjunction with the Botany Rail Duplication project, some additional, cumulative impacts may occur at times, depending on the locations of works during each phase of construction. Where other construction works in the area are also considered, depending on the timing and location of various works, cumulative noise impacts may occur.

These cumulative noise impacts should be reviewed during the detailed design stage, once detailed construction schedules are available.

7.5.1.2 Ground-borne noise

Ground-borne noise occurs when works are being undertaken under the ground surface or in some other fashion that results in the vibrations from noise moving through the ground rather than the air. When vibrations reach a building they enter the foundations, which are subject to a coupling loss and are then transmitted into the walls and ceiling. The excitation of the walls and ceiling results in the generation of low-frequency noise which could be audible if the vibration levels are high enough. The noise is typically considered to be a low ‘rumble’.

The majority of receivers are sufficiently distant from the works for ground-borne noise impacts to be minimal. Where residential receivers are located near to construction works, airborne noise levels would typically be dominant over the ground-borne component, however, several hotels are located close to the project and due to their existing high facade and glazing performance, would potentially be affected by ground-borne noise when vibration intensive equipment is in use nearby.

The extent of the impacts would be dependent on the requirement for vibration generating works in areas near to hotels, the location of sensitive uses inside the building relative to the works, the geology of the ground between the source and building and the existing facade performance in the potentially affected locations.

7.5.1.3 Vibration

A range of the equipment to be used in construction have the potential to cause unacceptable levels of vibration. Managing the potential for such vibration to actually cause discomfort or structural damage at community receptor locations is based on ensuring suitable separation distances between the equipment and the receptor locations.

The assessment identified that there are some receivers within the minimum working distance criteria for human comfort. Occupants of these buildings may be able to perceive vibration impacts at times when vibration intensive equipment is in used. These impacts are likely to only occur for relatively short durations.

The assessment did not identify any community receptors that would exceed the vibration criteria structural damage. Some commercial buildings are within the minimum working distance and require management.

7.5.1.4 Mitigation

A range of noise and vibration impacts have been identified during construction. These impacts would be managed as detailed in the *Technical Working Paper 2 – Noise and Vibration*.

7.5.1.5 Health impacts

Where the proposed management measures are implemented, the potential for construction noise and vibration to adversely impact community health is minimised. It should be noted that even where mitigation measures are implemented, some noise impacts may occur where works occur close to sensitive receivers. These impacts are expected to be of short duration, where annoyance and potentially sleep disturbance may occur on occasions.

7.5.2 Operational impacts

7.5.2.1 General

Assessment of operational noise impacts presented in *Technical Working Paper 2 – Noise and Vibration* has been undertaken by modelling noise associated with the project.

The noise modelling took into consideration both the location of the project (including topography, meteorology and buildings), physical design changes and additional traffic generated by the project. The assessment considered impacts in the years 2026 and 2036, with the assessment evaluating scenarios related to no project (ie Without project), with the project (ie With project) and a cumulative scenario that includes the project and other projects that interface or overlap (ie Motorway projects that include New M5, M4-M5 Link, F6 Extension Stage 1, and Western Harbour Tunnel and Beaches Link).

The assessment of road traffic noise has been completed in accordance with the relevant guidelines (as discussed in **section 7.4**). An assessment was undertaken to determine how well the model estimated noise impacts based on a current scenario (2018). The modelled and measured results were found to be within acceptable tolerances, which are +/- 2 dB(A).

7.5.2.2 Noise

The area evaluated is subject to existing high levels of operational road noise. The project, however would introduce new road noise sources, with some areas identified as having potentially substantial increases in noise levels. The assessment undertaken considered noise impacts without mitigation, where the following impacts were identified (refer to **Figure 7.5** for changes in noise predicted in 2036 night-time):

- NCA01 and NCA02, to the north of Princes Highway, noise increases of up to 5 dB during the daytime are predicted. Night-time noise was predicted to increase by up to 5.4 dB.

- NCA03, receivers in Tempe to the north of the former Tempe landfill are predicted to have noise increases during the daytime and night-time of up to 13 dB. The greatest increases relate to residents on Smith Street and South Street where existing noise levels are relatively low, however the project involves a new road alignment closer to these properties.
- NCA06 and NCA07, receivers near Joyce Drive and O'Riordan Street intersection are predicted to have daytime and night-time noise increases of up to 4 dB. This includes residential receivers and hotels located to the west of O'Riordan Street and hotels to the south of the intersection. This is due to the combined effect of increased traffic on Qantas Drive and the new viaduct to Sydney Airport Terminals 2/3.
- NCA08, Baxter Road in Mascot is predicted to have noise increases of up to 3 dB during the daytime and up to 3.5 dB during the night-time. This is mainly as a result of traffic increases on Joyce Drive.

These changes in noise (night-time in 2036) are shown in **Figure 7.5**.

The assessment identified 247 buildings (231 residential buildings) which includes 360 individual floors of multi-storey buildings (278 residential floors) where there are exceedances of the adopted operational road noise traffic criteria and where consideration of additional noise mitigation has been identified.

In relation to maximum noise levels at night-time, the existing environment is characterised by a significant number of maximum noise events. With the project maximum noise levels are predicted to change by up to 3 dB in NCA01, 9 dB in NCA02, 17 dB in NCA03 and 5 dB in NCA06. In NCA03, the maximum increases are predicted on South Street in Tempe due to the proximity of new roads in this area. These impacts occur at receivers already identified for consideration of additional noise mitigation. Mitigation measures to control road noise would also address maximum road noise events.

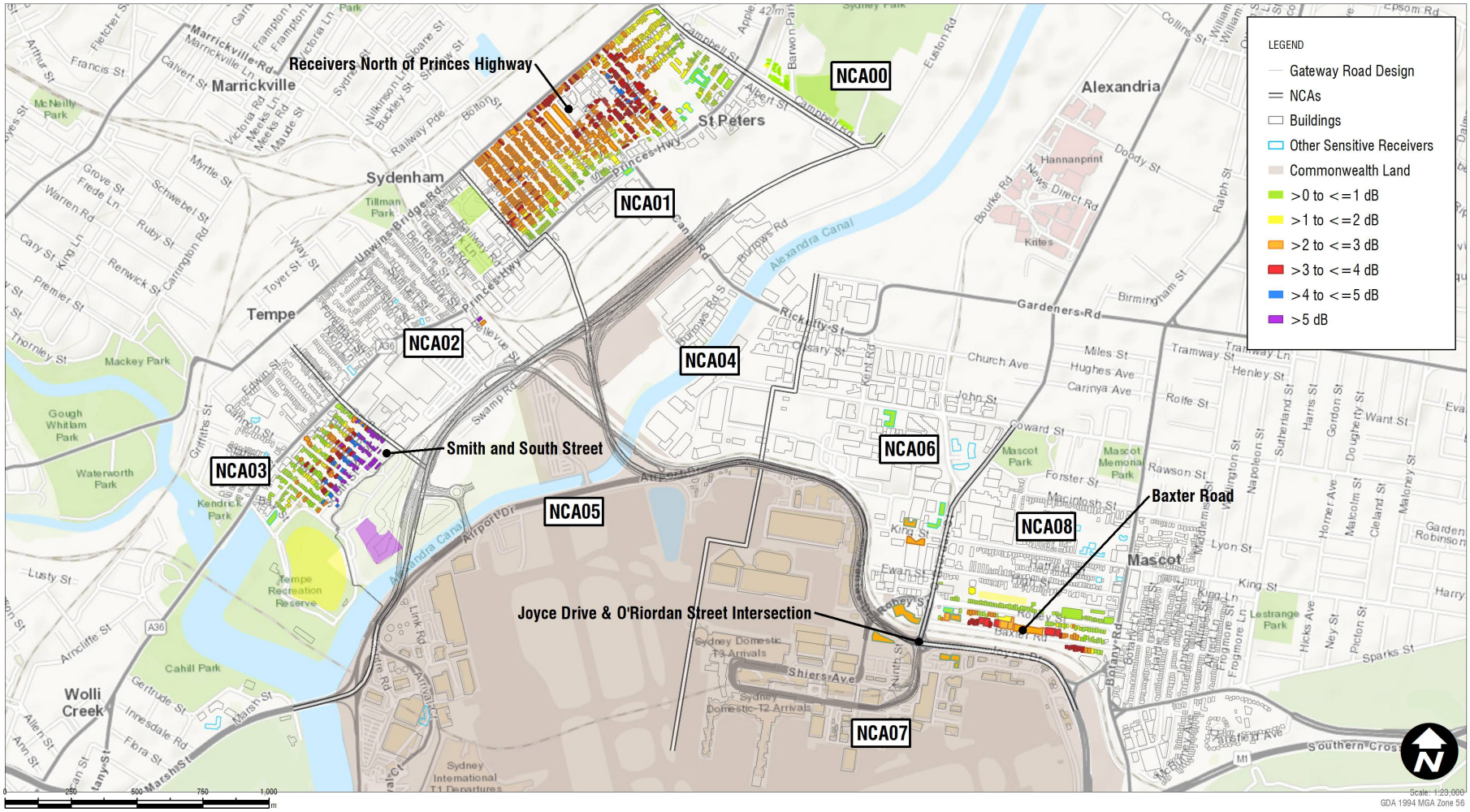


Figure 7.5: Predicted change in operational noise without mitigation (night-time 2036)

7.5.2.3 Ground-based Airport Noise

Increases in noise derived from the operation of Sydney Airport have been predicted to increase at the following locations:

- In NCA03 – receivers in Tempe to the north of the former Tempe landfill, where for the assessed scenarios, noise levels are predicted to increase by between 1 and 3 dB at residential receivers due to the removal of shipping containers at Tyne Container Services.
- In NCA06 and NCA08 – receivers near to O'Riordan Street, in Mascot, where the removal of several airport buildings adjacent to Qantas Drive is predicted to increase noise levels for receivers to the east by up to 16 dB for the assessed scenarios. The majority of this area is commercial, however a number of sensitive receivers (hotels and one residential apartment block) would also potentially be affected.

7.5.2.4 Mitigation

Noise mitigation measures considered for the project include:

- Quieter road pavement surfaces – quieter noise pavement such as dense graded asphalt has been considered in the noise modelling undertaken. Low noise pavement, such as open grade asphalt, was considered, but would not provide much noise benefit due likely vehicle speeds and traffic conditions relevant to the project
- Noise barriers – the installation of noise barriers has been considered in the assessment at the following locations:
  - NCA01 between the Princes Highway and Sydney Gateway road project. This only results in less than 2 dB noise benefit and does not meet the minimum requirement of 5 dB for barriers less than 5 metres in height. Given the minimal noise benefit construction of this noise barrier is considered unlikely
  - NCA02 near Smith Street and South Street where a barrier of 5 metres is recommended, providing 5 dB noise benefit
  - NCA03 near Baxter road where a barrier of 4.5 metres is recommended for further consideration.
- At property treatment – this includes architectural treatments such as thicker glazing and doors and upgraded façade constructions to achieve appropriate internal noise levels.

The final operational noise mitigation strategy would be determined as the project progresses and would likely use a combination of the approaches outlined above.

7.5.2.5 Health impacts

Without mitigation there are a number of residential, and other, properties where noise levels exceed the adopted operational noise criteria, that are designed to be protective of health. Review of the noise modelling undertaken indicates the following (also refer to the discussion in **section 7.2**):

- In all areas evaluated the predicted noise levels exceed thresholds where health effects have been identified (daytime and night-time).
- In areas NCA00, NCA01, NCA06 and NCA08, the predicted increase in noise levels during the day and night-time periods are below a level where health impacts related to cardiovascular effects, annoyance and sleep disturbance are considered to be unacceptable. Hence noise increases predicted in these areas are not considered to be associated with unacceptable health impacts.
- The maximum change in noise levels predicted in NCA02 is between 4.5 dB (2026 during the daytime) and 5.4 dB (2036 at night-time). These increases in noise levels (about 5 dB) are at the level identified as resulting in unacceptable risks to human health in terms of

cardiovascular health, noise annoyance and sleep-disturbance. Hence, where noise mitigation is not implemented there is the potential for unacceptable health impacts at some properties in this noise catchment area. The proposed mitigation measures outlined above indicate that installation of a noise barrier would provide a reduction in noise (potentially 5 dB) and therefore a reduction in the potential for adverse health effects.

- The maximum change in noise levels predicted in NCA03 is between 12.6 dB (2026 night-time) and 12.9 (2036 day-time). These increases in noise are significantly higher than levels identified as resulting in unacceptable risks to human health in terms of cardiovascular health, noise annoyance and sleep-disturbance. Hence, where noise mitigation is not implemented there is the potential for unacceptable health impacts at some properties in this noise catchment area. The proposed mitigation measures recommend the installation of a noise barrier. Where this is installed this may result in a 5 dB noise reduction. This noise reduction is not sufficient to reduce noise impacts to a level where health impacts would be considered acceptable. Hence additional noise mitigation would be required for a number of properties in this area, particularly the use of at-property treatments. The effectiveness of at-property treatments to reduce noise impacts in this area would need to be evaluated once all mitigation measures have been identified and designed.

It is noted that the use of at property treatments may have a number of downsides, and therefore treatment at or near the source should be the preferred option where possible. At property treatment downsides include:

- Potential loss of use of outdoor areas. In urban areas particularly where existing levels of noise are dominated by aircraft and/or road traffic noise, access to outdoor green space areas that are not (perceived to be) impacted by noise (eg where there is a quiet side of a specific property or there is access to a quiet green space areas close to the residential home) have been found to significantly improve wellbeing and lower levels of stress (Gidlöf-Gunnarsson & Öhrström 2007). Impacts on the use and enjoyment of outdoor areas due to increased noise may result in increased levels of stress at some individual properties.
- The requirement that residents take up at-property treatment measures and where they do, they keep external windows and doors shut. Where specific residents/properties do not take up recommended at-property treatments to mitigate noise indoors there is the potential for noise levels at these properties to exceed the relevant guidelines/criteria. In these situations, there is the potential for adverse health effects, particularly annoyance and sleep disturbance, to occur.

Community consultation would be an important part of the process in addressing noise impacts for the project as there are a number of individual homes where at-property treatment would be required to enable the noise criteria to be met and minimise the potential for adverse health effects associated with the project.

7.6 Cumulative impacts

7.6.1 Construction

Technical Working Paper 2 – Noise and Vibration has included a cumulative impact assessment of noise impacts that may occur where there are construction activities from the Sydney Gateway road project as well as the Botany Rail Duplication and other major developments and result in exposure to construction noise impacts for a longer period of time.

Cumulative impacts are most likely to occur as a result of the Sydney Gateway road project and Botany Rail Duplication, as well as the Airport North precinct road upgrade near to the Joyce Drive and O'Riordan Street intersection and Robey Street.4. In most cases, the areas impacted are commercial, however, some residential areas and hotels near O'Riordan Street, Baxter Road and Joyce Drive may be impacted. Other impacts have been identified in the terminal area as a result of Terminal 2/3 access.

The noise impacts identified indicate that worst case noise levels may increase by around 3 dB (low likelihood of occurring), with the more likely impact being an increase in the number of 15-minute periods where noise impacts occur at the closest receivers. Additional management and mitigation measures designed to address these cumulative impacts would be developed in consultation with the affected community to minimise the impacts.

7.6.2 Operation

Where the operation of the Sydney Gateway road project and the Botany Rail Duplication are considered together, potential cumulative noise impacts have not be quantified in *Technical Working Paper 2 – Noise and Vibration* due to the different noise characteristics of road and rail noise. The location where cumulative noise impacts may be relevant is at the Joyce Drive and O'Riordan Street intersection, however, health impacts related to cumulative noise impacts cannot be evaluated as these works were not assessed in the noise impact assessment.

In relation to other key road infrastructure projects, traffic changes related to the cumulative operation of these other road projects and Sydney Gateway road project have been included in the noise impact assessment (cumulative scenario) and hence health impacts have been addressed. The cumulative scenario results in 22 fewer receivers where additional noise mitigation is required, providing some small health benefit. This decrease relates to less traffic on roads around Sydney Gateway road project where other infrastructure projects are operating.

7.7 Summary of impacts relevant to Commonwealth land

7.7.1 Construction

In relation to Commonwealth land, construction noise impacts would be limited to NCA05 and NCA07 which are mostly commercial premises, however three hotels are located in these areas. Impacts were identified for hotels, as well as the Qantas Flight Training Centre where noise-intensive equipment was used.

Several hotels are located close to the project and due to their existing high facade and glazing performance, would potentially be affected by ground-borne noise when vibration intensive equipment is in use nearby.

A range of noise and vibration impacts have been identified during construction. These impacts would be managed through the implementation of migration measures proposed in *Technical Working Paper 2 – Noise and Vibration*.

Where these management measures are implement the potential for construction noise and vibration to adversely impact community health is minimised. It should be noted that even where mitigation measures are implemented, some noise impacts may occur where works occur close to sensitive receivers. These impacts are expected to be of short duration, where annoyance and potentially sleep disturbance may occur on occasions.

7.7.2 Operation

Operational noise impacts relevant to Commonwealth land relates to NCA05 and NCA06. These areas are mainly commercial however there existing and future hotels in this area and the Qantas Flight Training Centre. Impacts in these areas are predicted to be an increase in noise levels at existing and future hotels of up to 3 dB. These increases in noise are not considered to be sufficiently elevated to be of concern in relation to health impacts.

7.8 Uncertainties

Any assessment of potential human health risks or impacts needs to consider the uncertainties inherent in the information and data relied upon for undertaking such an assessment as well as the methodology and assumptions adopted in the quantification of risk or impact. **Annexure H** presents a detailed review of the uncertainties relevant to the assessment of health impacts from changes in noise. Overall, the approach adopted is expected to overestimate noise impacts, and hence conclusions drawn from the noise impact assessment in relation to community health would also be overestimated.

8 Public safety and contamination

8.1 Summary of key findings

This section provides a review of the available information in relation to aspects of the project that may impact on public safety during construction and operation.

Based on the assessment undertaken there are no public safety risk issues of concern relevant to the project. In addition, where proposed management measures are implemented there are no health impacts of concern in relation to soil or water contamination that may be present within the project area.

8.2 Introduction

This section provides a review of the potential risks posed to public safety, associated with the project. This section also presents a review of health impacts associated with the presence and management of contamination (in soil or water) relevant to the project.

This section only addresses risks to the community, ie risks that only have the potential to adversely affect the community. Issues relevant to workplace health and safety during construction (including contamination remediation) and operation have not been further discussed or addressed.

Evaluation of public safety has been considered in the screening assessment conducted for hazardous and dangerous goods (refer to Chapter 23 Health, safety and hazards in the EIS/preliminary draft MDP). This assessment was undertaken in accordance with the *State Environmental Planning Policy No. 33 Hazardous and Offensive Developments* (SEPP 33), that identified and addresses risks during construction and operation. Pedestrian safety aspects are addressed in detail in *Technical Working Paper 1 –Transport and Traffic*. Issues from these assessments specifically relevant to public health and safety have been further detailed in this section.

Health impacts associated with contamination have been assessed on the basis of *Technical Working Paper 5 – Contamination and Soil*.

8.3 Public safety

8.3.1 Construction

A range of potential hazards have been identified that have the potential to affect public safety during construction. These are outlined in **Table 8.1**, along with discussion on the risks that may be posed by these hazards. Not all the hazards identified in the Hazard and Risk assessment have been included in the table, only those where there is the potential for risks to public safety.

Table 8.1: Overview of public safety hazards and risks: Construction

Hazard: Public safety	Risk to public safety	Management measures
Storage and handling of dangerous goods on construction sites that may impact on the off-site community	Low The storage would comply with screening thresholds prescribed under SEPP 33.	All materials would be stored in accordance with appropriate Acts, Standards and Code that includes the use of bunding and ventilation of areas where gases are stored, maintaining a register and inventory.
Transport of dangerous goods and hazardous substances on public roads within the community	Low The transportation would comply with screening thresholds prescribed under SEPP 33.	All materials would be transported in accordance with the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW 2005), *Dangerous Goods (Road and Rail Transport) Act 2008* (NSW), *Dangerous Goods (Road and Rail Transport) Regulation 2014* (NSW) and relevant Australian Standards.
Acid sulfate soil, that may result in acidification and the mobilisation of metals, adversely impacting groundwater that can then migrate off-site	Low	Construction and mitigation measures in accordance with the *Acid Sulfate Soils Manual (Acid Sulfate Soil Management Advisory Committee 1998)* would be applied to mitigate the potential risks associated with the disturbance of acid sulfate soils.
Contamination, specifically the presence of hazardous materials such as asbestos and works in areas where contamination is present in soil, which may result in contaminants migrating off-site and affecting the community	Low	Removal of asbestos would be undertaken in accordance with procedures detailed in the Asbestos Management Plan prepared in accordance with relevant legislation ,regulations and guidelines. Other contaminants would be managed using relevant guidelines.
Flooding issues that extend outside the construction areas into the community	Low as flooding risks to off-site areas evaluated have been considered to be minor.	The project design would include measures to minimise the potential for off-site flooding impacts.
Damage to underground utilities, affecting roadways and services provided to the community	Low	A preliminary assessment of utilities in the area has been undertaken as well as consultation with utilities and service infrastructure providers to mitigate the risk of unplanned or unexpected disturbance of utilities.
Bushfire or fire risks that may spread off-site and affect neighbouring properties	Low	The project is in a highly urbanised area that is not in or near a bushfire prone area. Management of construction facilities and activities involving flammable materials and ignition sources would be undertaken to minimise fire risks. High risk construction activities, such as welding and metal work, would be subject to a risk assessment on total fire ban days, and restricted or ceased as appropriate.

Hazard: Public safety	Risk to public safety	Management measures
Aviation risks, specifically works that may affect the safety of aircraft using Sydney Airport	Low	Construction activities would be carried out to minimise the intrusion of equipment such as cranes and materials into prescribed airspace for the airport. The Civil Aviation and Safety Authority (CASA) and Department of Infrastructure, Transport, Cities and Regional Development (DITCARD) are being consulted to ensure construction works are undertaken in line with the Airports (Protection of Airspace) *Regulations 1996* (Commonwealth) and the *Airports Act 1996* (Commonwealth), in a manner that satisfies the requirements of CASA. This includes compliance with CASA requirements for lighting.
Traffic and trucks on surface roads and the potential for changes in public safety	Low Changes to the surface road network may require temporary traffic detours, and significant localised impacts to travel times and intersection performance expected. Construction traffic would use specific routes.	Proposed changes to the road network would be planned and carried out to minimise potential traffic, access and public safety risks, in consultation with the Transport Management Centre. Traffic Management Plans would be put in place at all worksites showing how the safe movement of vehicles, cyclists and pedestrians would be achieved.
Pedestrian and cyclist safety	Low to moderate A number of changes to the pedestrian and cycleway networks would occur. Some areas include relocation of access, however some crossings and pedestrian pathways would be removed and not replaced. Where safe alternatives are provided impacts would be low, however where no alternatives provided a moderate impact on safety may occur.	Traffic Management Plans would be put in place at all worksites showing how the safe movement of vehicles, cyclists and pedestrians would be achieved. Pedestrian and cyclist pathways would include the principles of crime prevention through environmental design to minimise safety risks.

On the basis of the above, there are no issues related to construction that have the potential to result in significant public safety risks to the community.

8.3.2 Operation

A range of potential hazards have been identified that have the potential to affect public safety during operation of the project, principally in relation to traffic accidents. These are outlined in **Table 8.2** along with discussion on the risks that may be posed by these hazards. Not all the hazards identified in the Hazard and Risk assessment have been included in the table, only those where there is potential for risks to public safety.

Table 8.2: Overview of public safety hazards and risks: Operation

Hazard: Public safety	Risk to public safety	Management measures
Storage, handling and transport of dangerous goods required for maintenance of the project, that may impact on the off-site community	Low The storage would comply with screening thresholds prescribed under SEPP 33.	All materials would be stored and transported in accordance with the relevant legislation and codes.
Transport of dangerous goods and hazardous substances	Low	The transport of dangerous goods would be in accordance with the *Dangerous Goods (Road and Rail Transport) Act 2008* (NSW), *Dangerous Goods (Road and Rail Transport) Regulation 2014* (NSW) and relevant Australian Standards.
Traffic accidents on surface roads (including pedestrian and cyclist safety)	Moderate, however the risk is considered to be reduced with the project	The design of the project has been developed to inherently minimise the likelihood of incidents and crashes. The project would involve a reduction in traffic on some roadways, which has the potential to reduce crash rates, improve pedestrian and cyclist safety.
Bushfire risks	Low	The project is in a highly urbanised area that is not in or near a bushfire prone area. Operational infrastructure is largely invulnerable to bushfires as it is not combustible.
Aviation risks, specifically works that may affect the safety of aircraft using Sydney Airport	Low	The project design has considered airspace protection and associated risk and hazards. This includes the design of lighting to ensure it meets the safety requirements set by Department of Infrastructure, Regional Development and Cities and CASA.

On the basis of the above, there are no issues related to the operation of the project that have the potential to result in significant public safety risks to the community.

8.4 Contamination

8.4.1 General

Contamination risk issues to the community are more relevant to the construction phase of the project because exposure to contaminated soil or groundwater would most likely occur during the excavation and construction phase, if not appropriately managed. The interaction with contamination and the community during the operations phase is primarily related to spills and accidents associated with the completed project. *Technical Working Paper 5 – Contamination and Soils* has considered the location

of the construction activities in relation to known areas of contamination in soil and groundwater, as well as issues associated with the impact of construction on the environment, where the community may be exposed.

The assessment of contamination identified a number of project areas where contamination issues require further assessment, in relation to the project:

- Project area 1 – former Tempe landfill, where a range of contaminants of concern have been identified associated with the former Tempe landfill including total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAHs), heavy metals, asbestos, phenols, PFAS, polychlorinated biphenyls (PCBs) organochlorine pesticides (OCPs) and organophosphorus pesticides (OCPs), volatile organic compounds (VOCs), semi volatile organic compounds (SVOCs), nutrients and landfill gases
- Project area 2 – Sydney Airport northern lands (located on Commonwealth-land), where a range of contaminants of potential concern have been identified as a result of former storages and uses (including fuel storages and fire-fighting activities) and include TRH, PAHs, heavy metals, asbestos, phenols, landfill gases, nutrients and PFAS
- Project area 3 – Sydney Airport Corporation leased areas (located on Commonwealth-land), where a range of contaminants of potential concern have been identified as a result of former storages and uses (including fuel storages and fire-fighting activities) and include TRH, PAHs, heavy metals, asbestos, phenols, PCBs, pesticides and PFAS
- Project area 4 – Sydney Airport Land (located on Commonwealth-land), where a range of contaminants of potential concern have been identified as a result of former storages and uses (including fuel storages and fire-fighting activities) and include TRH, PAHs, heavy metals, asbestos, phenols, PCBs, VOCs and PFAS
- Project area 5 – Alexandria Canal, which was declared a remediation site by the NSW EPA in relation to sediments contaminated with chlorinated hydrocarbons including OCPs, PCBs and metals.

8.4.2 Construction

Construction works proposed to be undertaken for the project have been considered in each of the Project areas. The assessment of potential impacts related to the presence of contamination has considered the known nature and extent of contamination as well as the location and nature of construction works. The assessment has also considered if sufficient data is available to understand the nature and extent of contamination and any on-going monitoring and management requirements that may be in place for some of the identified contaminant sources. The potential for these construction works to result in the migration of contamination from the known source areas and impact on the community has been evaluated.

For the community to be exposed to contaminants that are present or disturbed during construction, the works need to result in the movement of these contaminants to air where they may be blown off-site to where the community may be located, or discharged to a water body that the community may be exposed to during recreational activities. The assessment has not considered existing risks to human health, where no construction works are undertaken, only changes in risk related to the construction works.

Without mitigation risks to the community and/or the off-site environment in relation to contamination that may be encountered during construction works was characterised in *Technical Working Paper 5 – Contamination and Soils* as low to high. For the off-site risks to human health, risks characterised as medium or high are as follows:

- Project area 1 – potential exposure to nuisance odours during excavation of landfill materials (medium risk); potential off-site migration of dust (medium risk) and asbestos fibres (high risk) during excavation works

- Project area 2 – potential off-site migration of dust (medium risk) and asbestos fibres (high risk) during excavation works
- Project area 3 - potential off-site migration of asbestos fibres (high risk) during excavation works.

These risk issues would be managed through the implementation of a range of various mitigation and management measures.

Soil and sediment removed during construction works would be classified in accordance with NSW EPA Waste Classification Guidelines. In addition management measures would be implemented to manage the excavation of contaminated soil and prevent surface water run-off.

Where PFAS is present (in soil, water or waste materials) these would be managed in accordance with the NEMP (HEPA 2018).

In all the project areas, the current known contamination status was not found to affect the suitability of the site for the proposed project. In some areas, additional data is required, or on-going monitoring and management is required, which includes:

- Project area 1: On-going monitoring and maintenance of landfill gas, cut-off wall and leachate treatment at the former Tempe Landfill
- Project area 2: The area is currently managed under a site-specific environmental management plan, Sydney Airport Corporation has also commissioned two remedial action plans. Where the project has the potential to damage and/or remove the existing Sydney Airport systems or impact on their effectiveness a remediation action plan would be developed that describes the reinstatement of these systems as part of the construction phase such that they continue to operate effectively post construction. On-going monitoring and maintenance of the existing passive gas system would be required (where present)
- Project area 3: Collection of additional soil and groundwater data is required to characterise the nature and extent of contamination and inform construction management requirements. A remedial action plan would be required to manage contamination in this area
- Project area 4: Collection of additional groundwater data is required to characterise the nature and extent of contamination and inform construction management requirements. A remedial action plan would be required to manage contamination in this area
- Project area 5: Work proposed in Alexandria Canal must submit, for the EPAs approval, a written plan directed at minimising disturbance and migration of contaminated sediments.

There are also a number of areas where there is the potential for acid sulfate soil. These would be managed in accordance with the *Acid Sulfate Soils Manual* (Acid Sulfate Soil Management Advisory Committee 1998).

Technical Working Paper 5 – Contamination and Soils provides details of the mitigation and management measures required to be considered and implemented during construction. Prior to construction a contamination management plan (CMP) would be developed that would inform the construction contractor of the known areas of contamination and provide a management framework for addressing soil, sediment, groundwater and ground gas contamination during construction. Additional management requirements are outlined as follows:

- Groundwater - *Technical Working Paper 7 – Groundwater*
- Surface water - *Technical Working Paper 8 – Surface Water*
- Landfills - *Technical Working Paper 16 – Former Tempe Landfill Assessment*.

Disturbance of contaminated soil during construction is not expected to have a cumulative impact as long as appropriate mitigation measures are implemented for Sydney Gateway road project and all other projects that may be undertaken in similar areas.

Where construction works are undertaken in accordance with relevant guidance, and appropriate management measures are implemented, there is a very low potential for contamination to adversely impact community health during construction.

8.4.3 Operation

The primary operational impact related to the road infrastructure is the potential contamination of soil, surface water and groundwater arising from vehicle accidents, leaks and spills on constructed project roadways. State emergency services will be responsible for the management of spills and leaks associated with vehicle accidents.

Specific sites may have long-term management of contamination required, such as areas where soil is encapsulated or in relation to the former Tempe Landfill. Long term management plans would be develop in accordance with current applicable guidelines. Where these are implemented, there are no risk issues of concern in relation to community health.

8.5 Summary of impacts relevant to Commonwealth land

Consistent with the outcomes presented above, where proposed management measures are implemented, there are no public safety risk issues of concern relevant to the Commonwealth land areas of the project. In addition, where proposed management measures are implemented there are no health impacts of concern in relation to soil or water contamination that may be present within the Commonwealth areas.

9 Assessment of changes in social aspects on community health

9.1 Summary of key findings

Changes in the urban environment associated with the project have the potential to result in a range of impacts on health and wellbeing of the community. The potential for changes to result in impacts on health and wellbeing is complex. Changes that may occur have the potential to result in both positive and negative impacts on community health.

Positive impacts include economic benefits, changes in traffic levels in some areas and increased pedestrian and cyclist access. These impacts have the potential to improve health and wellbeing within the community through the provision of employment, easier access to employment, reduced levels of stress and anxiety and the provision for active transport.

Negative impacts may occur as a result of traffic changes during construction, property acquisitions, visual changes, noise impacts, loss of some green space and existing recreation facilities and changes in access/cohesion of local areas. These may result in increased levels of stress and anxiety. In many cases, the impacts identified are either short-term (associated with construction only) and/or mitigation/management measures have been identified to minimise the impacts on the community.

9.2 Overview of approach

The World Health Organisation defines health as ‘a (dynamic) state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity’. Hence the assessment of health should include both the traditional/medical definition that focuses on illness and disease as well as the broader social definition that includes the general health and wellbeing of a population.

The assessment of changes in air quality and noise on the health of the local community (presented in **sections 6 and 7**) addressed key aspects that have the potential to directly affect health.

This section has more specifically evaluated changes in the community that have the potential to indirectly affect the health and wellbeing of the community. This section also provides a review of whether there are any impacts that are likely to be more significant in any section of the community, and if these areas may result in inequitable impacts on the health of the population. This may affect population groups that may be advantaged or disadvantaged based on age, gender, socioeconomic status, geographic location, cultural background, aboriginality, current health status or existing disability. The evaluation presented in this section provides a qualitative evaluation of potential health impacts on the community.

Within an urban environment there are a wide range of complex factors (acting and interacting at different scales) that can affect health and wellbeing. This is conceptualised in **section 10**, and specifically **Figure 10.1**, which also presents a summary of the outcomes of this assessment. The broad range of factors identified may result in either positive or negative impacts on health and wellbeing. It is noted that no single element or determinant acts in isolation. Health and wellbeing in the urban environment depends on the sum of the total interactions between many factors. It is within this complex model that changes associated with the project have been evaluated in relation to impacts on health and wellbeing.

Technical Working Paper 11 – Socio-Economic Impact Assessment provides details in relation to many of the socio-economic impacts associated with the project. Aspects that are specifically relevant to potential impacts on the health and wellbeing of the community, either positive or negative, have been further highlighted in this section.

9.3 Changes in traffic

9.3.1 General

Technical Working Paper 1 – Transport and Traffic, has identified a number of roads within the regional study area that provide important connectivity for commuter traffic, freight and airport-related activity, and community access to destinations around the region as well as to other parts of Greater Sydney. These include connections to key employment areas of Sydney CBD, Sydney Airport and Port Botany. Key roads include:

- O'Riordan Street and Robey Street - an important north-south connection between Sydney Airport and Sydney CBD
- Joyce Drive, General Holmes Drive and M1 and M5 Motorways - regional connections to and from the airport and Port Botany
- Bourke Street - connection from Mascot through to Sydney's eastern suburbs
- Botany Road – traverses the Mascot town centre connecting Sydney CBD to Botany
- Foreshore Road – a key regional connection to and from Port Botany
- Airport Drive and Qantas Drive - an important east-west connection between the Terminal 1 and Terminal 2/3 precincts.

Many of these roads experience competition between airport traffic, local and through traffic, and freight traffic from Port Botany. There are a number of intersections within the project site where delays are currently experienced by road users, including General Holmes Drive and Mill Pond Drive, Joyce Drive and O'Riordan Street and Qantas Drive and Seventh Street.

Residents and commuters in the region are also connected by rail services, including the T4 Eastern Suburbs and Illawarra train line and T8 Airport and South Line.

Active transport provides connectivity as well as physical activity and recreation. The area also contains a number of cycleways utilised by both local and regional active transport users, including:

- Alexandria Canal shared path – is the primary east-west connection across the study area
- Bourke Road Cycleway - connects the precinct to Sydney's CBD and eastern suburbs
- Cooks River Shared Path - connects the precinct to Sydney's inner western suburbs.

9.3.2 Construction

A number of changes to local roads are proposed during the construction phase of works. A number of different construction scenarios have been evaluated with all identifying substantial localised impacts to travel times and intersection performance particularly at the Qantas Drive/Seventh Street/Robey Street intersection impacting access to Terminal 2/3 and travel through the Mascot area. Regional impacts to traffic are predicted in one construction traffic scenario. Impacts would likely be greater if they occur after the opening of M4-M5 Link in 2023.

A range of strategies have been identified to reduce impacts during construction, including the rerouting of traffic in the local area.

In relation to traffic changes in the project area during construction, most of the issues that are relevant to community health relate to public safety, which is addressed in **section 8**.

In addition to safety risks to the public, construction works are expected to result in some increases in travel times for motorists, bus travel, pedestrians and cyclists. These changes have the potential to result in increased levels of stress and anxiety in the local community (as discussed below). These impacts, however, are expected to occur during the period of construction only.

Changes in road and traffic conditions during construction would be planned to minimise potential disruption in consultation with the Transport Management Centre, local councils, Sydney Airport Corporation and relevant transport stakeholders. Management measures would be prepared in accordance *RTA Traffic Control at Work Sites* manual and AS1742.3: *Manual of uniform traffic control devices – Part 3: Traffic control for works on roads*, and any other relevant standard, guide or manual.

9.3.3 Operations

The intent of the Sydney Gateway road project is to create faster, easier and safer journeys to and from Sydney Airport, and in the local areas of Mascot and Botany. More specifically the project has a number of benefits that include:

- Support the forecast growth of the passenger, air freight and commuter movements across the Sydney region, through improvement in connectivity and capacity of the road network to and from the Airport
- Improve road connections and travel times between Sydney Airport and Port Botany to the Sydney-wide network when used with the New M5, M4-M5Link and M4 East, and planned projects such as the F6 Extension and the Western Harbour Tunnel and Beaches Link.
- Reduced congestion and improved road safety performance in adjacent local areas such as Mascot and Botany by taking cars off local roads by providing new roads to the airport connected to the Sydney motorway network.

Traffic congestion, including localised traffic congestion, and long commuting times can contribute to increased levels of stress and fatigue, more aggressive behaviour and increased traffic and accident risks on residential and local roads as drivers try to avoid congested areas (Hansson et al. 2011). Congestion in local areas such as Mascot and Botany can hinder the development of connected and functioning local communities, leading to increased feelings of isolation, stress and anxiety. Increased travel times reduce the available time to spend on heathy behaviours such as exercise, or engage in social interactions with family and friends. Long commute times are also associated with sleep disturbance, low self-rated health and absence from work (Hansson et al. 2011). Reducing travel times and road congestion is expected to reduce these health impacts.

9.3.4 Public transport

Access to public transport is important, particularly for people who cannot or are unable to drive (such as the elderly and those with disabilities). Lack of good access to public transport for these individuals can result in increased feelings of isolation, helplessness and dependence.

During construction of the project, public transport in the project corridor and surrounding areas would be temporarily affected. This particularly relates to bus services that access the airport. Some services would experience increased travel times during construction. Bus stops located at Qantas Drive and Lancastrian Drive would be permanently closed.

There would be no impacts to rail services.

From a public transport network perspective, the project, once complete, would improve bus travel times for some bus routes (Routes 400 and 420) to the airport, resulting in a more feasible alternative to driving.

9.3.5 Pedestrian and cyclist access

Active transport has many health benefits including maintaining a healthy weight and improved mental status (Hansson et al. 2011; Lindström 2008; Wen & Rissel 2008; WHO 2000b).

There is currently a network of cycleways in the area, comprising a mixture of shared paths, recreational facilities and footpaths, the quality of which varies from poor to excellent. Pedestrian access in the Mascot area has a high degree of amenity. However pedestrian access to the Terminal 1 precinct via Marsh St and the Terminal 2/T3 precinct is poor.

During construction, temporary alterations and diversions to pedestrian and cyclist networks have the potential to affect commuter departure times, travel durations, movement patterns and accessibility. Construction and operation of the project would result in changes to pedestrian and cyclist access, including temporary and permanent closures or diversions of some pathways.

While the opportunity to walk or cycle in the project area would be addressed in construction management plans, the alterations and changes to amenity may detract from the experience of an environment and potentially deter people from enjoying an active lifestyle or feeling connected with their community. Hence it is important that the diversions and detours are safe, and perceived by the community to be a safe alternative. **Figure 9.1** shows the location of the preferred and alternate temporary cyclist access routes proposed during construction.

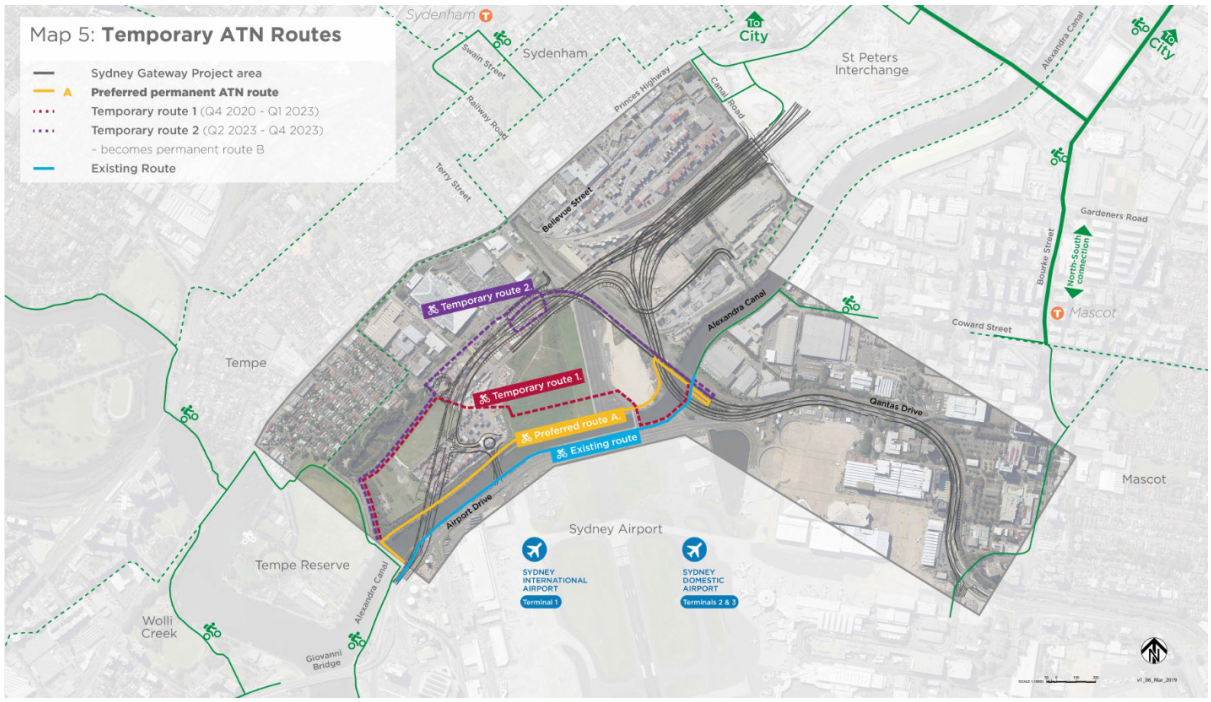


Figure 9.1: Temporary cycleway routes proposed during construction

The overall active transport network within the Sydney Gateway road project area would be maintained with the completion of the project, with the preferred route shown in Figure 9.2. The St Peters interchange (New M5) includes both off road shared paths (west of Canal Road) and separated cycling facilities along Campbell Road. These new routes are planned to connect to other local and regional corridors. Local councils have also proposed a number of routes within the study area that increase connectivity to other local and regional corridors.

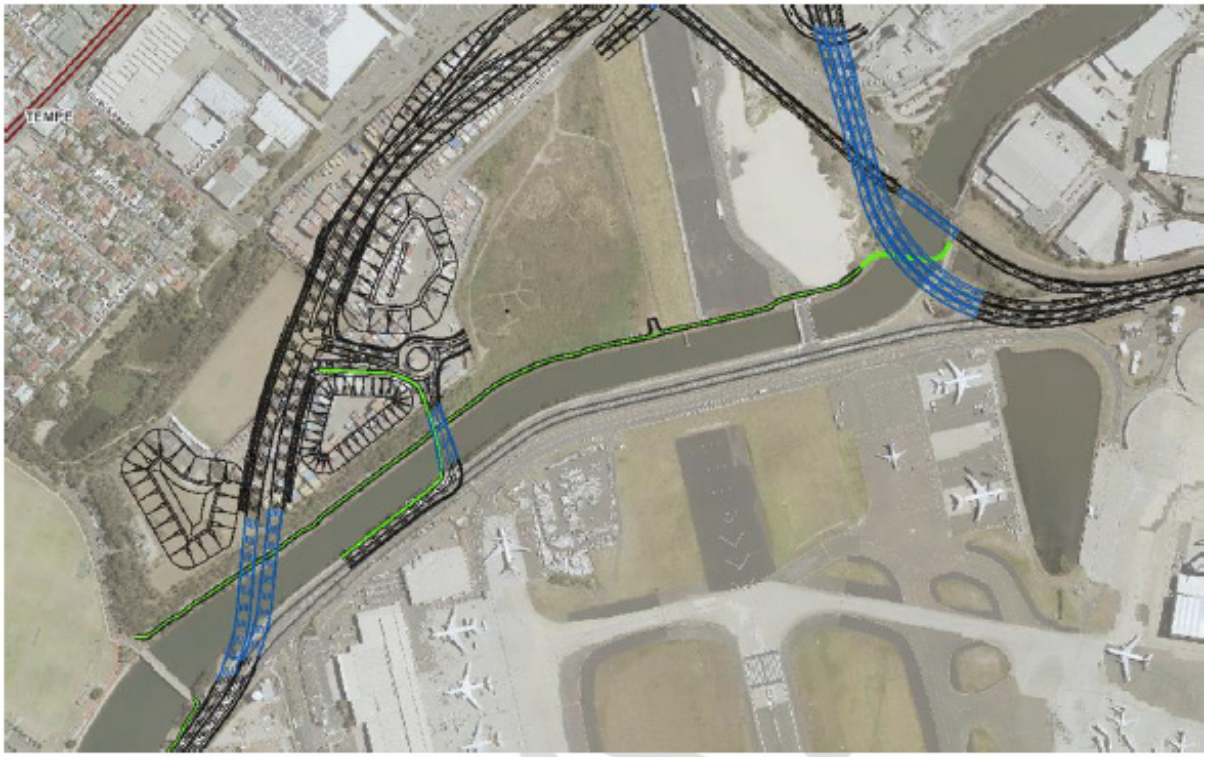


Figure 9.2: Proposed cycleway routes

Overall, the cumulative impact of all project would be positive both during construction and operation for pedestrians and cyclists due to the provision of temporary active transport link during construction and the provision of permanent link and improved strategic connections during operation.

Provision of an active transport link connecting to the active transport network, including improvements in transport connections, would have a positive benefit on community health. Where active transport opportunities are provided and offer safe alternatives to driving and public transport, they can encourage more active recreation and commuting activities.

9.3.6 Impacts on health and emergency services

The existing arterial roads and the local road network are currently used by emergency services to travel to and from call-outs. Construction of the project may require temporary traffic diversions, road occupation, temporary road closures and alternative property access arrangements. Comprehensive communication of changes to roads or paths to emergency services would be an integral part of construction management plans.

9.4 Land requirements

The project has been designed and developed such that there are no impacts on residential land and impacts to local businesses are minimised.

A workplace is central to daily routine with the location of a business influencing how a person may travel to/from work or study, the social infrastructure and businesses they visit and the people they interact with. Impacts to businesses may disrupt social networks and affect health and wellbeing due to raised levels of stress and anxiety. These impacts would be minimised and managed through business management plans and a business support program (refer to *Technical Working Paper 12 - Business impacts* for further information).

9.5 Green space

Green space within urban areas includes green corridors (paths, rivers and canals), grassland, parks and gardens, outdoor sporting facilities, playing fields and children play areas. At a fundamental level there are links between human health/wellbeing and nature/biodiversity including within the urban setting (Brown & Grant 2005; EC 2011a; WHO 2015).

Epidemiological studies have been undertaken that show a positive relationship between green space and health and wellbeing (de Vries et al. 2003; Health Scotland 2008; Kendal et al. 2016; Maas et al. 2006; Mitchell & Popham 2007). The outcomes of these international studies depend on the quality of the available green space. They showed that green space areas in low socio-economic areas often had poor facilities, higher levels of graffiti, vacant/boarded up buildings and lower levels of safety. These studies showed that such spaces had few health benefits.

The health benefits of green space in urban areas include the following (Health Scotland 2008; Kendal et al. 2016; Lee & Maheswaran 2011; Rozek et al. 2018):

- Green space areas, including urban forest areas, that include large trees and shrubs can protect people from environmental exposures associated with flooding, air pollution, noise and extreme temperature (by regulating microclimates and reducing the urban heat island effect)
- Reduced morbidity and mortality
- Improved opportunities for physical activity and exercise. The benefits depend on a range of factors including the distance, ease of access, size of green space, location in relation to connectivity to residential or workplace areas, attractiveness, available facilities (particularly where used by specific sporting clubs) and multi-use (ie including children play areas, garden, seating, sporting facilities that can be used by a wide range of the community for different purposes)
- Improved mental health and feelings of wellbeing, particularly lower stress levels and the perception of restorative effects
- Improve opportunities for social interactions.

Green space areas in urban areas may also present some hazards, such as attracting anti-social behaviours (particularly in isolated areas), providing areas for drug or sexual activity and unintentional injuries from sports or use of playground equipment. It has also been found that individuals from ethnic or minority groups and those with disabilities are less frequent users of green spaces areas (Friedrich, Hillier & Chiaradia 2009; Lee & Maheswaran 2011). It is noted that the detailed review of health benefits of urban green space areas undertaken by Lee (Lee & Maheswaran 2011) determined that there is only weak evidence for links between physical, mental health and wellbeing and urban green space. However, many of the studies are limited and confounded by other factors which affects the ability to be able to draw conclusions. More recent reviews (that include a number of Australian studies) (Dickinson 2018; Rozek et al. 2018) conclude that access to high-quality public open space encourages people to be physically active and supports good mental and physical health. This is particularly evident where there is good access (ie walking distance and even up to 5 kilometres) to green public space, particularly where the open space is large and has desired amenities, safe or perceived safe walking neighbourhoods with good access and connections to green space, the green space area was considered safe, aesthetically pleasing, included desired amenities (such as playgrounds, picnic tables, skate parks barbeques and toilets) and well maintained. The specific design and existing quality of green space that may be available in the local area has not been assessed in this report, only the changes that may occur as a result of the project.

Hence while the following discussion outlines changes to green space related to the project, being able to draw clear conclusions on how these changes may affect health and wellbeing is difficult and complex. Changes in green space may result in changes in stress and anxiety (refer to **section 9.11** for further discussion).

The project would affect the Tempe Golf Range and Academy, an existing off-leash dog area (temporary impacts only) and adjacent surrounding open space of the former Tempe landfill. **Table 9.1** provides a summary of the open space areas impacted by construction and operation. In addition, there may be changes to the community use of other green space areas (such as the adjacent Tempe Recreation Reserve) due to the presence of construction noise and changes in access (including increased travel times) and visual amenity.

Impacts to green space as a result of the project may reduce opportunities for physical activity and exercise, social interactions and increase in stress levels for the community. A reduction in green spaces with trees and shrubs may also reduce the protection offered by these green spaces from air pollution, noise and extreme temperatures.

It is noted that land, or part of the land, occupied by Tyne Containers is proposed to be returned to the local council for use as green space. Where this occurs there is the potential for some community benefits in relation to the amount of green space accessible in the local area.

Table 9.1: Impacts to green space during construction and operation

Construction impacts to open space	Operational impacts to open space
Tempe Golf Range and Academy	
Construction would require the relocation of the Tempe Golf Range and Academy. The closest alternate facility is about four kilometres away in Arncliffe. This may require some further travel by some local residents, however given the presence of alternative facilities in the area, access to golfing recreational activities is not expected to change. Hence changes to recreational golfing access is expected to result in negligible impacts on health.	The permanent relocation of this facility would require users to access and use similar facilities in the local area (refer to comments in relation to construction). Hence changes to recreational golfing access is expected to result in negligible impacts on health.
Existing off-leash dog area and open space within Tempe Reserve	
Construction would require relocation of the existing off-leash dog exercise area. A temporary off-leash dog exercise area would be provided as close as possible to the existing off-leash dog exercise area. The exact location will be confirmed in consultation with Inner West Council. The proximity to a construction compound may result in some users preferring to use other off-leash dog areas, such as at in Wolli Creek or Sydenham (around 1.4 kilometres and three kilometres away respectively). Alternatively, some users may prefer to use the southern part of Tempe Recreation Reserve and Kendrick Park to exercise their dogs (on-leash). Mitigation: A temporary off-leash dog exercise area will be provided. Access to this area will be maintained throughout construction, and temporary parking spaces will be provided. The location of the off-leash dog area and the number of temporary parking spaces will be confirmed in consultation with Council. The condition of the temporary off-leash dog exercise area will be regularly monitored and maintained. Based on the above, changes to recreational/active walking access is expected to result in negligible impacts on health.	The project would result in the permanent loss of around one hectare of land within Tempe Lands. This area includes land currently occupied by the Tempe Golf Range and Academy and the off-leash dog exercise area. However, upon completion of the project, up to 10 hectares of residual land would be available for use in this area. This would consist of land temporarily required during construction, including about four hectares currently occupied by recreational facilities within Tempe Lands, and land currently occupied by Tyne Container Services. Potential future uses could include open/space recreation, or other future uses in accordance with the priorities of local and regional strategic planning and Inner West Council. Mitigation: Roads and Maritime will continue to consult with Inner West Council to ensure: - Impacts on open space and recreational facilities in Tempe Lands will be offset; and - Consistency between the project's urban design and landscape plan and Council's master plan for Tempe Lands. Based on the above, changes to recreational/active walking access is expected to result in negligible impacts on health.

9.6 Changes in community access and connectivity

Roads and freeways can divide residential communities hindering social contact. The presence of busy roads inhibits residents from socialising and children from playing, or accessing nearby recreational areas. Heavy traffic also affects child development (WHO 2000b). Children learn how to make responsible decisions, how to behave in different situations and develop a relationship with their environment and community through independent mobility. Where children have the opportunity to be able to play in local streets or safely access local parks they have been found to have twice as many social contacts as those where such activities are prevented by heavy traffic or unsafe conditions.

Social connectedness and relationships are important aspects of feeling safe and secure. Streets with heavy traffic have been associated with fewer neighbourhood social support networks and has been linked to adverse health outcomes (WHO 2000b). Any temporary and permanent changes to the access to social infrastructure, community resources or to other desirable locations (such as employment, study, friends and family) and safety to movement may affect community networks and in turn trigger community severance.

Community severance effects often occur during major transportation projects (during construction and operation) due to detours in the local road network, changes to active and public transport routes, and connector roads receiving an increase or decrease in traffic movements. The changes to the road networks may contribute to feelings of community severance and disconnection.

Construction of the project would involve the temporary disruption of pedestrian and cycleway routes especially around Canal Road, Airport Drive, Alexandria Canal (at Coward Street end). While these disruptions may deter people from active transport, the impacts are considered to be minor (as alternate routes are expected to be provided) and temporary.

Once operational the project would reduce traffic and decrease travel times on a number of key local roads. In addition, the project would provide new high capacity and continuous connections between the Sydney motorway network via St Peters Interchange and Sydney Airport terminals, Mascot and Port Botany precincts (refer to *Technical Working Paper 20 – Socio-Economic Assessment*). This has the potential to reduce barriers to travel across and into these local areas (particularly Mascot), providing access for active transport and individuals with mobility difficulties. Improvements in access has
the potential to improve general health and wellbeing.

9.7 Visual changes

Visual amenity can be described as the pleasantness of the view or outlook of an identified receptor or group of receptors (eg residences, recreational users). Visual amenity is an important part of an area's identity and offers a wide variety of benefits to the community in terms of quality of life, wellbeing and economic activity. For some individuals, changes in visual amenity can increase levels of stress and anxiety. These impacts, however, are typically of short duration as most people adapt to changes in the visual landscape, particularly within an already urbanised area. As a result, most changes in visual impacts are not expected to have a significant impact on the health of the community.

During construction, visual amenity throughout the project area has the potential to be affected by factors such as the removal of established vegetation, the installation of construction compounds, stockpile areas for materials, temporary storage of spoil, crane pads and fencing. Many of these changes would be highly visible.

The operational project would include changes to local visual amenity due to the presence of new and amended infrastructure (including new roadways and bridges), landscaping and urban design features (refer to the *Technical Working Paper 21 – Urban Design, Place-Making and Visual Amenity*).

These impacts are of most noticeable in the area of the terminals, Alexandria Canal, Airport Drive and the Botany rail line. No visual impacts are expected to be noticeable in the residential areas surrounding the project and hence there are no health impacts expected as a result of visual changes associated with the project.

9.8 Equity

The health effects associated with impacts related to transport projects are not equally distributed across the community. Groups at higher risk, or more sensitive to impacts, include:

- Elderly
- Individuals with pre-existing health problems
- Infants and young children
- Individuals with disabilities
- Individuals who live in areas of higher levels of air or noise pollution.

Often the impacts can accumulate in the same areas, which may already have poorer socio-economic and health status, most commonly due to the affordability of housing in areas that are closer to main roads, industry or rail infrastructure. Disadvantaged urban areas are commonly characterised by high traffic volumes, higher levels of air and noise pollution, feelings of insecurity and lower levels of social interactions and physical activity in the community.

To further evaluate potential equity issues associated with the project, the location of impacts identified in relation to air quality, noise and traffic were reviewed individually and in combination, in conjunction with available information on the location of sensitive community groups.

It is noted that in many urban areas, housing prices are lower on main roadways. The median house prices in the study area are variable, however in most areas they are consistent with the Sydney average. Some public housing is located in the study area; however, these properties are mixed in with privately owned property such that there are no specific areas with higher populations of public housing tenants. Hence there are no social equity issues identified in relation to the change in air quality in the local community.

Review of the predicted increases in key air pollutants (in particular nitrogen dioxide and $PM_{2.5}$) and noise has not identified any areas where there is an alignment of increases in both of these aspects, that may adversely impact on health.

Review of the 2016 Census Data - Socio-Economic Index for Areas indicates that there are a number of small areas considered to be more disadvantaged within the general area of the project and surrounding areas. Specifically in areas where there are increases in air pollutants, adjacent to roadways with increased traffic, and these areas are ranked as average to least disadvantaged. There are a number of areas where decreases in air pollution are predicted, and these areas are ranked as average to disadvantaged. This means that the localised changes in air quality do not more significantly affect areas of low socioeconomic status. In relation to increases in noise, none of the elevated increases in noise predicted in relation to the project are in areas ranked as disadvantaged. On this basis, the major impacts from the project in relation to air quality and noise would not disproportionately impact on low socioeconomic areas within the project area. Hence there are no local equity impacts related to the project.

In relation to broader equity aspects, the Sydney Gateway road project, along with other projects in the region that include the F6 Extension, M4-M5 Link, M4 East and New M5 are aimed at improving access to the area from outer lying areas in the south and west. The Socio-Economic Index for Areas for populations in the outer south and west are lower, indicating they are more disadvantaged, than many of the populations in the study area. Improving access and travel times for these more disadvantaged populations provides the potential for health benefits such as those that are derived from improved employment opportunities, decreased travel times (and potentially more time available for other active, family or community activities) and reduced levels of stress and anxiety.

9.9 Construction fatigue

Construction fatigue relates to receptors that experience construction impacts from a variety of projects over an extended period of time with few or no breaks between construction periods. Construction fatigue typically relates to traffic and access disruptions, noise and vibration, air quality, visual amenity and social impacts from projects that have overlapping construction phases or are back to back. Construction impacts that occur in this manner are no longer considered to be transient and/or short-term.

The assessment of construction fatigue in this report includes the construction impacts of the Sydney Gateway road project that may occur at the same time as the Botany Rail Duplication as well as works at the St Peters Interchange as part of the New M5 and M4-M5 Link projects.

The area is also subject to ongoing urban development, with many of the LGAs in the study area projected to have significant population growth (refer to **section 4.4**) driven by increased development density.

Long-term construction activities have the potential to impact on the health and wellbeing of the community. This includes:

- Air quality:
  - Continual emissions of nuisance dust over long periods of time
- Noise and vibration:
  - Prolonged construction noise and vibration impacts (during the day and night-time) that may no longer be considered short-term or of short duration
- Traffic and transport:
  - Congestion on surface roads from the movement of construction vehicles including heavy vehicles for spoil haulage and light vehicles such as worker access to construction ancillary facility sites
  - Temporary access disruption to private properties including residences and businesses
  - Partial and/or complete closure of roads, diversion of the current active transport link to create a temporary route, and potential loss of street parking
  - Changes to the location of bus stops
- Visual amenity:
  - Views of temporary construction sites and fencing/hoarding, plant and equipment
  - Alteration of views through removal of landscaping.

Where these impacts occur for extended periods of time, there is the potential that increased levels of stress and anxiety may also continue for extended periods of time.

It is noted that the project areas where the community may be affected by these consecutive construction activities is small, and the noise impacts relevant to these areas from the project are low. Hence the potential for construction fatigue issues from noise is considered to be low.

Health effects associated with stress and anxiety are further discussed in **section 9.11**.

Specific additional management and mitigation measures designed to address potential consecutive impacts should be developed and used to minimise the impacts as far as practicable, in consultation with the affected community.

9.10 Economic aspects

The construction expenditure of the project would be of significant benefit to the economy. This expenditure would inject economic stimulus benefits into the local, regional and state economies. Ongoing or improved economic vitality brings significant health benefit to the community. Employment opportunities would grow in the region through the potential increase in business customers, improved access to employment opportunities and through the increase in demand for construction workers. The increase in demand for labour may increase wages in the region, particularly for construction workers, who would be in high demand.

It is noted that some local businesses would be adversely impacted by both construction and operational activities, along with other businesses where leases would be terminated. This can cause stress for the impacted individuals and lead to health impacts if not appropriately managed. To minimise these impacts the project would include development of business management plans. These plans should include ways to minimise stress to impacted individuals.

Sydney Airport and Port Botany are among the busiest and most important air and sea freight terminals in Australia. Together, they are known as the State's trade gateways, generating over $10 billion of economic activity and handling close to $100 billion of freight per year. Sydney Airport caters for around 40 per cent of Australia's international passenger movements, 46 per cent of domestic/regional passenger movements and 50 per cent of air freight. The airport and associated businesses are also a significant employer, with around 31,000 jobs located at the airport itself. Port Botany handles 99 per cent of NSW's container demand, moving more than 6,000 containers on average every day. The port also handles 98 per cent of NSW's consumption of liquid petroleum gas (LPG), 90 per cent of bulk chemical products, 30 per cent of refined petroleum fuels and 100 per cent of bitumen products (NSW Government 2018, Sydney Gateway, State Significant Infrastructure Scoping Report).

Efficient access to Sydney Airport and towards Port Botany is critical to the economic growth and prosperity of Sydney. Over the next 20 years, air travel, air freight, container freight and general traffic in and around the Sydney Airport and Port Botany area are expected to grow significantly.

The primary objective of the project is to support sustainable growth in the economy and cater for projected increases in passenger and freight demand. This is via improved connectivity, efficient freight distribution and improvements to liability of the Mascot town centre.

These economic benefits are a factor influencing community health with lowered levels of stress and anxiety related to congestion, access to travel and transport and employment opportunities.

The transport modelling undertaken for the project highlighted that the project would result in substantial potential benefits for freight and commercial vehicle movements. Improvements in the efficiency and reliability of these transport networks would likely result in increased productivity, reduced costs and broader economic benefits for these workforces.

9.11 Stress and anxiety issues

A number of changes within the community (discussed in **sections 9.3 to 9.10)** have the potential to affect levels of stress and anxiety. Some changes may result in a lowering of feelings of stress and anxiety, and there are others that may result in higher levels of stress or anxiety within the community. In addition, construction fatigue (as discussed in **section 9.9**) from the combined infrastructure projects and ongoing urban developments associated with urban growth, may result in elevated levels of stress and anxiety for extended periods of time.

Chronic and persistent negative stress, or distress, can lead to many adverse health problems including physical illness and mental, emotional and social problems. Response to stress would vary between individuals with genetic inheritance and personal/environmental experiences of importance (Schneiderman, Ironson & Siegel 2005).

An acute stressful event results in changes to the nervous, cardiovascular, endocrine and immune systems, more commonly known as the “fight or flight” response (Schneiderman, Ironson & Siegel 2005). Unless there is an accident or other significant event, such acute stress events are not expected to be associated with construction or operation of the Sydney Gateway road project.

For shorter-term events, stress causes the immune system to release hormones that trigger the production of white blood cells that fight infection and other disease-fighting elements. This response is important for fighting injuries and acute illness. However, this activity within the body is not beneficial if it occurs for a long period of time. Hormones released during extended or chronic stress can inhibit the production of cytokines (the messengers that allow cells to talk together to fight infection) lowering the body’s ability to fight infections. This makes some individuals more susceptible to infections, and may mean they also experience more severe infections. It can also trigger a flare up of pre-existing autoimmune diseases (which are a range of diseases where the immune system gets confused and starts attacking healthy cells) (Mills, Reiss & Dombeck 2008; Schneiderman, Ironson & Siegel 2005).

Other physiological effects associated with chronic stress include (Brosschot, Gerin & Thayer 2006; McEwen, Bruce S. 2008; McEwen, B. S. & Stellar 1993; Mills, Reiss & Dombeck 2008; Moreno-Villanueva & Bürkle 2015):

- Digestive disorders, with hormones released in response to stress causing a number of people to experience stomach ache or diarrhoea, with appetite also affected in some individuals (resulting in under-eating or over-eating).
- Chronic activation of stress hormones can raise an individual’s heart rate, cause chest pain and/or heart palpitations and increase blood pressure and blood lipid (fat) levels. Sustained high levels of cholesterol and other fatty substances can lead to atherosclerosis and other cardiovascular disease and sometimes a heart attack (Pimple et al. 2015; Seldenrijk et al. 2015).
- Cortisol levels, release at higher levels with stress, play a role in the accumulation of abdominal fat, which has been linked to a range of other health conditions.
- Stress can cause muscles to contract or tighten, cause tension aches and pains (Ortego et al. 2016)

Some individuals respond to elevated levels of stress by taking up or continuing unhealthy stress coping strategies such as smoking, drinking or overeating, all of which are associated with significant health risks. Chronic levels of stress have also been found to cause or exacerbate existing mental health issues, including mood disorders such as depression and anxiety, cognitive problems, personality changes and problem behaviours. It can also affect individuals with pre-existing bipolar disorders.

By-products of stress hormones can act as sedatives (chemical substances which cause us to become calm or fatigued). When such hormone by-products occur in large amounts (which would happen under conditions of chronic stress), they may contribute to a sustained feeling of low energy or depression. Habitual patterns of thought which influence appraisal and increase the likelihood that a person would experience stress as negative (such as low self-efficacy, or a conviction that you are incapable of managing stress) can also increase the likelihood that a person would become depressed. It is normal to experience a range of moods, both high and low, in everyday life. While some "down in the dumps" feelings are a part of life, sometimes, people fall into depressing feelings that persist and start interfering with their ability to complete daily activities, hold a job, and enjoy successful interpersonal relationships (Mills, Reiss & Dombeck 2008; Schneiderman, Ironson & Siegel 2005).

Some people who are stressed may show relatively mild outward signs of anxiety, such as fidgeting, biting their fingernails, tapping their feet, etc. In other people, chronic activation of stress hormones can contribute to severe feelings of anxiety (eg racing heartbeat, nausea, sweaty palms, etc.), feelings of helplessness and a sense of impending doom. Thought patterns that lead to stress (and depression, as described above) can also leave people vulnerable to intense anxiety feelings (Mills, Reiss & Dombeck 2008).

Anxiety or dread feelings that persist for an extended period of time; which cause people to worry excessively about upcoming situations (or potential situations); which lead to avoidance; and cause people to have difficulty coping with everyday situations may be symptoms of one or more anxiety disorders (Mills, Reiss & Dombeck 2008).

More generally, it must be noted that urbanisation, or increased urbanisation, regardless of specific projects has been found to affect levels of stress and mental health (Srivastava 2009). These impacts are greater where there is urbanisation without improvements in infrastructure to improve equitable access to employment and social areas/communities (Srivastava 2009).

The role of either acute or long-term environmental stress on the health of any community, in general and for specific project(s), including the Sydney Gateway road project, cannot be quantified. There are a wide range of complex factors that influence health and wellbeing, specifically mental health. It is not possible to determine any specific outcomes that may occur as a result of a specific project, or number of projects. However, it is noted that within any urban environment there will be a wide range of stressors present from infrastructure projects as well as other urban developments that may or may not contribute to the health effects outlined above.

It is noted that the project, along with the other approved infrastructure projects, aims to improve infrastructure, connections and access within the urban environment. Hence on a broader scale, the longer-term projects, while requiring long-term management to minimise construction impacts, may assist in reducing stress and associated physiological and mental health impacts within the urban environment.

10 Recommended mitigation measures

There are no additional mitigation measures identified in the HIA, over and above the mitigation measures identified in other technical studies associated with the EIS/draft MDP.

11 Conclusion

The assessment of potential health impacts associated with the project involved evaluation of a wide range of impacts that have the potential to affect the health and wellbeing of the community. The assessment has utilised a range of methods to evaluate potential health impacts within the project area, that includes the Commonwealth land. Based on the assessment undertaken, the following can be concluded:

Health impacts during construction:

- Changes in air quality:
  - Impacts associated with dust generated from construction activities would require management to ensure impacts to community health are minimised.
  - Chapter 8 of *Technical Working Paper 4 – Air Quality* provides additional details in relation to the management of dust during construction). If these measures are implemented, significant impacts due to dust are not anticipated
- Changes in noise:
  - Overall, given the distant location of the nearest residential or other sensitive receivers to the project in some areas, there are a number of locations where there are no exceedances of the relevant noise criteria during construction, and hence no potential for health impacts.
  - Construction noise and vibration impacts would generally be limited to NCA03, NCA06 and NCA08, and related to the use of noise intensive equipment. Management of noise and vibration from this equipment would be in accordance with Roads and Maritime's CNVG to reduce impacts on community health and wellbeing.
  - Where the proposed management measures (as outlined in *Technical Working Paper 2 – Noise and vibration*) are implemented, the potential for construction noise and vibration to adversely impact community health is minimised. It should be noted that even where mitigation measures are implemented, some noise impacts may occur where works occur close to sensitive receivers. These impacts are expected to be of short duration, where annoyance and potentially sleep disturbance may occur on occasions.
- Public safety and contamination:
  - Where all proposed management measures are implemented, no community health risk issues of concern were identified in relation to public safety, associated with the project, from issues such as dangerous goods, subsidence, contamination and road safety during construction.
- Changes in other social determinants:
  - Changes in the urban environment associated with the project have the potential to result in a range of impacts on health and wellbeing of the community. The potential for changes to result in impacts on health and wellbeing is complex. Changes that may occur have the potential to result in both positive and negative impacts on community health.
  - The construction phase of works has the greatest potential for negative impacts as a result of traffic changes during construction, property acquisitions, visual changes, loss of some green space and existing recreation facilities and changes in access/cohesion of local areas. These may result in increased levels of stress and anxiety within the community. In many cases, the impacts identified are either temporary (associated with construction only) and/or mitigation/management measures have been identified to minimise the impacts on the community.

- Positive impacts for the project during construction relate to employment, which has the potential to benefit health.

Health impacts during operation:

- Changes in air quality:
  - Impacts within the community: the project is expected to result in a redistribution of impacts associated with vehicle emissions, specifically in relation to emissions derived from vehicles using surface roads.
  - For much of the community this would result in no measurable change or a small improvement (ie decreased concentrations and health impacts), however, for some areas located near key surface roads, a small increase in pollutant concentrations may occur.
  - Where these increases in pollutant concentrations are evaluated, no health impacts have been identified that would be considered to be of significance (ie measurable) within the community.
- Changes in noise:
  - Where no mitigation measures are implemented, during the operation of the project 247 buildings (231 residential buildings) which includes 360 individual floors of multi-storey buildings (278 residential floors) have been identified where road noise exceeds the adopted criteria and has the potential to be elevated and adversely affect health.
  - Where noise mitigation measures are implemented, these noise impacts are reduced, however, there remains a number of properties, particularly within NCA03 where additional mitigation measures would be required to protect the health of occupants. These mitigation measures may include at-property architectural treatments.
- Public safety and contamination:
  - Where all proposed management measures are implemented, no community health risk issues of concern were identified in relation to public safety, associated with the project, from issues such as dangerous goods, subsidence and road safety during operation.
- Changes in other social determinants:
  - Changes in the urban environment associated with the project have the potential to result in a range of impacts on health and wellbeing of the community. The potential for changes to result in impacts on health and wellbeing is complex. Changes that may occur have the potential to result in both positive and negative impacts on community health.
  - A number of benefits are associated with the operation of the project. These include changes in traffic levels and improved travel times in some areas and increased pedestrian and cyclist access. These impacts have the potential to improve health and wellbeing within the community through easier access to employment, reduced levels of stress and anxiety and provision for active transport.

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Annexure A: Approach to risk assessment using exposure-response relationships

A.1 Overview

This Annexure summarises the approach adopted for the assessment of risk on the basis of exposure-response relationships.

A.2 Mortality and morbidity health endpoints

A quantitative assessment of risk for these endpoints uses a mathematical relationship between an exposure concentration (ie concentration in air) and a response (namely a health effect). This relationship is termed an exposure-response relationship and is relevant to the range of health effects (or endpoints) identified as relevant (to the nature of the emissions assessed) and robust (as identified in the main document). An exposure-response relationship can have a threshold, where there is a safe level of exposure, below which there are no adverse effects; or the relationship can have no threshold (and is regarded as linear) where there is some potential for adverse effects at any level of exposure.

In relation to the health effects associated with exposure to nitrogen dioxide and particulate matter, no threshold has been identified. Non-threshold exposure-response relationships have been identified for the health endpoints considered in this assessment.

The assessment of potential risks associated with exposure to particulate matter involves the calculation of a relative risk (RR). For the purpose of this assessment the shape of the exposure-response function used to calculate the relative risk is assumed to be linear[1]. The calculation of a relative risk based on the change in relative risk exposure concentration from baseline/existing (ie based on incremental impacts from the project) can be calculated on the basis of the following equation (Ostro 2004):

Equation 1 $RR = \exp[\beta(X-X0)]$

Where:

X-X0 = the change in particulate matter concentration to which the population is exposed (µg/m^3)

β = regression/slope coefficient, or the slope of the exposure-response function which can also be expressed as the per cent change in response per 1 µg/m^3 increase in particulate matter exposure.

Based on this equation, where the published studies have derived relative risk values that are associated with a 10 micrograms per cubic metre increase in exposure, the β coefficient can be calculated using the following equation:

1 Some reviews have identified that a log-linear exposure-response function may be more relevant for some of the health endpoints considered in this assessment. Review of outcomes where a log-linear exposure-response function has been adopted (Ostro 2004) for $PM_{2.5}$ identified that the log-linear relationship calculated slightly higher relative risks compared with the linear relationship within the range 10–30 micrograms per cubic metre,(relevant for evaluating potential impacts associated with air quality goals or guidelines) but lower relative risks below and above this range. For this assessment (where impacts from a particular project are being evaluated) the impacts assessed relate to concentrations of $PM_{2.5}$ that are well below 10 micrograms per cubic metre and hence use of the linear relationship is expected to provide a more conservative estimate of relative risk.

Equation 2

$$\beta = \frac{\ln(RR)}{10}$$

Where:
RR = relative risk for the relevant health endpoint as published (µg/m³)
10 = increase in particulate matter concentration associated with the RR (where the RR is associated with a 10 µg/m³ increase in concentration).

A.3 Quantification of impact and risk

The assessment of health impacts for a particular population associated with exposure to particulate matter has been undertaken utilising the methodology presented by the WHO (Ostro 2004)[2] where the exposure-response relationships identified have been directly considered on the basis of the approach outlined below.

The calculation of changes in health endpoints associated with exposure to nitrogen dioxide and particulate matter as outlined by the WHO (Ostro 2004) has considered the following four elements:

- Estimates of the changes in particulate matter exposure levels (ie incremental impacts) due to the project for the relevant modelled scenarios
- Estimates of the number of people exposed to particulate matter at a given location
- Baseline incidence of the key health endpoints that are relevant to the population exposed
- Exposure-response relationships expressed as a percentage change in health endpoint per microgram per cubic metre change in NO_2 or particulate matter exposure, where a relative risk (RR) is determined (refer to Equation 1).

From the above, the increased incidence of a health endpoint corresponding to a particular change in particulate matter concentrations can be calculated using the following approach:

The attributable fraction/portion (AF) of health effects from air pollution, or impact factor, can be calculated from the relative risk (calculated for the incremental change in concentration considered as per Equation 1) as:

Equation 3

$$AF = \frac{RR-1}{RR}$$

The total number of cases attributable to exposure to particulate matter (where a linear dose-response is assumed) can be calculated as:

Equation 4

$$E = AF \times B \times P$$

Where:
B = baseline incidence of a given health effect (eg mortality rate per person per year)
P = relevant exposed population

2 For regional guidance, such as that provided for Europe by the WHO WHO 2006a, Health risks or particulate matter from long-range transboundary air pollution regional background incidence data for relevant health endpoints are combined with exposure-response functions to present an impact function, which is expressed as the number/change in incidence/new cases per 100,000 population exposed per microgram per cubic metre change in particulate matter exposure. These impact functions are simpler to use than the approach adopted in this assessment, however in utilising this approach it is assumed that the baseline incidence of the health effects is consistent throughout the whole population (as used in the studies) and is specifically applicable to the sub-population group being evaluated. For the assessment of exposures in the areas evaluated surrounding the project it is more relevant to utilise local data in relation to baseline incidence rather than assume that the population is similar to that in Europe (where these relationships are derived).

The above approach (while presented slightly differently) is consistent with that presented in Australia (Burgers & Walsh 2002), US (OEHHA 2002; USEPA 2005b, 2010) and Europe (Martuzzi et al. 2002; Sjoberg et al. 2009).

The calculation of an increased incidence (ie number of cases) of a particular health endpoint is not relevant to a specific individual, rather this is relevant to a statistically relevant population. This calculation has been undertaken for populations within the suburbs surrounding the proposed project. When considering the potential impact of the project on the population, the calculation has been undertaken using the following:

- Equation 1 has been used to calculate a relative risk. The relative risk has been calculated for a population weighted annual average incremental increase in concentrations. The population weighted average has been calculated on the basis of the smallest statistical division provided by the Australian Bureau of Statistics within a suburb (ie mesh blocks – which are small blocks that cover an area of about 30 urban residences). For each mesh block in a suburb the average incremental increase in concentration has been calculated and multiplied by the population living in the mesh block (data available from the ABS for the 2011 census year). The weighted average has been calculated by summing these calculations for each mesh block in a suburb and dividing by the total population in the suburb (ie in all the mesh block)
- Equation 3 has been used to calculate an attributable fraction
- Equation 4 has been used to calculate the increased number of cases associated with the incremental impact evaluated. The calculation is undertaken utilising the baseline incidence data relevant for the endpoint considered and the population (for the relevant age groups) present in the suburb.

The above approach can be simplified (mathematically, where the incremental change in particulate concentration is low, less than one microgram per cubic metre) as follows:

Equation 5 $E=\beta \times B \times \sum_{mesh}(\Delta X_{mesh} \times P_{mesh})$

Where:
β = slope coefficient relevant to the per cent change in response to a 1 µg/m^3 change in exposure concentration
B = baseline incidence of a given health effect per person (eg annual mortality rate)
ΔXmesh = change (increment) in exposure concentration in µg/m^3 as an average within a small area defined as a mesh block (from the ABS – where many mesh blocks make up a suburb)
Pmesh = population (residential – based on data form the ABS) within each small mesh block

An additional risk can then be calculated as:

Equation 6 $Risk=\beta \times \Delta X \times B$

Where:
β = slope coefficient relevant to the per cent change in response to a 1 µg/m^3 change in exposure
ΔX = change (increment) in exposure concentration in µg/m^3 relevant to the project at the point of exposure
B = baseline incidence of a given health effect per person (eg annual mortality rate)

This calculation provides an annual risk for individuals exposed to changes in air quality from the project at specific locations (such as the maximum, or at specific sensitive receptor locations). The calculated risk does not take into account the duration of exposure at any one location and hence is considered to be representative of a population risk.

A.4 Quantification short and long term effects

The concentration-response functions adopted for the assessment of exposure are derived from long and short term studies and relate to short or long term effects endpoints (eg change in incidence from daily changes in nitrogen dioxide or particulate matter, or chronic incidence from long term exposures to particulate matter).

Long term or chronic effects are assessed on the basis of the identified exposure-response function and annual average concentrations. These then allow the calculation of a chronic incidence of the assessed health endpoint.

Short term effects are also assessed on the basis of an exposure-response function that is expressed as a percentage change in endpoint per microgram per cubic metre change in concentration. For short term effects, the calculations relate to daily changes in nitrogen dioxide and particulate matter exposures to calculate changes in daily effects endpoints. While it may be possible to measure daily incidence of the evaluated health endpoints in a large population study specifically designed to include such data, it is not common to collect such data in hospitals nor are effects measurable in smaller communities. Instead these calculations relate to a parameter that is measurable, such as annual incidence of hospitalisations, mortality or lung cancer risks. The calculation of an annual incidence or additional risk can be undertaken using two approaches (Ostro 2004; USEPA 2010):

- Calculate the daily incidence or risk at each receptor location over every 24 hour period of the year (based on the modelled incremental 24 hour average concentration for each day of the year and daily baseline incidence data) and then sum the daily incidence/risk to get the annual risk
- Calculate the annual incidence/risk based on the incremental annual average concentration at each receptor (and using annual baseline incidence data).

In the absence of a threshold, and assuming a linear concentration-response function (as is the case in this assessment), these two approaches result in the same outcome mathematically (calculated incidence or risk). Given that it is much simpler computationally to calculate the incidence (for each receptor) based on the incremental annual average, compared with calculating effects on each day of the year and then summing, this is the preferred calculation method. It is the recommended method outlined by the WHO (Ostro 2004).

The use of the simpler approach, based on annual average concentrations should not be taken as implying or suggesting that the calculation is quantifying the effects of long term exposure.

Hence for the calculations presented in this technical report that relate to the expected use of the project tunnel, for both long term and short term effects, annual average concentrations of nitrogen dioxide and particulate matter have been utilised.

Where short term worst case exposures are assessed (such as those related to a breakdown in the tunnel) short term, daily, calculations have been undertaken to assessed short term health endpoints. This has been undertaken as the exposure being assessed relates to an infrequent short duration event. It would not occur each day of the year and hence it is not appropriate to assess on the basis of an annual average.

Annexure B : Approach to the assessment of cancer risk

B.1 Overview

This Annexure summarises the approach adopted for the assessment of carcinogenic risks. This relates to the assessment of benzene, 1,3-butadiene, carcinogenic polycyclic aromatic hydrocarbons as benzo(a)pyrene toxicity equivalents and diesel particulate matter. Toxicity reference values relevant to these chemicals, with the exception of diesel particulate matter are presented in **Section 6** of the main report.

B.2 Diesel particulate matter

Diesel exhaust (DE) is emitted from 'on-road' diesel engines (vehicle engines) and can be formed from the gaseous compounds emitted by diesel engines (secondary particulate matter). After emission from the exhaust pipe, diesel exhaust undergoes dilution and chemical and physical transformations in the atmosphere, as well as dispersion and transport in the atmosphere. The atmospheric lifetime for some compounds present in diesel exhaust ranges from hours to days.

Data from the USEPA (USEPA 2002) indicates that diesel exhaust as measured as diesel particulate matter made up about six per cent of the total ambient/urban air $PM_{2.5}$. In this project, emissions to air from the operation of the tunnel include a significant proportion of diesel powered vehicles. Available evidence indicates that there are human health hazards associated with exposure to diesel particulate matter. The hazards include acute exposure-related symptoms, chronic exposure related non-cancer respiratory effects, and lung cancer.

In relation to non-carcinogenic effects, acute or short term (eg episodic) exposure to diesel particulate matter can cause acute irritation (eg eye, throat, bronchial), neurophysiological symptoms (eg light-headedness, nausea), and respiratory symptoms (cough, phlegm). There also is evidence for an immunologic effect-exacerbation of allergenic responses to known allergens and asthma-like symptoms. Chronic effects include respiratory effects. The review of these effects (USEPA 2002) identified a threshold concentration for the assessment of chronic non-carcinogenic effects. The review conducted by the USEPA also concluded that exposures to diesel particulate matter also consider $PM_{2.5}$ goals (as these also address the presence of diesel particulate matter in urban air environments). The review found that the diesel particulate matter chronic guideline would also be met if the $PM_{2.5}$ guideline was met.

Review of exposures to diesel particulate matter (USEPA 2002) identified that such exposures are 'likely to be carcinogenic to humans by inhalation'. A more recent review by IARC (Attfield et al. 2012; IARC 2012; Silverman et al. 2012) classified diesel engine exhaust as carcinogenic to humans (Group 1) based on sufficient evidence that exposure is associated with an increased risk for lung cancer. In addition, outdoor air pollution and particulate matter (that includes diesel particulate matter) have been classified by IARC as carcinogenic to humans based on sufficient evidence of lung cancer.

Many of the organic compounds present in diesel exhaust are known to have mutagenic and carcinogenic properties and hence it is appropriate that a non-threshold approach is considered for the quantification of lung-cancer endpoints.

In relation to quantifying carcinogenic risks associated with exposure to diesel exhaust, the USEPA (USEPA 2002) has not established a non-threshold value (due to uncertainties identified in the available data).

WHO has used data from studies in rats to estimate unit risk values for cancer (WHO 1996). Using four different studies where lung cancer was the cancer endpoint, WHO calculated a range of 1.6×10^{-5} to 7.1×10^{-5} per microgram per cubic metres (mean value of 3.4×10^{-5} per microgram per cubic metres). This would suggest that an increase in lifetime exposure to diesel particulate matter between 0.14 and 0.625 microgram per cubic metres could result in a one in one hundred thousand excess risk of cancer.

The California Environmental Protection Agency has proposed a unit lifetime cancer risk of 3.0×10^{-4} per microgram per cubic metres diesel particulate matter (OEHHA 1998). This was derived from data on exposed workers and based on evidence that suggested unit risks between 1.5×10^{-4} and 15×10^{-4} per microgram per cubic metres. This would suggest that an increase in lifetime exposure to diesel particulate matter of 0.033 microgram per cubic metres could result in a one in one hundred thousand excess risk of cancer. This estimate has been widely criticised as overestimating the risk and hence has not been considered in this assessment.

On the basis of the above, the WHO cancer unit risk value (mean value of 3.4×10^{-5} per microgram per cubic metres) has been used to evaluate potential excess lifetime risks associated with incremental impacts from diesel particulate matter exposures.

Diesel particulate matter has not been specifically modelled in *Technical Working Paper 4 – Air Quality*; rather diesel particulate matter is part of the $PM_{2.5}$ assessment. For the purpose of this assessment it has been conservatively assumed that 100 per cent of the incremental $PM_{2.5}$ (from the project only) is derived from diesel sources. This is conservative as not all the vehicles using the tunnel (and emitting $PM_{2.5}$) would be diesel powered (as currently there is a mix of petrol, diesel, LPG and hybrid-electric powered vehicles with the proportion of alternative fuels rising in the future).

B.3 Calculation of carcinogenic risk

For the assessment of potential carcinogenic risks, a non-threshold cancer risk is calculated. Non-threshold carcinogenic risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential non-threshold carcinogen. The numerical estimate of excess lifetime cancer risk is calculated as follows for inhalation exposures (USEPA 2009):

Equation 1 Carcinogenic Risk (inhalation) = Concentration in Air x Inhalation Unit Risk x AF

Additional information of the exposure adjustment factor (AF):

The above calculation assumes the receptor is exposed at the same location for 24 hours of the day, every day, for a lifetime (which is assumed to be 70 years). This assumption is overly conservative for residents and workers in the community surrounding the project. Residents do not live in the one home for a lifetime. Guidance from enHealth indicates that an appropriate assumption for the time living in the one home is 35 years (enHealth 2012). For residents, it is assumed that they may be at home for 20 hours per day for 365 days of the year, for 35 years. This results in an adjustment factor of 0.4 (20/24 hours x 35 years/70 years). This factor has been adopted for the assessment of all exposures regardless of whether these are residential areas, schools, recreational areas or workplaces.

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Annexure C: Acceptable risk levels

C.1 General

The acceptability of an additional population risk is the subject of some discussion as there are currently no guidelines available in Australia, or internationally, in relation to an acceptable level of population risk associated with exposure to particulate matter. More specifically there are no guidelines available that relate to an acceptable level of risk for a small population (associated with impacts from a specific activity or project) compared with risks that are relevant to whole urban populations (that are considered when deriving guidelines). The following provides additional discussion in relation to evaluating calculated risk levels.

> *'The solution to developing better criteria for environmental contaminants is not to adopt arbitrary thresholds of 'acceptable risk' in an attempt to manage the public's perception of risk, or develop oversimplified tools for enforcement or risk assessment. Rather, the solution is to standardize the process by which risks are assessed, and to undertake efforts to narrow the gap between the public's understanding of actual vs. perceived risk. A more educated public with regard to the actual sources of known risks to health, environmental or otherwise, will greatly facilitate the regulatory agencies' ability to prioritize their efforts and standards to reduce overall risks to public health.' (Kelly 1991).*

Most human activities that have contributed to economic progress present also some disadvantages, including risks of different kinds that adversely affect human health. These risks include air or water pollution due to industrial activities (coal power generation, chemical plants, and transportation), food contaminants (pesticide residues, additives), and soil contamination (hazardous waste). Despite all possible efforts to reduce these threats, it is clear that the zero risk objective is unobtainable or simply not necessary for human and environmental protection and that a certain level of risk in a given situation is deemed 'acceptable' as the effects are so small as to be negligible or undetectable. Risk managers need to cope with some residual risks and thus must adopt some measure of an acceptable risk.

Much has been written about how to determine the acceptability of risk. The general consensus in the literature is that 'acceptability' of a risk is a judgment decision properly made by those exposed to the hazard or their designated health officials. It is not a scientifically derived value or a decision made by outsiders to the process. Acceptability is based on many factors, such as the number of people exposed, the consequences of the risk, the degree of control over exposure, and many other factors.

The USEPA (Hoffman 1988) 'surveyed a range of health risks that our society faces' and reviewed acceptable-risk standards of government and independent institutions. The survey found that 'No fixed level of risk could be identified as acceptable in all cases and under all regulatory programs...,' and that: '...the acceptability of risk is a relative concept and involves consideration of different factors'. Considerations may include:

- The certainty and severity of the risk
- The reversibility of the health effect
- The knowledge or familiarity of the risk
- Whether the risk is voluntarily accepted or involuntarily imposed
- Whether individuals are compensated for their exposure to the risk
- The advantages of the activity
- The risks and advantages for any alternatives.

To regulate a technology in a logically defensible way, one must consider all its consequences, ie both risks and benefits.

C.2 10-6 as an 'acceptable' risk level?

The concept of $1x10^{-6}$ (10^{-6}) was originally an arbitrary number, finalised by the US Food and Drug Administration (FDA) in 1977 as a screening level of 'essentially zero' or de minimus risk. The term de minimus is an abbreviation of the legal concept, 'de minimus non curat lex: the law does not concern itself with trifles.' In other words, 10^{-6} was developed as a level of risk below which risk was considered a 'trifle' and not of concern in a legal case.

This concept was traced back to a 1961 proposal by two scientists from the National Cancer Institute regarding methods to determine 'safety' levels in carcinogenicity testing. The FDA applied the concept in risk assessment in its efforts to deal with diethylstilboestrol as a growth promoter in cattle. The threshold of one in a million risk of developing cancer was established as a screening level to determine what carcinogenic animal drug residues merited further regulatory consideration. In the FDA legislation, the regulators specifically stated that this level of 'essentially zero' was not to be interpreted as equal to an acceptable level of residues in meat products. Since then, the use of risk assessment and 10^{-6} (or variations thereof) have been greatly expanded to almost all areas of chemical regulation, to the point where today one-in-a-million (10^{-6}) risk means different things to different regulatory agencies in different countries. What the FDA intended to be a lower regulatory level of 'zero risk' below which no consideration would be given as to risk to human health, for many regulators it somehow came to be considered a maximum or target level of 'acceptable' risk (Kelly 1991).

When evaluating human health risks, the quantification of risk can involve the calculation of an increased lifetime chance of cancer (as is calculated for diesel particulate matter in this assessment) or an increased probability of some adverse health effect (or disease) occurring, over and above the baseline incidence of that health effect/disease in the community (as is calculated for exposure to particulate matter).

In the context of human health risks, 10^{-6} is a shorthand description for an increased chance of 0.000001 in one (one chance in a million) of developing a specific adverse health effect due to exposure (over a lifetime or a shorter duration as relevant for particulate matter) to a substance. The number 10^{-5} represents one chance in 100,000, and so on.

Where cancer may be considered, lifetime exposure to a substance associated with a cancer risk of $1x10^{-6}$ would increase an individual's current chances of developing cancer from all causes (which is 40 per cent, or 0.4 – the background incidence of cancer in a lifetime) from 0.4 to 0.400001, an increase of 0.00025 per cent.

For other health indicators considered in this assessment, such as cardiovascular hospitalisations for people aged 65 years and older (for example), an increased risk of 10^{-6} (one chance in a million) would increase an individual's (aged 65 years and older) chance of hospitalisation for cardiovascular disease (above the baseline incidence of 23 per cent, or 0.23) from 0.23 to 0.230001, an increase of 0.00043 per cent.

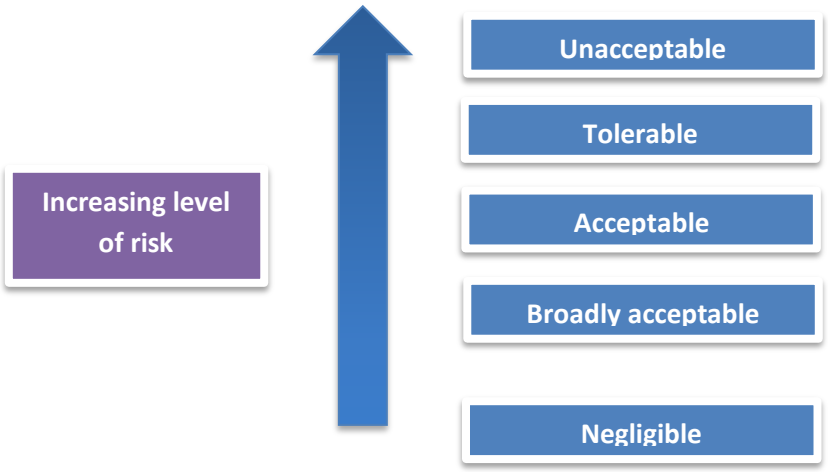
To provide more context in relation to the concept of a one in a million risk, the following presents a range of everyday life occurrences. The activity and the time spent undertaking the activity that is associated with reaching a risk of one in a million for mortality are listed below (Higson 1989; NSW Planning 2011):

- Motor vehicle accident – 2.5 days spent driving a motor vehicle to reach one in a million chance of having an accident that causes mortality (death)
- Home accidents – 3.3 days spent within a residence to reach a one in a million chance of having an accident at home that causes mortality
- Pedestrian accident (being struck by vehicles) – 10 days spent walking along roads to reach a one in a million chance of being struck by a vehicle that causes mortality
- Train accident – 12 days spent travelling on a train to reach a one in a million chance of being involved in an accident that causes mortality

- Falling down stairs [1] – 66 days spent requiring the use of stairs in day-to-day activities to reach a one in a million chance of being involved in a fall that causes mortality
- Falling objects – 121 days spent in day-to-day activities to reach a one in a million chance of being hit by a falling object that causes mortality.

This risk level should also be considered in the context that everyone has a cumulative risk of death that ultimately must equal one and the annual risk of death for most of one's life is about one in 1000.

While various terms have been applied, it is clear that the two ends of what is a spectrum of risk are the 'negligible' level and the 'unacceptable' level. Risk levels intermediate between these are frequently adopted by regulators with varying terms often used to describe the levels. When considering a risk derived for an environmental impact it is important to consider that the level of risk that may be considered acceptable would lie somewhere between what is negligible and unacceptable, as illustrated below.



The calculated individual or localised lifetime risk of death or illness due to an exposure to a range of different environmental hazards covers many orders of magnitude, ranging from well less than 10^{-6} to levels of 10^{-3} and higher (in some situations). However, most figures for an acceptable or a tolerable risk range between 10^{-6} to 10^{-4}, used for either one year of exposure or a whole life exposure. It is noteworthy that 10^{-6} as a criterion for 'acceptable risk' has not been applied to all sources of exposure or all agents that pose risk to public health.

A review of the evolution of 10^{-6} reveals that perception of risk is a major determinant of the circumstances under which this criterion is used. The risk level 10^{-6} is not consistently applied to all environmental legislation. Rather, it seems to be applied according to the general perception of the risk associated with the source being regulated and where the risk is being regulated (with different levels selected in different countries for the same sources).

A review of acceptable risk levels at the USEPA (Schoeny 2008) points out that risk assessors can identify risks and possibly calculate their value but cannot determine what is acceptable. Acceptability is a value judgment that varies with type of risk, culture, voluntariness and many other factors. Acceptability may be set by convention or law. The review also states that the USEPA aims for risk levels between 10^{-6} and 10^{-4} for risks calculated to be linear at low dose, while for other endpoints, not thought to be linear at low dose, the risk is compared to Reference Dose/Concentrations or guideline levels. The USEPA typically uses a target reference risk range of 10^{-4} to 10^{-6} for carcinogens in drinking

[1] Mortality risks as presented by: http://www.riskcomm.com/visualaids/riskscale/datasources.php.

water, which is in line with World Health Organization (WHO) guidelines for drinking water quality which, where practical, base guideline values for genotoxic carcinogens on the upper bound estimate of an excess lifetime cancer risk of 10^{-5}.

There are many different ways to define acceptable risk and each way gives different weight to the views of different stakeholders in the debate. No definition of 'acceptable' would be acceptable to all stakeholders. Resolving such issues, therefore, becomes a political (in the widest sense) rather than a strictly health process.

The following is a list of standpoints that could be used as a basis for determining when a risk is acceptable or, perhaps, tolerable. The WHO (Fewtrell & Bartram 2001) address standards related to water quality. They offer the following guidelines for determining acceptable risk. A risk is acceptable when:

- It falls below an arbitrary defined probability
- It falls below some level that is already tolerated
- It falls below an arbitrary defined attributable fraction of total disease burden in the community
- The cost of reducing the risk would exceed the costs saved
- The cost of reducing the risk would exceed the costs saved when the 'costs of suffering' are also factored in
- The opportunity costs would be better spent on other, more pressing, public health problems
- Public health professionals say it is acceptable
- The general public say it is acceptable (or more likely, do not say it is not)
- Politicians say it is acceptable.

In everyday life individual risks are rarely considered in isolation. It could be argued that a sensible approach would be to consider health risks in terms of the total disease burden of a community and to define acceptability in terms of it falling below an arbitrary defined level. A problem with this approach is that the current burden of disease attributable to a single factor, such as air pollution, may not be a good indicator of the potential reductions available from improving other environmental health factors. For diseases such as cardiovascular disease where causes are multifactorial, reducing the disease burden by one route may have little impact on the overall burden of disease.

C.3 Overall

It is not possible to provide a rigid definition of acceptable risk due to the complex and context driven nature of the challenge. It is possible to propose some general guidelines as to what might be an acceptable risk for specific development projects.

If the level of 10^{-6} (one chance in a million) were retained as a level of increased risk that would be considered as a negligible risk in the community, then the level of risk that could be considered to be tolerable would lie between this level and an upper level that is considered to be unacceptable.

While there is no guidance available on what level of risk is considered to be unacceptable in the community, a level of 10^{-4} for increased risk (one chance in 10,000) has been generally adopted by health authorities as a point where risk is considered to be unacceptable in the development of drinking water guidelines (that impact on whole populations) (for exposure to carcinogens as well as for annual risks of disease (Fewtrell & Bartram 2001)) and in the evaluation of exposures from pollutants in air (NSW DEC 2005).

Between an increased risk level considered negligible (10^{-6}) and unacceptable (10^{-4}) lie risks that may be considered to be tolerable or even acceptable. Tolerable risks are those that can be tolerated (and where the best available, and most appropriate, technology has been implemented to minimise exposure) in order to realise some benefit.

In a societal context, risks are inevitable and any new development would be accompanied by risks which are not amenable or economically feasible to reduce below a certain level. It is not good policy

to impose an arbitrary risk level to such developments without consideration of the myriad factors that should be brought into play to determine what is 'tolerable'.

When considering the impacts associated with this project, it is important to note that there are a range of benefits associated with the project and the design of the project has incorporated measures to minimise exposures to traffic-related emissions in the local areas. Hence for this project the calculated risks have been considered to be tolerable when in the range of 10^{-6} and 10^{-4} of increased risk and where the increased incidence of the health impacts are considered to be insignificant.

C.4 Determining the significance of population impacts

The assessment of potential health impacts associated with emissions to air from the project has not only calculated an increased annual risk, relevant to the health endpoints considered, but also a change in the incidence, ie the additional (or saving of) number of cases, of the adverse effects occurring within the population potentially exposed. The calculated change in incidence need to be considered in terms of what may be significant.

In relation to the calculated change in incidence of an adverse health effect occurring in a population, the following is noted for the primary health indicators (based on statistics available from NSW Health):

- In relation to mortality (all causes), the health statistics available show that for the year 2011/2012 the variability in all admissions data reported (based on the 95 per cent confidence interval for data reported in Sydney) is around ± 2.5 per cent. This is the variability in the data reported in one year. Each year the mortality rate also varies with around one per cent variability reported in the mortality rate (number reported for all causes) between 2010/11 and 2011/12. Based on the population considered in this assessment and the baseline incidence, a one per cent variability results in ± 10 cases per year. Changes in mortality within this range would not be detected (above normal variability) in the health statistics
- In relation to cardiovascular disease hospitalisations, the health statistics available show that for the year 2013/2014 the variability in all admissions data reported (based on the 95 percent confidence interval for data reported in Sydney) is around ± two percent. This is the variability in the data reported in one year. Each year the rate of hospitalisations (all ages) also varies with around two to three per cent variability reported in the number of hospitalisations for people aged 65 years and older in each year between 2010/11 and 2013/14. Based on the baseline incidence of cardiovascular hospitalisations considered in this assessment for individuals aged 65 years and the population considered in this assessment a variability of two per cent equates to ± 40 cases per year. Changes in cardiovascular hospitalisations in the population aged 65 years and older within this range would not be detected (above normal variability) in the health statistics
- In relation to respiratory disease hospitalisations, the health statistics available show that for the year 2013/2014 the variability in all admissions data reported (based on the 95 per cent confidence interval for data reported in Sydney) is around ± six per cent. This is the variability in the data reported in one year. Each year the rate of hospitalisations (all ages) also varies with around three to four per cent variability reported in the number of hospitalisations (all ages) in each year between 2011 and 2014. Based on the baseline incidence of respiratory hospitalisations considered in this assessment for individuals aged 65 years and older, and the population evaluated in this assessment, a variability of three per cent equates to ± 25 cases per year. Changes in respiratory hospitalisations in the population aged 65 years and older within this range would not be detected (above normal variability) in the health statistics.

Where changes in air quality associated with this project are well below 10 cases per year they are considered to be within the normal variability of health statistics. For evaluating impacts form this project a 10 fold margin of safety has been included to determine what changes in incidence may be considered negligible within the study population. This means that changes in the population incidence of any health effect evaluated that is less than one case per year are considered negligible.

C.5 References

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Annexure D: Risk calculations – Nitrogen dioxide

Quantification of Effects - NO_2
Gateway Road Project

	2026		
Air quality indicator:	**NO2**	**NO2**	**NO2**
Endpoint:	**Mortality - All Causes**	**Mortality - Respiratory**	**Asthma - ED Hospital admissions**
Effect Exposure Duration:	Short-term	Short-term	Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m^3 NO2) (as per Table 6.12)	0.00188	0.00426	0.00115
Annual Baseline Incidence (as per Table 4.5)			
Annual baseline incidence (per 100,000)	457	41.3	1209
Baseline Incidence (per person per year)	0.00457	0.000413	0.01209

2026 - Cumulative		
NO2	**NO2**	**NO2**
Mortality - All Causes	**Mortality - Respiratory**	**Asthma - ED Hospital admissions**
Short-term	Short-term	Short-term
All ages	All ages	1-14 years
0.00188	0.00426	0.00115
457	41.3	1209
0.00457	0.000413	0.01209

Sensitive Receptors		**Change in Annual Average NO2 Concentration (µg/m^3)**	**Risk**	**Risk**	**Risk**	**Change in Annual Average NO2 Concentration (µg/m^3)**	**Risk**	**Risk**	**Risk**
Maximum impacts from all RWR receptors									
Grid receptors: maximum regardless of landuse		**4.48**	**4E-05**	**8E-06**	**6E-05**	**4.11**	**4E-05**	**7E-06**	**6E-05**
Grid receptors: maximum residential		**4.00**	**3E-05**	**7E-06**	**6E-05**	**3.98**	**3E-05**	**7E-06**	**6E-05**
Grid receptors: commercial/industrial		**4.48**	**4E-05**	**8E-06**	**6E-05**	**4.11**	**4E-05**	**7E-06**	**6E-05**
Grid receptors: maximum childcare and schools		**0.57**	**5E-06**	**1E-06**	**8E-06**	**0.31**	**3E-06**	**5E-07**	**4E-06**
Grid receptors: maximum aged care		**0.08**	**7E-07**	**1E-07**	**1E-06**	**0.03**	**3E-07**	**6E-08**	**5E-07**
Grid receptors: maximum hospital and medical		**0.47**	**4E-06**	**8E-07**	**7E-06**	**0.35**	**3E-06**	**6E-07**	**5E-06**
Grid receptors: open space		**0.27**	**2E-06**	**5E-07**	**4E-06**	**0.44**	**4E-06**	**8E-07**	**6E-06**
Community Receptors									
Aero Kids Early Learning Centre	Childcare	-0.352	-3E-06	-6E-07	-5E-06	-0.123	-1E-06	-2E-07	-2E-06
Guardian Early Learning Centre	Childcare	0.099	9E-07	2E-07	1E-06	0.153	1E-06	3E-07	2E-06
Gardeners Road Public School	School	0.406	3E-06	7E-07	6E-06	0.408	4E-06	7E-07	6E-06
Botany Public School	School	-0.654	-6E-06	-1E-06	-9E-06	-1.043	-9E-06	-2E-06	-1E-05
Mascot Public School	School	-0.782	-7E-06	-1E-06	-1E-05	-0.376	-3E-06	-7E-07	-5E-06
Tempe High School	School	-0.464	-4E-06	-8E-07	-6E-06	-0.930	-8E-06	-2E-06	-1E-05
JJ Cahill Memorial High School	School	-0.613	-5E-06	-1E-06	-9E-06	-1.003	-9E-06	-2E-06	-1E-05
St Bernard's Catholic Primary School	School	-2.390	-2E-05	-4E-06	-3E-05	-2.296	-2E-05	-4E-06	-3E-05
Active Kids Mascot	Childcare	-1.331	-1E-05	-2E-06	-2E-05	-1.126	-1E-05	-2E-06	-2E-05
Betty Spears Child Care Centre	Childcare	-1.009	-9E-06	-2E-06	-1E-05	-1.595	-1E-05	-3E-06	-2E-05
Toybox Early Learning	Childcare	-1.260	-1E-05	-2E-06	-2E-05	-1.254	-1E-05	-2E-06	-2E-05
Mascot Child Care Centre	Childcare	-0.143	-1E-06	-3E-07	-2E-06	-0.550	-5E-06	-1E-06	-8E-06
St Theres Catholic Primary School	School	-0.122	-1E-06	-2E-07	-2E-06	-0.413	-4E-06	-7E-07	-6E-06
St Peters Public School	School	-0.238	-2E-06	-4E-07	-3E-06	-0.348	-3E-06	-6E-07	-5E-06
Tillman Park Child Care Centre	Childcare	0.025	2E-07	4E-08	3E-07	-0.011	-1E-07	-2E-08	-2E-07
Tempe Public School	School	-0.478	-4E-06	-8E-07	-7E-06	-0.373	-3E-06	-7E-07	-5E-06
Pagewood Kindergarten	Childcare	-0.137	-1E-06	-2E-07	-2E-06	0.121	1E-06	2E-07	2E-06

Quantification of Effects - NO_2
Gateway Road Project

Air quality indicator:	2036			2036 - Cumulative		
	NO2	NO2	NO2	NO2	NO2	NO2
Endpoint:	Mortality - All Causes	Mortality - Respiratory	Asthma - ED Hospital admissions	Mortality - All Causes	Mortality - Respiratory	Asthma - ED Hospital admissions
Effect Exposure Duration:	Short-term	Short-term	Short-term	Short-term	Short-term	Short-term
Age Group:	All ages	All ages	1-14 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m^3 NO2) (as per Table 6.12)	0.00188	0.00426	0.00115	0.00188	0.00426	0.00115
Annual Baseline Incidence (as per Table 4.5)						
Annual baseline incidence (per 100,000)	457	41.3	1209	457	41.3	1209
Baseline Incidence (per person per year)	0.00457	0.000413	0.01209	0.00457	0.000413	0.01209

Sensitive Receptors		Change in Annual Average NO2 Concentration (µg/m^3)	Risk	Risk	Risk	Change in Annual Average NO2 Concentration (µg/m^3)	Risk	Risk	Risk
Maximum impacts from all RWR receptors									
Grid receptors: maximum regardless of landuse		**5.33**	**5E-05**	**9E-06**	**7E-05**	**5.35**	**5E-05**	**9E-06**	**7E-05**
Grid receptors: maximum residential		**5.25**	**5E-05**	**9E-06**	**7E-05**	**5.13**	**4E-05**	**9E-06**	**7E-05**
Grid receptors: commercial/industrial		**5.33**	**5E-05**	**9E-06**	**7E-05**	**5.35**	**5E-05**	**9E-06**	**7E-05**
Grid receptors: maximum childcare and schools		**0.41**	**4E-06**	**7E-07**	**6E-06**	**0.37**	**3E-06**	**7E-07**	**5E-06**
Grid receptors: maximum aged care		**-0.005**	**-4E-08**	**-9E-09**	**-7E-08**	**-0.09**	**-8E-07**	**-2E-07**	**-1E-06**
Grid receptors: maximum hospital and medical		**0.32**	**3E-06**	**6E-07**	**4E-06**	**0.43**	**4E-06**	**8E-07**	**6E-06**
Grid receptors: open space		**0.35**	**3E-06**	**6E-07**	**5E-06**	**0.35**	**3E-06**	**6E-07**	**5E-06**
Community Receptors									
Aero Kids Early Learning Centre	Childcare	0.370	3E-06	7E-07	5E-06	0.023	2E-07	4E-08	3E-07
Guardian Early Learning Centre	Childcare	-0.492	-4E-06	-9E-07	-7E-06	-0.371	-3E-06	-7E-07	-5E-06
Gardeners Road Public School	School	0.106	9E-07	2E-07	1E-06	-0.399	-3E-06	-7E-07	-6E-06
Botany Public School	School	-0.721	-6E-06	-1E-06	-1E-05	-1.230	-1E-05	-2E-06	-2E-05
Mascot Public School	School	-0.235	-2E-06	-4E-07	-3E-06	-0.588	-5E-06	-1E-06	-8E-06
Tempe High School	School	-0.618	-5E-06	-1E-06	-9E-06	-0.992	-9E-06	-2E-06	-1E-05
JJ Cahill Memorial High School	School	-0.448	-4E-06	-8E-07	-6E-06	-0.565	-5E-06	-1E-06	-8E-06
St Bernard's Catholic Primary School	School	-1.713	-1E-05	-3E-06	-2E-05	-2.211	-2E-05	-4E-06	-3E-05
Active Kids Mascot	Childcare	-1.639	-1E-05	-3E-06	-2E-05	-1.177	-1E-05	-2E-06	-2E-05
Betty Spears Child Care Centre	Childcare	-1.325	-1E-05	-2E-06	-2E-05	-1.513	-1E-05	-3E-06	-2E-05
Toybox Early Learning	Childcare	-1.453	-1E-05	-3E-06	-2E-05	-1.556	-1E-05	-3E-06	-2E-05
Mascot Child Care Centre	Childcare	-0.622	-5E-06	-1E-06	-9E-06	-1.010	-9E-06	-2E-06	-1E-05
St Theres Catholic Primary School	School	-0.527	-5E-06	-9E-07	-7E-06	-0.697	-6E-06	-1E-06	-1E-05
St Peters Public School	School	0.055	5E-07	1E-07	8E-07	0.037	3E-07	7E-08	5E-07
Tillman Park Child Care Centre	Childcare	0.017	1E-07	3E-08	2E-07	0.171	1E-06	3E-07	2E-06
Tempe Public School	School	0.117	1E-06	2E-07	2E-06	0.069	6E-07	1E-07	1E-06
Pagewood Kindergarten	Childcare	0.327	3E-06	6E-07	5E-06	0.300	3E-06	5E-07	4E-06

Annexure E: Population incidence calculations – Nitrogen dioxide

Assessment of Increased Incidence - NO2
Gateway Road Project: 2026

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Inner West (including Strathfield - Burwood - Ashfield LGA)			
Total Population in study area:	62688	62688	62688
% population in assessment age-group:	100%	100%	14%
total change	-3155	-3155	-3155
Population weighted Δx (µg/m^3):	-0.05032861	-0.05032861	-0.05032861
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999905	0.999786	0.999942
Attributable fraction (AF):	-9.5E-05	-2.1E-04	-5.8E-05
Increased number of cases in population:	-0.0310	-0.00555	-0.00619
Risk:	-4.9E-07	-8.9E-08	-7.0E-07
Individual subrubs within LGA			
Marrickville			
Total Population in study area:	26542	26542	26542
% population in assessment age-group:	100%	100%	14%
total change	-1279	-1279	-1279
Population weighted Δx (µg/m^3):	-0.04818778	-0.04818778	-0.04818778
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999909	0.999795	0.999945
Attributable fraction (AF):	-9.1E-05	-2.1E-04	-5.5E-05
Increased number of cases in population:	-0.013	-0.0023	-0.00251
Risk:	-4.7E-07	-8.5E-08	-6.7E-07
Petersham - Stanmore			
Total Population in study area:	4922	4922	4922
% population in assessment age-group:	100%	100%	14%
total change	-388	-388	-388
Population weighted Δx (µg/m^3):	-0.07882974	-0.07882974	-0.07882974
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999852	0.999664	0.999909
Attributable fraction (AF):	-1.5E-04	-3.4E-04	-9.1E-05
Increased number of cases in population:	-0.0038	-0.00068	-0.00076
Risk:	-7.7E-07	-1.4E-07	-1.1E-06
Sydenham - Tempe - St Peters			
Total Population in study area:	7829	7829	7829
% population in assessment age-group:	100%	100%	14%
total change	-731	-731	-731
Population weighted Δx (µg/m^3):	-0.09337080	-0.09337080	-0.09337080
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999824	0.999602	0.999893
Attributable fraction (AF):	-1.8E-04	-4.0E-04	-1.1E-04
Increased number of cases in population:	-0.0072	-0.0013	-0.0014
Risk:	-9.2E-07	-1.6E-07	-1.3E-06
Ashfield			
Total Population in study area:	1979	1979	1979
% population in assessment age-group:	100%	100%	14%
total change	-67.1	-67.1	-67.1
Population weighted Δx (µg/m^3):	-0.03390601	-0.03390601	-0.03390601
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999936	0.999856	0.999961
Attributable fraction (AF):	-6.4E-05	-1.4E-04	-3.9E-05
Increased number of cases in population:	-0.00066	-0.00012	-0.00013
Risk:	-3.3E-07	-6.0E-08	-4.7E-07
Canterbury (North) - Ashbury			
Total Population in study area:	7538	7538	7538

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
% population in assessment age-group:	100%	100%	14%
total change	-279	-279	-279
Population weighted Δx (µg/m^3):	-0.03701247	-0.03701247	-0.03701247
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999930	0.999842	0.999957
Attributable fraction (AF):	-7.0E-05	-1.6E-04	-4.3E-05
Increased number of cases in population:	-0.0027	-0.00049	-0.00055
Risk:	-3.6E-07	-6.5E-08	-5.1E-07
Dulwich Hill - Lewisham			
Total Population in study area:	13640	13640	13640
% population in assessment age-group:	100%	100%	14%
total change	-392	-392	-392
Population weighted Δx (µg/m^3):	-0.02873900	-0.02873900	-0.02873900
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999946	0.999878	0.999967
Attributable fraction (AF):	-5.4E-05	-1.2E-04	-3.3E-05
Increased number of cases in population:	-0.0038	-0.00069	-0.00077
Risk:	-2.8E-07	-5.1E-08	-4.0E-07
Haberfield - Summer Hill			
Total Population in study area:	238	238	238
% population in assessment age-group:	100%	100%	14%
total change	-17	-17	-17
Population weighted Δx (µg/m^3):	-0.07142857	-0.07142857	-0.07142857
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999866	0.999696	0.999918
Attributable fraction (AF):	-1.3E-04	-3.0E-04	-8.2E-05
Increased number of cases in population:	-0.00017	-0.000030	-0.000033
Risk:	-7.0E-07	-1.3E-07	-9.9E-07
Sydney Inner City LGA			
Total Population in study area:	47106	47106	47106
% population in assessment age-group:	100%	100%	6%
total change	-7399	-7399	-7399
Population weighted Δx (µg/m^3):	-0.15707129	-0.15707129	-0.15707129
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209
Relative Risk:	0.999705	0.999331	0.999819
Attributable fraction (AF):	-3.0E-04	-6.7E-04	-1.8E-04
Increased number of cases in population:	-0.063	-0.01302	-0.0061
Risk:	-1.3E-06	-2.8E-07	-2.2E-06
Individual subrubs within LGA			
Erskinville - Alexandria			
Total Population in study area:	14292	14292	14292
% population in assessment age-group:	100%	100%	6%
total change	-2194	-2194	-2194
Population weighted Δx (µg/m^3):	-0.15351245	-0.15351245	-0.15351245
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209
Relative Risk:	0.999711	0.999346	0.999823
Attributable fraction (AF):	-2.9E-04	-6.5E-04	-1.8E-04
Increased number of cases in population:	-0.0187	-0.00386	-0.001800
Risk:	-1.3E-06	-2.7E-07	-2.1E-06
Newtown - Camperdown - Darlington			
Total Population in study area:	6910	6910	6910
% population in assessment age-group:	100%	100%	6%
total change	-350	-350	-35000%
Population weighted Δx (µg/m^3):	-0.05065123	-0.05065123	-0.05065123
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Relative Risk:	0.999905	0.999784	0.999942
Attributable fraction (AF):	-9.5E-05	-2.2E-04	-5.8E-05
Increased number of cases in population:	-0.0030	-0.00062	-0.00029
Risk:	-4.3E-07	-8.9E-08	-7.0E-07
Waterloo - Beaconsfield			
Total Population in study area:	25904	25904	25904
% population in assessment age-group:	100%	100%	6%
total change	-4853	-4853	-4853
Population weighted Δx (µg/m^3):	-0.18734558	-0.18734558	-0.18734558
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209
Relative Risk:	0.999648	0.999202	0.999785
Attributable fraction (AF):	-3.5E-04	-8.0E-04	-2.2E-04
Increased number of cases in population:	-0.041	-0.0085	-0.0040
Risk:	-1.6E-06	-3.3E-07	-2.6E-06
Canterbury LGA			
Total Population in study area:	12648	12648	12648
% population in assessment age-group:	100%	100%	19%
total change	-364.00	-364	-364
Population weighted Δx (µg/m^3):	-0.02877925	-0.02877925	-0.02877925
Baseline Incidence (per 100,000) (as per Table 4.5)	508	41	1209
Baseline Incidence (per person)	0.00508	0.00041	0.01209
Relative Risk:	0.999946	0.999877	0.999967
Attributable fraction (AF):	-5.4E-05	-1.2E-04	-3.3E-05
Increased number of cases in population:	-0.0035	-0.00064	-0.0010
Risk:	-2.8E-07	-5.1E-08	-4.0E-07
Individual subrubs within LGA			
Canterbury (South) - Campsie			
Total Population in study area:	149	149	149
% population in assessment age-group:	100%	100%	19%
total change	3.3	3.3	3.3
Population weighted Δx (µg/m^3):	0.02214765	0.02214765	0.02214765
Baseline Incidence (per 100,000) (as per Table 4.5)	508	41	1209
Baseline Incidence (per person)	0.00508	0.00041	0.01209
Relative Risk:	1.000042	1.000094	1.000025
Attributable fraction (AF):	4.2E-05	9.4E-05	2.5E-05
Increased number of cases in population:	0.000032	0.0000058	0.0000088
Risk:	2.1E-07	3.9E-08	3.1E-07
Kingsgrove (North) - Earlwood			
Total Population in study area:	12499	12499	12499
% population in assessment age-group:	100%	100%	19%
total change	-367	-367	-367
Population weighted Δx (µg/m^3):	-0.02936235	-0.02936235	-0.02936235
Baseline Incidence (per 100,000) (as per Table 4.5)	508	41	1209
Baseline Incidence (per person)	0.00508	0.00041	0.01209
Relative Risk:	0.999945	0.999875	0.999966
Attributable fraction (AF):	-5.5E-05	-1.3E-04	-3.4E-05
Increased number of cases in population:	-0.0035	-0.00065	-0.0010
Risk:	-2.8E-07	-5.2E-08	-4.1E-07
Botany LGA			
Total Population in study area:	46677	46677	46677
% population in assessment age-group:	100%	100%	16%
total change	-22372.0	-22372	-22372
Population weighted Δx (µg/m^3):	-0.47929387	-0.47929387	-0.47929387
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.999099	0.997960	0.999449
Attributable fraction (AF):	-9.0E-04	-2.0E-03	-5.5E-04
Increased number of cases in population:	-0.235512	-0.039401	-0.048848
Risk:	-5.0E-06	-8.4E-07	-6.7E-06

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Individual subrubs within LGA			
Banksmeadow			
Total Population in study area:	21	21	21
% population in assessment age-group:	100%	100%	16%
total change	5.3	5.3	5.3
Population weighted Δx (µg/m^3):	0.25238095	0.25238095	0.25238095
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	1.000475	1.001076	1.000290
Attributable fraction (AF):	4.7E-04	1.1E-03	2.9E-04
Increased number of cases in population:	0.000056	0.0000093	0.0000116
Risk:	2.7E-06	4.4E-07	3.5E-06
Botany			
Total Population in study area:	10780	10780	10780
% population in assessment age-group:	100%	100%	16%
total change	-638	-638	-638
Population weighted Δx (µg/m^3):	-0.05918367	-0.05918367	-0.05918367
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.999889	0.999748	0.999932
Attributable fraction (AF):	-1.1E-04	-2.5E-04	-6.8E-05
Increased number of cases in population:	-0.0067	-0.0011	-0.0014
Risk:	-6.2E-07	-1.0E-07	-8.2E-07
Mascot - Eastlakes			
Total Population in study area:	24409	24409	24409
% population in assessment age-group:	100%	100%	16%
total change	-21283	-21283	-21283
Population weighted Δx (µg/m^3):	-0.87193248	-0.87193248	-0.87193248
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.998362	0.996292	0.998998
Attributable fraction (AF):	-1.6E-03	-3.7E-03	-1.0E-03
Increased number of cases in population:	-0.2241	-0.0375	-0.0465
Risk:	-9.2E-06	-1.5E-06	-1.2E-05
Pagewood - Hillsdale - Daceyville			
Total Population in study area:	11400	11400	11400
% population in assessment age-group:	100%	100%	16%
total change	-465	-465	-465
Population weighted Δx (µg/m^3):	-0.04078947	-0.04078947	-0.04078947
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.999923	0.999826	0.999953
Attributable fraction (AF):	-7.7E-05	-1.7E-04	-4.7E-05
Increased number of cases in population:	-0.0049	-0.00082	-0.0010
Risk:	-4.3E-07	-7.2E-08	-5.7E-07
Port Botany Industrial			
Total Population in study area:	6	6	6
% population in assessment age-group:	100%	100%	2100%
total change	1.5	1.5	1.5
Population weighted Δx (µg/m^3):	0.25000000	0.25000000	0.25000000
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	1.000470	1.001066	1.000288
Attributable fraction (AF):	4.7E-04	1.1E-03	2.9E-04
Increased number of cases in population:	0.0000158	0.0000026	0.00044
Risk:	2.6E-06	4.4E-07	3.5E-06
Sydney Airport			
Total Population in study area:	61	61	61
% population in assessment age-group:	100%	100%	16%
total change	8.4	8.4	8.4
Population weighted Δx (µg/m^3):	0.13770492	0.13770492	0.13770492
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	1.000259	1.000587	1.000158
Attributable fraction (AF):	2.6E-04	5.9E-04	1.6E-04
Increased number of cases in population:	0.00009	0.000015	0.000018
Risk:	1.4E-06	2.4E-07	1.9E-06
Kogarah - Rockdale LGA			
Total Population in study area:	102876	102876	102876
% population in assessment age-group:	100%	100%	15%
total change	-1732.0	-1732	-1732
Population weighted Δx (µg/m^3):	-0.01683580	-0.01683580	-0.01683580
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999968	0.999928	0.999981
Attributable fraction (AF):	-3.2E-05	-7.2E-05	-1.9E-05
Increased number of cases in population:	-0.016	-0.0030	-0.0035
Risk:	-1.5E-07	-3.0E-08	-2.3E-07
Individual subrubs within LGA			
Arncliffe - Bardwell Park			
Total Population in study area:	21457	21457	21457
% population in assessment age-group:	100%	100%	15%
total change	-1439	-1439	-1439
Population weighted Δx (µg/m^3):	-0.06706436	-0.06706436	-0.06706436
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999874	0.999714	0.999923
Attributable fraction (AF):	-1.3E-04	-2.9E-04	-7.7E-05
Increased number of cases in population:	-0.0132	-0.0025	-0.00292
Risk:	-6.2E-07	-1.2E-07	-9.3E-07
Bexley			
Total Population in study area:	20419	20419	20419
% population in assessment age-group:	100%	100%	15%
total change	-695	-695	-695
Population weighted Δx (µg/m^3):	-0.03403693	-0.03403693	-0.03403693
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999936	0.999855	0.999961
Attributable fraction (AF):	-6.4E-05	-1.5E-04	-3.9E-05
Increased number of cases in population:	-0.0064	-0.0012	-0.00141
Risk:	-3.1E-07	-6.0E-08	-4.7E-07
Kingsgrove (South) - Bardwell Park			
Total Population in study area:	2879	2879	2879
% population in assessment age-group:	100%	100%	15%
total change	-86	-86	-86
Population weighted Δx (µg/m^3):	-0.02987148	-0.02987148	-0.02987148
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999944	0.999873	0.999966
Attributable fraction (AF):	-5.6E-05	-1.3E-04	-3.4E-05
Increased number of cases in population:	-0.0008	-0.00015	-0.00017
Risk:	-2.7E-07	-5.3E-08	-4.2E-07
Kogarah			
Total Population in study area:	11323	11323	11323
% population in assessment age-group:	100%	100%	15%
total change	382	382	382
Population weighted Δx (µg/m^3):	0.03373664	0.03373664	0.03373664
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	1.000063	1.000144	1.000039
Attributable fraction (AF):	6.3E-05	1.4E-04	3.9E-05
Increased number of cases in population:	0.0035	0.00067	0.00078
Risk:	3.1E-07	5.9E-08	4.7E-07

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Kogarah Bay			
Total Population in study area:	10788	10788	10788
% population in assessment age-group:	100%	100%	15%
total change	-28	-28	-28
Population weighted Δx (µg/m^3):	-0.00259548	-0.00259548	-0.00259548
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999995	0.999989	0.999997
Attributable fraction (AF):	-4.9E-06	-1.1E-05	-3.0E-06
Increased number of cases in population:	-0.00026	-0.000049	-0.000057
Risk:	-2.4E-08	-4.6E-09	-3.6E-08
Monterey - Brighton-le-Sands - Kyeemagh			
Total Population in study area:	13915	13915	13915
% population in assessment age-group:	100%	100%	15%
total change	116	116	116
Population weighted Δx (µg/m^3):	0.00833633	0.00833633	0.00833633
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	1.000016	1.000036	1.000010
Attributable fraction (AF):	1.6E-05	3.6E-05	9.6E-06
Increased number of cases in population:	0.00106	0.00020	0.000235
Risk:	7.7E-08	1.5E-08	1.2E-07
Rockdale - Banksia			
Total Population in study area:	19957	19957	19957
% population in assessment age-group:	100%	100%	15%
total change	101	101	101
Population weighted Δx (µg/m^3):	0.00506088	0.00506088	0.00506088
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	1.000010	1.000022	1.000006
Attributable fraction (AF):	9.5E-06	2.2E-05	5.8E-06
Increased number of cases in population:	0.00093	0.00018	0.000205
Risk:	4.6E-08	8.9E-09	7.0E-08
Sans Souci - Ramsgate			
Total Population in study area:	2036	2036	2036
% population in assessment age-group:	100%	100%	15%
total change	-74	-74	-74
Population weighted Δx (µg/m^3):	-0.03634578	-0.03634578	-0.03634578
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999932	0.999845	0.999958
Attributable fraction (AF):	-6.8E-05	-1.5E-04	-4.2E-05
Increased number of cases in population:	-0.00068	-0.00013	-0.000150
Risk:	-3.3E-07	-6.4E-08	-5.1E-07
Hurstville			
Total Population in study area:	102	102	102
% population in assessment age-group:	100%	100%	15%
total change	-8.5	-8.5	-8.5
Population weighted Δx (µg/m^3):	-0.08333333	-0.08333333	-0.08333333
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999843	0.999645	0.999904
Attributable fraction (AF):	-1.6E-04	-3.6E-04	-9.6E-05
Increased number of cases in population:	-0.000078	-0.000015	-0.000017
Risk:	-7.6E-07	-1.5E-07	-1.2E-06
Eastern Suburbs			
Total Population in study area:	33621	33621	33621
% population in assessment age-group:	100%	100%	14%
total change	-5058.0	-5058	-5058
Population weighted Δx (µg/m^3):	-0.15044169	-0.15044169	-0.15044169
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999717	0.999359	0.999827
Attributable fraction (AF):	-2.8E-04	-6.4E-04	-1.7E-04
Increased number of cases in population:	-0.047	-0.0089	-0.0097
Risk:	-1.4E-06	-2.6E-07	-2.1E-06
Individual subrubs within LGA			
Centennial Park			
Total Population in study area:	0	0	0
Kensington			
Total Population in study area:	14903	14903	14903
% population in assessment age-group:	100%	100%	14%
total change	-3068	-3068	-3068
Population weighted Δx (µg/m^3):	-0.20586459	-0.20586459	-0.20586459
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999613	0.999123	0.999763
Attributable fraction (AF):	-3.9E-04	-8.8E-04	-2.4E-04
Increased number of cases in population:	-0.0284	-0.0054	-0.00589
Risk:	-1.9E-06	-3.6E-07	-2.9E-06
Kingsford			
Total Population in study area:	11769	11769	11769
% population in assessment age-group:	100%	100%	14%
total change	-1756	-1756	-1756
Population weighted Δx (µg/m^3):	-0.14920554	-0.14920554	-0.14920554
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999720	0.999365	0.999828
Attributable fraction (AF):	-2.8E-04	-6.4E-04	-1.7E-04
Increased number of cases in population:	-0.0163	-0.00309	-0.00337
Risk:	-1.4E-06	-2.6E-07	-2.1E-06
Malabar - La Perouse - Chiffley			
Total Population in study area:	3724	3724	3724
% population in assessment age-group:	100%	100%	14%
total change	111	111	111
Population weighted Δx (µg/m^3):	0.02980666	0.02980666	0.02980666
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	1.000056	1.000127	1.000034
Attributable fraction (AF):	5.6E-05	1.3E-04	3.4E-05
Increased number of cases in population:	0.0010	0.00020	0.00021
Risk:	2.8E-07	5.2E-08	4.1E-07
Maroubra (west)			
Total Population in study area:	2951	2951	2951
% population in assessment age-group:	100%	100%	14%
total change	-294	-294	-294
Population weighted Δx (µg/m^3):	-0.09962725	-0.09962725	-0.09962725
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999813	0.999576	0.999885
Attributable fraction (AF):	-1.9E-04	-4.2E-04	-1.1E-04
Increased number of cases in population:	-0.0027	-0.00052	-0.00056
Risk:	-9.2E-07	-1.8E-07	-1.4E-06
Paddington - Moore Park			
Total Population in study area:	189	189	189
% population in assessment age-group:	100%	100%	14%
total change	-50	-50	-50
Population weighted Δx (µg/m^3):	-0.26455026	-0.26455026	-0.26455026
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999503	0.998874	0.999696
Attributable fraction (AF):	-5.0E-04	-1.1E-03	-3.0E-04
Increased number of cases in population:	-0.00046	-0.00009	-0.000096

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Risk:	-2.4E-06	-4.7E-07	-3.7E-06
Randwick (North and South)			
Total Population in study area:	85	85	85
% population in assessment age-group:	100%	100%	14%
total change	0.2	0.2	0.2
Population weighted Δx (µg/m^3):	0.00235294	0.00235294	0.00235294
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	1.000004	1.000010	1.000003
Attributable fraction (AF):	4.4E-06	1.0E-05	2.7E-06
Increased number of cases in population:	0.0000019	0.00000035	0.00000038
Risk:	2.2E-08	4.1E-09	3.3E-08
Total population incidence - All Suburbs	**-0.40**	**-0.071**	**-0.075**

Assessment of Increased Incidence - NO2
Gateway Road Project: 2026 Cumulative

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Inner West (including Strathfield - Burwood - Ashfield LGA)			
Total Population in study area:	62688	62688	62688
% population in assessment age-group:	100%	100%	14%
total change	-3484	-3484	-3484
Population weighted Δx (µg/m^3):	-0.05557682	-0.05557682	-0.05557682
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999896	0.999763	0.999936
Attributable fraction (AF):	-1.0E-04	-2.4E-04	-6.4E-05
Increased number of cases in population:	-0.0342	-0.00613	-0.00683
Risk:	-5.5E-07	-9.8E-08	-7.7E-07
Individual subrubs within LGA			
Marrickville			
Total Population in study area:	26542	26542	26542
% population in assessment age-group:	100%	100%	14%
total change	-1430	-1430	-1430
Population weighted Δx (µg/m^3):	-0.05387687	-0.05387687	-0.05387687
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999899	0.999771	0.999938
Attributable fraction (AF):	-1.0E-04	-2.3E-04	-6.2E-05
Increased number of cases in population:	-0.014	-0.0025	-0.00280
Risk:	-5.3E-07	-9.5E-08	-7.5E-07
Petersham - Stanmore			
Total Population in study area:	4922	4922	4922
% population in assessment age-group:	100%	100%	14%
total change	-454	-454	-454
Population weighted Δx (µg/m^3):	-0.09223893	-0.09223893	-0.09223893
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999827	0.999607	0.999894
Attributable fraction (AF):	-1.7E-04	-3.9E-04	-1.1E-04
Increased number of cases in population:	-0.0045	-0.00080	-0.00089
Risk:	-9.0E-07	-1.6E-07	-1.3E-06
Sydenham - Tempe - St Peters			
Total Population in study area:	7829	7829	7829
% population in assessment age-group:	100%	100%	14%
total change	-740	-740	-740
Population weighted Δx (µg/m^3):	-0.09452037	-0.09452037	-0.09452037
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999822	0.999597	0.999891
Attributable fraction (AF):	-1.8E-04	-4.0E-04	-1.1E-04
Increased number of cases in population:	-0.0073	-0.0013	-0.0015
Risk:	-9.3E-07	-1.7E-07	-1.3E-06
Ashfield			
Total Population in study area:	1979	1979	1979
% population in assessment age-group:	100%	100%	14%
total change	-53.7	-53.7	-53.7
Population weighted Δx (µg/m^3):	-0.02713492	-0.02713492	-0.02713492
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999949	0.999884	0.999969
Attributable fraction (AF):	-5.1E-05	-1.2E-04	-3.1E-05
Increased number of cases in population:	-0.00053	-0.000094	-0.000105
Risk:	-2.7E-07	-4.8E-08	-3.8E-07
Canterbury (North) - Ashbury			
Total Population in study area:	7538	7538	7538

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
% population in assessment age-group:	100%	100%	14%
total change	-241	-241	-241
Population weighted Δx (µg/m^3):	-0.03197135	-0.03197135	-0.03197135
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999940	0.999864	0.999963
Attributable fraction (AF):	-6.0E-05	-1.4E-04	-3.7E-05
Increased number of cases in population:	-0.0024	-0.00042	-0.00047
Risk:	-3.1E-07	-5.6E-08	-4.4E-07
Dulwich Hill - Lewisham			
Total Population in study area:	13640	13640	13640
% population in assessment age-group:	100%	100%	14%
total change	-547	-547	-547
Population weighted Δx (µg/m^3):	-0.04010264	-0.04010264	-0.04010264
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999925	0.999829	0.999954
Attributable fraction (AF):	-7.5E-05	-1.7E-04	-4.6E-05
Increased number of cases in population:	-0.0054	-0.0010	-0.0011
Risk:	-3.9E-07	-7.1E-08	-5.6E-07
Haberfield - Summer Hill			
Total Population in study area:	238	238	238
% population in assessment age-group:	100%	100%	14%
total change	-17	-17	-17
Population weighted Δx (µg/m^3):	-0.07142857	-0.07142857	-0.07142857
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999866	0.999696	0.999918
Attributable fraction (AF):	-1.3E-04	-3.0E-04	-8.2E-05
Increased number of cases in population:	-0.00017	-0.000030	-0.000033
Risk:	-7.0E-07	-1.3E-07	-9.9E-07
Sydney Inner City LGA			
Total Population in study area:	47106	47106	47106
% population in assessment age-group:	100%	100%	6%
total change	-9211	-9211	-9211
Population weighted Δx (µg/m^3):	-0.19553772	-0.19553772	-0.19553772
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209
Relative Risk:	0.999632	0.999167	0.999775
Attributable fraction (AF):	-3.7E-04	-8.3E-04	-2.2E-04
Increased number of cases in population:	-0.079	-0.01621	-0.0076
Risk:	-1.7E-06	-3.4E-07	-2.7E-06
Individual subrubs within LGA			
Erskinville - Alexandria			
Total Population in study area:	14292	14292	14292
% population in assessment age-group:	100%	100%	6%
total change	-2450	-2450	-2450
Population weighted Δx (µg/m^3):	-0.17142457	-0.17142457	-0.17142457
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209
Relative Risk:	0.999678	0.999270	0.999803
Attributable fraction (AF):	-3.2E-04	-7.3E-04	-2.0E-04
Increased number of cases in population:	-0.0209	-0.00431	-0.002010
Risk:	-1.5E-06	-3.0E-07	-2.4E-06
Newtown - Camperdown - Darlington			
Total Population in study area:	6910	6910	6910
% population in assessment age-group:	100%	100%	6%
total change	-536	-536	-53600%
Population weighted Δx (µg/m^3):	-0.07756874	-0.07756874	-0.07756874
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Relative Risk:	0.999854	0.999670	0.999911
Attributable fraction (AF):	-1.5E-04	-3.3E-04	-8.9E-05
Increased number of cases in population:	-0.0046	-0.00094	-0.00044
Risk:	-6.6E-07	-1.4E-07	-1.1E-06
Waterloo - Beaconsfield			
Total Population in study area:	25904	25904	25904
% population in assessment age-group:	100%	100%	6%
total change	-6224	-6224	-6224
Population weighted Δx (µg/m^3):	-0.24027177	-0.24027177	-0.24027177
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209
Relative Risk:	0.999548	0.998977	0.999724
Attributable fraction (AF):	-4.5E-04	-1.0E-03	-2.8E-04
Increased number of cases in population:	-0.053	-0.011	-0.0051
Risk:	-2.0E-06	-4.2E-07	-3.3E-06
Canterbury LGA			
Total Population in study area:	12648	12648	12648
% population in assessment age-group:	100%	100%	19%
total change	-537.00	-537	-537
Population weighted Δx (µg/m^3):	-0.04245731	-0.04245731	-0.04245731
Baseline Incidence (per 100,000) (as per Table 4.5)	508	41	1209
Baseline Incidence (per person)	0.00508	0.00041	0.01209
Relative Risk:	0.999920	0.999819	0.999951
Attributable fraction (AF):	-8.0E-05	-1.8E-04	-4.9E-05
Increased number of cases in population:	-0.005	-0.00094	-0.0014
Risk:	-4.1E-07	-7.5E-08	-5.9E-07
Individual subrubs within LGA			
Canterbury (South) - Campsie			
Total Population in study area:	149	149	149
% population in assessment age-group:	100%	100%	19%
total change	9.5	9.5	9.5
Population weighted Δx (µg/m^3):	0.06375839	0.06375839	0.06375839
Baseline Incidence (per 100,000) (as per Table 4.5)	508	41	1209
Baseline Incidence (per person)	0.00508	0.00041	0.01209
Relative Risk:	1.000120	1.000272	1.000073
Attributable fraction (AF):	1.2E-04	2.7E-04	7.3E-05
Increased number of cases in population:	0.000091	0.000017	0.000025
Risk:	6.1E-07	1.1E-07	8.9E-07
Kingsgrove (North) - Earlwood			
Total Population in study area:	12499	12499	12499
% population in assessment age-group:	100%	100%	19%
total change	-547	-547	-547
Population weighted Δx (µg/m^3):	-0.04376350	-0.04376350	-0.04376350
Baseline Incidence (per 100,000) (as per Table 4.5)	508	41	1209
Baseline Incidence (per person)	0.00508	0.00041	0.01209
Relative Risk:	0.999918	0.999814	0.999950
Attributable fraction (AF):	-8.2E-05	-1.9E-04	-5.0E-05
Increased number of cases in population:	-0.0052	-0.0010	-0.0015
Risk:	-4.2E-07	-7.7E-08	-6.1E-07
Botany LGA			
Total Population in study area:	46677	46677	46677
% population in assessment age-group:	100%	100%	16%
total change	-23428.0	-23428	-23428
Population weighted Δx (µg/m^3):	-0.50191743	-0.50191743	-0.50191743
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.999057	0.997864	0.999423
Attributable fraction (AF):	-9.4E-04	-2.1E-03	-5.8E-04
Increased number of cases in population:	-0.246634	-0.041263	-0.051155
Risk:	-5.3E-06	-8.8E-07	-7.0E-06

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Individual subrubs within LGA			
Banksmeadow			
Total Population in study area:	21	21	21
% population in assessment age-group:	100%	100%	16%
total change	4.2	4.2	4.2
Population weighted Δx (µg/m^3):	0.20000000	0.20000000	0.20000000
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	1.000376	1.000852	1.000230
Attributable fraction (AF):	3.8E-04	8.5E-04	2.3E-04
Increased number of cases in population:	0.000044	0.0000074	0.0000092
Risk:	2.1E-06	3.5E-07	2.8E-06
Botany			
Total Population in study area:	10780	10780	10780
% population in assessment age-group:	100%	100%	16%
total change	-656	-656	-656
Population weighted Δx (µg/m^3):	-0.06085343	-0.06085343	-0.06085343
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.999886	0.999741	0.999930
Attributable fraction (AF):	-1.1E-04	-2.6E-04	-7.0E-05
Increased number of cases in population:	-0.0069	-0.0012	-0.0014
Risk:	-6.4E-07	-1.1E-07	-8.5E-07
Mascot - Eastlakes			
Total Population in study area:	24409	24409	24409
% population in assessment age-group:	100%	100%	16%
total change	-21572	-21572	-21572
Population weighted Δx (µg/m^3):	-0.88377238	-0.88377238	-0.88377238
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.998340	0.996242	0.998984
Attributable fraction (AF):	-1.7E-03	-3.8E-03	-1.0E-03
Increased number of cases in population:	-0.2272	-0.0380	-0.0471
Risk:	-9.3E-06	-1.6E-06	-1.2E-05
Pagewood - Hillsdale - Daceyville			
Total Population in study area:	11400	11400	11400
% population in assessment age-group:	100%	100%	16%
total change	-1225	-1225	-1225
Population weighted Δx (µg/m^3):	-0.10745614	-0.10745614	-0.10745614
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.999798	0.999542	0.999876
Attributable fraction (AF):	-2.0E-04	-4.6E-04	-1.2E-04
Increased number of cases in population:	-0.0129	-0.0022	-0.0027
Risk:	-1.1E-06	-1.9E-07	-1.5E-06
Port Botany Industrial			
Total Population in study area:	6	6	6
% population in assessment age-group:	100%	100%	2100%
total change	-0.6	-0.6	-0.6
Population weighted Δx (µg/m^3):	-0.10000000	-0.10000000	-0.10000000
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.999812	0.999574	0.999885
Attributable fraction (AF):	-1.9E-04	-4.3E-04	-1.2E-04
Increased number of cases in population:	-0.0000063	-0.0000011	-0.00018
Risk:	-1.1E-06	-1.8E-07	-1.4E-06
Sydney Airport			
Total Population in study area:	61	61	61
% population in assessment age-group:	100%	100%	16%
total change	22.5	22.5	22.5
Population weighted Δx (µg/m^3):	0.36885246	0.36885246	0.36885246
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	1.000694	1.001573	1.000424
Attributable fraction (AF):	6.9E-04	1.6E-03	4.2E-04
Increased number of cases in population:	0.00024	0.000040	0.000049
Risk:	3.9E-06	6.5E-07	5.1E-06
Kogarah - Rockdale LGA			
Total Population in study area:	102876	102876	102876
% population in assessment age-group:	100%	100%	15%
total change	-1884.0	-1884	-1884
Population weighted Δx (µg/m^3):	-0.01831331	-0.01831331	-0.01831331
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999966	0.999922	0.999979
Attributable fraction (AF):	-3.4E-05	-7.8E-05	-2.1E-05
Increased number of cases in population:	-0.017	-0.0033	-0.0038
Risk:	-1.7E-07	-3.2E-08	-2.5E-07
Individual subrubs within LGA			
Arncliffe - Bardwell Park			
Total Population in study area:	21457	21457	21457
% population in assessment age-group:	100%	100%	15%
total change	-2181	-2181	-2181
Population weighted Δx (µg/m^3):	-0.10164515	-0.10164515	-0.10164515
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999809	0.999567	0.999883
Attributable fraction (AF):	-1.9E-04	-4.3E-04	-1.2E-04
Increased number of cases in population:	-0.0200	-0.0038	-0.00443
Risk:	-9.3E-07	-1.8E-07	-1.4E-06
Bexley			
Total Population in study area:	20419	20419	20419
% population in assessment age-group:	100%	100%	15%
total change	-462	-462	-462
Population weighted Δx (µg/m^3):	-0.02262599	-0.02262599	-0.02262599
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999957	0.999904	0.999974
Attributable fraction (AF):	-4.3E-05	-9.6E-05	-2.6E-05
Increased number of cases in population:	-0.0042	-0.0008	-0.00094
Risk:	-2.1E-07	-4.0E-08	-3.1E-07
Kingsgrove (South) - Bardwell Park			
Total Population in study area:	2879	2879	2879
% population in assessment age-group:	100%	100%	15%
total change	-95	-95	-95
Population weighted Δx (µg/m^3):	-0.03299757	-0.03299757	-0.03299757
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999938	0.999859	0.999962
Attributable fraction (AF):	-6.2E-05	-1.4E-04	-3.8E-05
Increased number of cases in population:	-0.00087	-0.00017	-0.00019
Risk:	-3.0E-07	-5.8E-08	-4.6E-07
Kogarah			
Total Population in study area:	11323	11323	11323
% population in assessment age-group:	100%	100%	15%
total change	1672	1672	1672
Population weighted Δx (µg/m^3):	0.14766405	0.14766405	0.14766405
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	1.000278	1.000629	1.000170
Attributable fraction (AF):	2.8E-04	6.3E-04	1.7E-04
Increased number of cases in population:	0.0153	0.00294	0.00339
Risk:	1.4E-06	2.6E-07	2.1E-06

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Kogarah Bay			
Total Population in study area:	10788	10788	10788
% population in assessment age-group:	100%	100%	15%
total change	431	431	431
Population weighted Δx (µg/m^3):	0.03995180	0.03995180	0.03995180
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	1.000075	1.000170	1.000046
Attributable fraction (AF):	7.5E-05	1.7E-04	4.6E-05
Increased number of cases in population:	0.0040	0.00076	0.00087
Risk:	3.7E-07	7.0E-08	5.6E-07
Monterey - Brighton-le-Sands - Kyeemagh			
Total Population in study area:	13915	13915	13915
% population in assessment age-group:	100%	100%	15%
total change	-579	-579	-579
Population weighted Δx (µg/m^3):	-0.04160977	-0.04160977	-0.04160977
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999922	0.999823	0.999952
Attributable fraction (AF):	-7.8E-05	-1.8E-04	-4.8E-05
Increased number of cases in population:	-0.00531	-0.00102	-0.001175
Risk:	-3.8E-07	-7.3E-08	-5.8E-07
Rockdale - Banksia			
Total Population in study area:	19957	19957	19957
% population in assessment age-group:	100%	100%	15%
total change	-755	-755	-755
Population weighted Δx (µg/m^3):	-0.03783134	-0.03783134	-0.03783134
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999929	0.999839	0.999956
Attributable fraction (AF):	-7.1E-05	-1.6E-04	-4.4E-05
Increased number of cases in population:	-0.00693	-0.00133	-0.001533
Risk:	-3.5E-07	-6.7E-08	-5.3E-07
Sans Souci - Ramsgate			
Total Population in study area:	2036	2036	2036
% population in assessment age-group:	100%	100%	15%
total change	79	79	79
Population weighted Δx (µg/m^3):	0.03880157	0.03880157	0.03880157
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	1.000073	1.000165	1.000045
Attributable fraction (AF):	7.3E-05	1.7E-04	4.5E-05
Increased number of cases in population:	0.00073	0.00014	0.000160
Risk:	3.6E-07	6.8E-08	5.4E-07
Hurstville			
Total Population in study area:	102	102	102
% population in assessment age-group:	100%	100%	15%
total change	6	6	6
Population weighted Δx (µg/m^3):	0.05882353	0.05882353	0.05882353
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	1.000111	1.000251	1.000068
Attributable fraction (AF):	1.1E-04	2.5E-04	6.8E-05
Increased number of cases in population:	0.000055	0.000011	0.000012
Risk:	5.4E-07	1.0E-07	8.2E-07
Eastern Suburbs			
Total Population in study area:	33621	33621	33621
% population in assessment age-group:	100%	100%	14%
total change	-6260.0	-6260	-6260
Population weighted Δx (µg/m^3):	-0.18619315	-0.18619315	-0.18619315
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999650	0.999207	0.999786
Attributable fraction (AF):	-3.5E-04	-7.9E-04	-2.1E-04
Increased number of cases in population:	-0.058	-0.0110	-0.0120
Risk:	-1.7E-06	-3.3E-07	-2.6E-06
Individual subrubs within LGA			
Centennial Park			
Total Population in study area:	0	0	0
Kensington			
Total Population in study area:	14903	14903	14903
% population in assessment age-group:	100%	100%	14%
total change	-4177	-4177	-4177
Population weighted Δx (µg/m^3):	-0.28027914	-0.28027914	-0.28027914
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999473	0.998807	0.999678
Attributable fraction (AF):	-5.3E-04	-1.2E-03	-3.2E-04
Increased number of cases in population:	-0.0387	-0.0074	-0.00802
Risk:	-2.6E-06	-4.9E-07	-3.9E-06
Kingsford			
Total Population in study area:	11769	11769	11769
% population in assessment age-group:	100%	100%	14%
total change	-1745	-1745	-1745
Population weighted Δx (µg/m^3):	-0.14827088	-0.14827088	-0.14827088
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999721	0.999369	0.999830
Attributable fraction (AF):	-2.8E-04	-6.3E-04	-1.7E-04
Increased number of cases in population:	-0.0161	-0.00307	-0.00335
Risk:	-1.4E-06	-2.6E-07	-2.1E-06
Malabar - La Perouse - Chiffley			
Total Population in study area:	3724	3724	3724
% population in assessment age-group:	100%	100%	14%
total change	15	15	15
Population weighted Δx (µg/m^3):	0.00402793	0.00402793	0.00402793
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	1.000008	1.000017	1.000005
Attributable fraction (AF):	7.6E-06	1.7E-05	4.6E-06
Increased number of cases in population:	0.00014	0.000026	0.000029
Risk:	3.7E-08	7.1E-09	5.6E-08
Maroubra (west)			
Total Population in study area:	2951	2951	2951
% population in assessment age-group:	100%	100%	14%
total change	-316	-316	-316
Population weighted Δx (µg/m^3):	-0.10708234	-0.10708234	-0.10708234
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999799	0.999544	0.999877
Attributable fraction (AF):	-2.0E-04	-4.6E-04	-1.2E-04
Increased number of cases in population:	-0.0029	-0.00056	-0.00061
Risk:	-9.9E-07	-1.9E-07	-1.5E-06
Paddington - Moore Park			
Total Population in study area:	189	189	189
% population in assessment age-group:	100%	100%	14%
total change	-33	-33	-33
Population weighted Δx (µg/m^3):	-0.17460317	-0.17460317	-0.17460317
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999672	0.999256	0.999799
Attributable fraction (AF):	-3.3E-04	-7.4E-04	-2.0E-04
Increased number of cases in population:	-0.00031	-0.00006	-0.000063

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Risk:	-1.6E-06	-3.1E-07	-2.4E-06
Randwick (North and South)			
Total Population in study area:	85	85	85
% population in assessment age-group:	100%	100%	14%
total change	-4	-4	-4
Population weighted Δx (µg/m^3):	-0.04705882	-0.04705882	-0.04705882
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999912	0.999800	0.999946
Attributable fraction (AF):	-8.8E-05	-2.0E-04	-5.4E-05
Increased number of cases in population:	-0.000037	-0.0000070	-0.0000077
Risk:	-4.4E-07	-8.3E-08	-6.5E-07
Total population incidence - All Suburbs	**-0.4398**	**-0.0789**	**-0.0828**

Assessment of Increased Incidence - NO2
Gateway Road Project: 2036

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Inner West (including Strathfield - Burwood - Ashfield LGA)			
Total Population in study area:	62688	62688	62688
% population in assessment age-group:	100%	100%	14%
total change	-2684	-2684	-2684
Population weighted Δx (µg/m^3):	-0.04281521	-0.04281521	-0.04281521
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999920	0.999818	0.999951
Attributable fraction (AF):	-8.0E-05	-1.8E-04	-4.9E-05
Increased number of cases in population:	-0.0263	-0.00472	-0.00526
Risk:	-4.2E-07	-7.5E-08	-6.0E-07
Individual subrubs within LGA			
Marrickville			
Total Population in study area:	26542	26542	26542
% population in assessment age-group:	100%	100%	14%
total change	-1476	-1476	-1476
Population weighted Δx (µg/m^3):	-0.05560998	-0.05560998	-0.05560998
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999895	0.999763	0.999936
Attributable fraction (AF):	-1.0E-04	-2.4E-04	-6.4E-05
Increased number of cases in population:	-0.014	-0.0026	-0.00289
Risk:	-5.5E-07	-9.8E-08	-7.7E-07
Petersham - Stanmore			
Total Population in study area:	4922	4922	4922
% population in assessment age-group:	100%	100%	14%
total change	-296	-296	-296
Population weighted Δx (µg/m^3):	-0.06013816	-0.06013816	-0.06013816
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999887	0.999744	0.999931
Attributable fraction (AF):	-1.1E-04	-2.6E-04	-6.9E-05
Increased number of cases in population:	-0.0029	-0.00052	-0.00058
Risk:	-5.9E-07	-1.1E-07	-8.4E-07
Sydenham - Tempe - St Peters			
Total Population in study area:	7829	7829	7829
% population in assessment age-group:	100%	100%	14%
total change	4.5	4.5	4.5
Population weighted Δx (µg/m^3):	0.00057479	0.00057479	0.00057479
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	1.000001	1.000002	1.000001
Attributable fraction (AF):	1.1E-06	2.4E-06	6.6E-07
Increased number of cases in population:	0.000044	0.0000079	0.0000088
Risk:	5.6E-09	1.0E-09	8.0E-09
Ashfield			
Total Population in study area:	1979	1979	1979
% population in assessment age-group:	100%	100%	14%
total change	-84	-84	-84
Population weighted Δx (µg/m^3):	-0.04244568	-0.04244568	-0.04244568
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999920	0.999819	0.999951
Attributable fraction (AF):	-8.0E-05	-1.8E-04	-4.9E-05
Increased number of cases in population:	-0.00082	-0.000148	-0.00016
Risk:	-4.2E-07	-7.5E-08	-5.9E-07
Canterbury (North) - Ashbury			
Total Population in study area:	7538	7538	7538

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
% population in assessment age-group:	100%	100%	14%
total change	-325	-325	-325
Population weighted Δx (µg/m^3):	-0.04311488	-0.04311488	-0.04311488
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999919	0.999816	0.999950
Attributable fraction (AF):	-8.1E-05	-1.8E-04	-5.0E-05
Increased number of cases in population:	-0.0032	-0.00057	-0.00064
Risk:	-4.2E-07	-7.6E-08	-6.0E-07
Dulwich Hill - Lewisham			
Total Population in study area:	13640	13640	13640
% population in assessment age-group:	100%	100%	14%
total change	-487	-487	-487
Population weighted Δx (µg/m^3):	-0.03570381	-0.03570381	-0.03570381
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999933	0.999848	0.999959
Attributable fraction (AF):	-6.7E-05	-1.5E-04	-4.1E-05
Increased number of cases in population:	-0.0048	-0.00086	-0.0010
Risk:	-3.5E-07	-6.3E-08	-5.0E-07
Haberfield - Summer Hill			
Total Population in study area:	238	238	238
% population in assessment age-group:	100%	100%	14%
total change	-19.7	-19.7	-19.7
Population weighted Δx (µg/m^3):	-0.08277311	-0.08277311	-0.08277311
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999844	0.999647	0.999905
Attributable fraction (AF):	-1.6E-04	-3.5E-04	-9.5E-05
Increased number of cases in population:	-0.00019	-0.000035	-0.000039
Risk:	-8.1E-07	-1.5E-07	-1.2E-06
Sydney Inner City LGA			
Total Population in study area:	47106	47106	47106
% population in assessment age-group:	100%	100%	6%
total change	-7670	-7670	-7670
Population weighted Δx (µg/m^3):	-0.16282427	-0.16282427	-0.16282427
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209
Relative Risk:	0.999694	0.999307	0.999813
Attributable fraction (AF):	-3.1E-04	-6.9E-04	-1.9E-04
Increased number of cases in population:	-0.065	-0.01350	-0.0063
Risk:	-1.4E-06	-2.9E-07	-2.3E-06
Individual subrubs within LGA			
Erskinville - Alexandria			
Total Population in study area:	14292	14292	14292
% population in assessment age-group:	100%	100%	6%
total change	-2328	-2328	-2328
Population weighted Δx (µg/m^3):	-0.16288833	-0.16288833	-0.16288833
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209
Relative Risk:	0.999694	0.999306	0.999813
Attributable fraction (AF):	-3.1E-04	-6.9E-04	-1.9E-04
Increased number of cases in population:	-0.0199	-0.00410	-0.001910
Risk:	-1.4E-06	-2.9E-07	-2.3E-06
Newtown - Camperdown - Darlington			
Total Population in study area:	6910	6910	6910
% population in assessment age-group:	100%	100%	6%
total change	-496	-496	-49600%
Population weighted Δx (µg/m^3):	-0.07178003	-0.07178003	-0.07178003
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Relative Risk:	0.999865	0.999694	0.999917
Attributable fraction (AF):	-1.3E-04	-3.1E-04	-8.3E-05
Increased number of cases in population:	-0.0042	-0.00087	-0.00041
Risk:	-6.1E-07	-1.3E-07	-1.0E-06
Waterloo - Beaconsfield			
Total Population in study area:	25904	25904	25904
% population in assessment age-group:	100%	100%	6%
total change	-4845	-4845	-4845
Population weighted Δx (µg/m^3):	-0.18703675	-0.18703675	-0.18703675
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209
Relative Risk:	0.999648	0.999204	0.999785
Attributable fraction (AF):	-3.5E-04	-8.0E-04	-2.2E-04
Increased number of cases in population:	-0.041	-0.0085	-0.0040
Risk:	-1.6E-06	-3.3E-07	-2.6E-06
Canterbury LGA			
Total Population in study area:	12648	12648	12648
% population in assessment age-group:	100%	100%	19%
total change	-468.00	-468	-468
Population weighted Δx (µg/m^3):	-0.03700190	-0.03700190	-0.03700190
Baseline Incidence (per 100,000) (as per Table 4.5)	508	41	1209
Baseline Incidence (per person)	0.00508	0.00041	0.01209
Relative Risk:	0.999930	0.999842	0.999957
Attributable fraction (AF):	-7.0E-05	-1.6E-04	-4.3E-05
Increased number of cases in population:	-0.004	-0.00082	-0.0012
Risk:	-3.5E-07	-6.5E-08	-5.1E-07
Individual subrubs within LGA			
Canterbury (South) - Campsie			
Total Population in study area:	149	149	149
% population in assessment age-group:	100%	100%	19%
total change	-8.9	-8.9	-8.9
Population weighted Δx (µg/m^3):	-0.05973154	-0.05973154	-0.05973154
Baseline Incidence (per 100,000) (as per Table 4.5)	508	41	1209
Baseline Incidence (per person)	0.00508	0.00041	0.01209
Relative Risk:	0.999888	0.999746	0.999931
Attributable fraction (AF):	-1.1E-04	-2.5E-04	-6.9E-05
Increased number of cases in population:	-0.000085	-0.000016	-0.000024
Risk:	-5.7E-07	-1.1E-07	-8.3E-07
Kingsgrove (North) - Earlwood			
Total Population in study area:	12499	12499	12499
% population in assessment age-group:	100%	100%	19%
total change	-459	-459	-459
Population weighted Δx (µg/m^3):	-0.03672294	-0.03672294	-0.03672294
Baseline Incidence (per 100,000) (as per Table 4.5)	508	41	1209
Baseline Incidence (per person)	0.00508	0.00041	0.01209
Relative Risk:	0.999931	0.999844	0.999958
Attributable fraction (AF):	-6.9E-05	-1.6E-04	-4.2E-05
Increased number of cases in population:	-0.0044	-0.00081	-0.0012
Risk:	-3.5E-07	-6.5E-08	-5.1E-07
Botany LGA			
Total Population in study area:	46677	46677	46677
% population in assessment age-group:	100%	100%	16%
total change	-21951.0	-21951	-21951
Population weighted Δx (µg/m^3):	-0.47027444	-0.47027444	-0.47027444
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.999116	0.997999	0.999459
Attributable fraction (AF):	-8.8E-04	-2.0E-03	-5.4E-04
Increased number of cases in population:	-0.231078	-0.038659	-0.047929
Risk:	-4.9E-06	-8.3E-07	-6.5E-06

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Individual subrubs within LGA			
Banksmeadow			
Total Population in study area:	21	21	21
% population in assessment age-group:	100%	100%	16%
total change	2.2	2.2	2.2
Population weighted Δx (µg/m^3):	0.10476190	0.10476190	0.10476190
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	1.000197	1.000446	1.000120
Attributable fraction (AF):	2.0E-04	4.5E-04	1.2E-04
Increased number of cases in population:	0.000023	0.0000039	0.0000048
Risk:	1.1E-06	1.8E-07	1.5E-06
Botany			
Total Population in study area:	10780	10780	10780
% population in assessment age-group:	100%	100%	16%
total change	-471	-471	-471
Population weighted Δx (µg/m^3):	-0.04369202	-0.04369202	-0.04369202
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.999918	0.999814	0.999950
Attributable fraction (AF):	-8.2E-05	-1.9E-04	-5.0E-05
Increased number of cases in population:	-0.0050	-0.00083	-0.0010
Risk:	-4.6E-07	-7.7E-08	-6.1E-07
Mascot - Eastlakes			
Total Population in study area:	24409	24409	24409
% population in assessment age-group:	100%	100%	16%
total change	-21545	-21545	-21545
Population weighted Δx (µg/m^3):	-0.88266623	-0.88266623	-0.88266623
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.998342	0.996247	0.998985
Attributable fraction (AF):	-1.7E-03	-3.8E-03	-1.0E-03
Increased number of cases in population:	-0.2269	-0.0380	-0.0471
Risk:	-9.3E-06	-1.6E-06	-1.2E-05
Pagewood - Hillsdale - Daceyville			
Total Population in study area:	11400	11400	11400
% population in assessment age-group:	100%	100%	16%
total change	42	42	42
Population weighted Δx (µg/m^3):	0.00368421	0.00368421	0.00368421
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	1.000007	1.000016	1.000004
Attributable fraction (AF):	6.9E-06	1.6E-05	4.2E-06
Increased number of cases in population:	0.00044	0.000074	0.000092
Risk:	3.9E-08	6.5E-09	5.1E-08
Port Botany Industrial			
Total Population in study area:	6	6	6
% population in assessment age-group:	100%	100%	2100%
total change	0.87	0.87	0.87
Population weighted Δx (µg/m^3):	0.14500000	0.14500000	0.14500000
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	1.000273	1.000618	1.000167
Attributable fraction (AF):	2.7E-04	6.2E-04	1.7E-04
Increased number of cases in population:	0.0000092	0.0000015	0.00025
Risk:	1.5E-06	2.6E-07	2.0E-06
Sydney Airport			
Total Population in study area:	61	61	61
% population in assessment age-group:	100%	100%	16%
total change	20.2	20.2	20.2
Population weighted Δx (µg/m^3):	0.33114754	0.33114754	0.33114754
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	1.000623	1.001412	1.000381
Attributable fraction (AF):	6.2E-04	1.4E-03	3.8E-04
Increased number of cases in population:	0.00021	0.000036	0.000044
Risk:	3.5E-06	5.8E-07	4.6E-06
Kogarah - Rockdale LGA			
Total Population in study area:	102876	102876	102876
% population in assessment age-group:	100%	100%	15%
total change	-2424.0	-2424	-2424
Population weighted Δx (µg/m^3):	-0.02356235	-0.02356235	-0.02356235
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999956	0.999900	0.999973
Attributable fraction (AF):	-4.4E-05	-1.0E-04	-2.7E-05
Increased number of cases in population:	-0.022	-0.0043	-0.0049
Risk:	-2.2E-07	-4.1E-08	-3.3E-07
Individual subrubs within LGA			
Arncliffe - Bardwell Park			
Total Population in study area:	21457	21457	21457
% population in assessment age-group:	100%	100%	15%
total change	-1336	-1336	-1336
Population weighted Δx (µg/m^3):	-0.06226406	-0.06226406	-0.06226406
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999883	0.999735	0.999928
Attributable fraction (AF):	-1.2E-04	-2.7E-04	-7.2E-05
Increased number of cases in population:	-0.0123	-0.0024	-0.00271
Risk:	-5.7E-07	-1.1E-07	-8.7E-07
Bexley			
Total Population in study area:	20419	20419	20419
% population in assessment age-group:	100%	100%	15%
total change	-801	-801	-801
Population weighted Δx (µg/m^3):	-0.03922817	-0.03922817	-0.03922817
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999926	0.999833	0.999955
Attributable fraction (AF):	-7.4E-05	-1.7E-04	-4.5E-05
Increased number of cases in population:	-0.0074	-0.0014	-0.00163
Risk:	-3.6E-07	-6.9E-08	-5.5E-07
Kingsgrove (South) - Bardwell Park			
Total Population in study area:	2879	2879	2879
% population in assessment age-group:	100%	100%	15%
total change	-91	-91	-91
Population weighted Δx (µg/m^3):	-0.03160820	-0.03160820	-0.03160820
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999941	0.999865	0.999964
Attributable fraction (AF):	-5.9E-05	-1.3E-04	-3.6E-05
Increased number of cases in population:	-0.00084	-0.00016	-0.00018
Risk:	-2.9E-07	-5.6E-08	-4.4E-07
Kogarah			
Total Population in study area:	11323	11323	11323
% population in assessment age-group:	100%	100%	15%
total change	148	148	148
Population weighted Δx (µg/m^3):	0.01307074	0.01307074	0.01307074
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	1.000025	1.000056	1.000015
Attributable fraction (AF):	2.5E-05	5.6E-05	1.5E-05
Increased number of cases in population:	0.0014	0.00026	0.00030
Risk:	1.2E-07	2.3E-08	1.8E-07

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Kogarah Bay			
Total Population in study area:	10788	10788	10788
% population in assessment age-group:	100%	100%	15%
total change	-54	-54	-54
Population weighted Δx (µg/m^3):	-0.00500556	-0.00500556	-0.00500556
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999991	0.999979	0.999994
Attributable fraction (AF):	-9.4E-06	-2.1E-05	-5.8E-06
Increased number of cases in population:	-0.00050	-0.00010	-0.00011
Risk:	-4.6E-08	-8.8E-09	-7.0E-08
Monterey - Brighton-le-Sands - Kyeemagh			
Total Population in study area:	13915	13915	13915
% population in assessment age-group:	100%	100%	15%
total change	9.4	9.4	9.4
Population weighted Δx (µg/m^3):	0.00067553	0.00067553	0.00067553
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	1.000001	1.000003	1.000001
Attributable fraction (AF):	1.3E-06	2.9E-06	7.8E-07
Increased number of cases in population:	0.000086	0.000017	0.000019
Risk:	6.2E-09	1.2E-09	9.4E-09
Rockdale - Banksia			
Total Population in study area:	19957	19957	19957
% population in assessment age-group:	100%	100%	15%
total change	-364	-364	-364
Population weighted Δx (µg/m^3):	-0.01823921	-0.01823921	-0.01823921
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999966	0.999922	0.999979
Attributable fraction (AF):	-3.4E-05	-7.8E-05	-2.1E-05
Increased number of cases in population:	-0.00334	-0.00064	-0.000739
Risk:	-1.7E-07	-3.2E-08	-2.5E-07
Sans Souci - Ramsgate			
Total Population in study area:	2036	2036	2036
% population in assessment age-group:	100%	100%	15%
total change	51	51	51
Population weighted Δx (µg/m^3):	0.02504912	0.02504912	0.02504912
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	1.000047	1.000107	1.000029
Attributable fraction (AF):	4.7E-05	1.1E-04	2.9E-05
Increased number of cases in population:	0.00047	0.000090	0.000104
Risk:	2.3E-07	4.4E-08	3.5E-07
Hurstville			
Total Population in study area:	102	102	102
% population in assessment age-group:	100%	100%	15%
total change	13.8	13.8	13.8
Population weighted Δx (µg/m^3):	0.13529412	0.13529412	0.13529412
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	1.000254	1.000577	1.000156
Attributable fraction (AF):	2.5E-04	5.8E-04	1.6E-04
Increased number of cases in population:	0.00013	0.000024	0.000028
Risk:	1.2E-06	2.4E-07	1.9E-06
Eastern Suburbs			
Total Population in study area:	33621	33621	33621
% population in assessment age-group:	100%	100%	14%
total change	-4907.0	-4907	-4907
Population weighted Δx (µg/m^3):	-0.14595045	-0.14595045	-0.14595045
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999726	0.999378	0.999832
Attributable fraction (AF):	-2.7E-04	-6.2E-04	-1.7E-04
Increased number of cases in population:	-0.045	-0.0086	-0.0094
Risk:	-1.4E-06	-2.6E-07	-2.0E-06
Individual subrubs within LGA			
Centennial Park			
Total Population in study area:	0	0	0
Kensington			
Total Population in study area:	14903	14903	14903
% population in assessment age-group:	100%	100%	14%
total change	-2825	-2825	-2825
Population weighted Δx (µg/m^3):	-0.18955915	-0.18955915	-0.18955915
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999644	0.999193	0.999782
Attributable fraction (AF):	-3.6E-04	-8.1E-04	-2.2E-04
Increased number of cases in population:	-0.0261	-0.0050	-0.00542
Risk:	-1.8E-06	-3.3E-07	-2.6E-06
Kingsford			
Total Population in study area:	11769	11769	11769
% population in assessment age-group:	100%	100%	14%
total change	-2262	-2262	-2262
Population weighted Δx (µg/m^3):	-0.19219985	-0.19219985	-0.19219985
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999639	0.999182	0.999779
Attributable fraction (AF):	-3.6E-04	-8.2E-04	-2.2E-04
Increased number of cases in population:	-0.0209	-0.00398	-0.00434
Risk:	-1.8E-06	-3.4E-07	-2.7E-06
Malabar - La Perouse - Chiffley			
Total Population in study area:	3724	3724	3724
% population in assessment age-group:	100%	100%	14%
total change	78	78	78
Population weighted Δx (µg/m^3):	0.02094522	0.02094522	0.02094522
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	1.000039	1.000089	1.000024
Attributable fraction (AF):	3.9E-05	8.9E-05	2.4E-05
Increased number of cases in population:	0.0007	0.00014	0.00015
Risk:	1.9E-07	3.7E-08	2.9E-07
Maroubra (west)			
Total Population in study area:	2951	2951	2951
% population in assessment age-group:	100%	100%	14%
total change	63	63	63
Population weighted Δx (µg/m^3):	0.02134870	0.02134870	0.02134870
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	1.000040	1.000091	1.000025
Attributable fraction (AF):	4.0E-05	9.1E-05	2.5E-05
Increased number of cases in population:	0.0006	0.00011	0.00012
Risk:	2.0E-07	3.8E-08	3.0E-07
Paddington - Moore Park			
Total Population in study area:	189	189	189
% population in assessment age-group:	100%	100%	14%
total change	18.8	18.8	18.8
Population weighted Δx (µg/m^3):	0.09947090	0.09947090	0.09947090
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	1.000187	1.000424	1.000114
Attributable fraction (AF):	1.9E-04	4.2E-04	1.1E-04
Increased number of cases in population:	0.00017	0.000033	0.000036

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Risk:	9.2E-07	1.8E-07	1.4E-06
Randwick (North and South)			
Total Population in study area:	85	85	85
% population in assessment age-group:	100%	100%	14%
total change	20	20	20
Population weighted Δx (µg/m^3):	0.23529412	0.23529412	0.23529412
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	1.000442	1.001003	1.000271
Attributable fraction (AF):	4.4E-04	1.0E-03	2.7E-04
Increased number of cases in population:	0.00019	0.000035	0.000038
Risk:	2.2E-06	4.1E-07	3.3E-06
Total population incidence - All Suburbs	**-0.3950**	**-0.0706**	**-0.0751**

Assessment of Increased Incidence - NO2
Gateway Road Project: 2036 Cumulative

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Inner West (including Strathfield - Burwood - Ashfield LGA)			
Total Population in study area:	62688	62688	62688
% population in assessment age-group:	100%	100%	14%
total change	-4382	-4382	-4382
Population weighted Δx (µg/m^3):	-0.06990174	-0.06990174	-0.06990174
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999869	0.999702	0.999920
Attributable fraction (AF):	-1.3E-04	-3.0E-04	-8.0E-05
Increased number of cases in population:	-0.0430	-0.00771	-0.00859
Risk:	-6.9E-07	-1.2E-07	-9.7E-07
Individual subrubs within LGA			
Marrickville			
Total Population in study area:	26542	26542	26542
% population in assessment age-group:	100%	100%	14%
total change	-1821	-1821	-1821
Population weighted Δx (µg/m^3):	-0.06860824	-0.06860824	-0.06860824
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999871	0.999708	0.999921
Attributable fraction (AF):	-1.3E-04	-2.9E-04	-7.9E-05
Increased number of cases in population:	-0.018	-0.0032	-0.00357
Risk:	-6.7E-07	-1.2E-07	-9.5E-07
Petersham - Stanmore			
Total Population in study area:	4922	4922	4922
% population in assessment age-group:	100%	100%	14%
total change	-339	-339	-339
Population weighted Δx (µg/m^3):	-0.06887444	-0.06887444	-0.06887444
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999871	0.999707	0.999921
Attributable fraction (AF):	-1.3E-04	-2.9E-04	-7.9E-05
Increased number of cases in population:	-0.0033	-0.00060	-0.00066
Risk:	-6.8E-07	-1.2E-07	-9.6E-07
Sydenham - Tempe - St Peters			
Total Population in study area:	7829	7829	7829
% population in assessment age-group:	100%	100%	14%
total change	-736	-736	-736
Population weighted Δx (µg/m^3):	-0.09400945	-0.09400945	-0.09400945
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999823	0.999600	0.999892
Attributable fraction (AF):	-1.8E-04	-4.0E-04	-1.1E-04
Increased number of cases in population:	-0.0072	-0.0013	-0.0014
Risk:	-9.2E-07	-1.7E-07	-1.3E-06
Ashfield			
Total Population in study area:	1979	1979	1979
% population in assessment age-group:	100%	100%	14%
total change	-107.7	-107.7	-107.7
Population weighted Δx (µg/m^3):	-0.05442142	-0.05442142	-0.05442142
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999898	0.999768	0.999937
Attributable fraction (AF):	-1.0E-04	-2.3E-04	-6.3E-05
Increased number of cases in population:	-0.0011	-0.00019	-0.00021
Risk:	-5.3E-07	-9.6E-08	-7.6E-07
Canterbury (North) - Ashbury			
Total Population in study area:	7538	7538	7538

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
% population in assessment age-group:	100%	100%	14%
total change	-473	-473	-473
Population weighted Δx (µg/m^3):	-0.06274874	-0.06274874	-0.06274874
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999882	0.999733	0.999928
Attributable fraction (AF):	-1.2E-04	-2.7E-04	-7.2E-05
Increased number of cases in population:	-0.0046	-0.00083	-0.00093
Risk:	-6.2E-07	-1.1E-07	-8.7E-07
Dulwich Hill - Lewisham			
Total Population in study area:	13640	13640	13640
% population in assessment age-group:	100%	100%	14%
total change	-891	-891	-891
Population weighted Δx (µg/m^3):	-0.06532258	-0.06532258	-0.06532258
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999877	0.999722	0.999925
Attributable fraction (AF):	-1.2E-04	-2.8E-04	-7.5E-05
Increased number of cases in population:	-0.0087	-0.0016	-0.0017
Risk:	-6.4E-07	-1.1E-07	-9.1E-07
Haberfield - Summer Hill			
Total Population in study area:	238	238	238
% population in assessment age-group:	100%	100%	14%
total change	-12	-12	-12
Population weighted Δx (µg/m^3):	-0.05042017	-0.05042017	-0.05042017
Baseline Incidence (per 100,000) (as per Table 4.5)	522	41	1209
Baseline Incidence (per person)	0.00522	0.00041	0.01209
Relative Risk:	0.999905	0.999785	0.999942
Attributable fraction (AF):	-9.5E-05	-2.1E-04	-5.8E-05
Increased number of cases in population:	-0.00012	-0.000021	-0.000024
Risk:	-4.9E-07	-8.9E-08	-7.0E-07
Sydney Inner City LGA			
Total Population in study area:	47106	47106	47106
% population in assessment age-group:	100%	100%	6%
total change	-12900	-12900	-12900
Population weighted Δx (µg/m^3):	-0.27385046	-0.27385046	-0.27385046
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209
Relative Risk:	0.999485	0.998834	0.999685
Attributable fraction (AF):	-5.1E-04	-1.2E-03	-3.1E-04
Increased number of cases in population:	-0.110	-0.02271	-0.0106
Risk:	-2.3E-06	-4.8E-07	-3.8E-06
Individual subrubs within LGA			
Erskinville - Alexandria			
Total Population in study area:	14292	14292	14292
% population in assessment age-group:	100%	100%	6%
total change	-2016	-2016	-2016
Population weighted Δx (µg/m^3):	-0.14105793	-0.14105793	-0.14105793
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209
Relative Risk:	0.999735	0.999399	0.999838
Attributable fraction (AF):	-2.7E-04	-6.0E-04	-1.6E-04
Increased number of cases in population:	-0.0172	-0.00355	-0.001654
Risk:	-1.2E-06	-2.5E-07	-2.0E-06
Newtown - Camperdown - Darlington			
Total Population in study area:	6910	6910	6910
% population in assessment age-group:	100%	100%	6%
total change	-490	-490	-49000%
Population weighted Δx (µg/m^3):	-0.07091172	-0.07091172	-0.07091172
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Relative Risk:	0.999867	0.999698	0.999918
Attributable fraction (AF):	-1.3E-04	-3.0E-04	-8.2E-05
Increased number of cases in population:	-0.0042	-0.00086	-0.00040
Risk:	-6.0E-07	-1.2E-07	-9.9E-07
Waterloo - Beaconsfield			
Total Population in study area:	25904	25904	25904
% population in assessment age-group:	100%	100%	6%
total change	-10393	-10393	-10393
Population weighted Δx (µg/m^3):	-0.40121217	-0.40121217	-0.40121217
Baseline Incidence (per 100,000) (as per Table 4.5)	454	41	1209
Baseline Incidence (per person)	0.00454	0.00041	0.01209
Relative Risk:	0.999246	0.998292	0.999539
Attributable fraction (AF):	-7.5E-04	-1.7E-03	-4.6E-04
Increased number of cases in population:	-0.089	-0.018	-0.0085
Risk:	-3.4E-06	-7.1E-07	-5.6E-06
Canterbury LGA			
Total Population in study area:	12648	12648	12648
% population in assessment age-group:	100%	100%	19%
total change	-597.00	-597	-597
Population weighted Δx (µg/m^3):	-0.04720114	-0.04720114	-0.04720114
Baseline Incidence (per 100,000) (as per Table 4.5)	508	41	1209
Baseline Incidence (per person)	0.00508	0.00041	0.01209
Relative Risk:	0.999911	0.999799	0.999946
Attributable fraction (AF):	-8.9E-05	-2.0E-04	-5.4E-05
Increased number of cases in population:	-0.006	-0.00105	-0.0016
Risk:	-4.5E-07	-8.3E-08	-6.6E-07
Individual subrubs within LGA			
Canterbury (South) - Campsie			
Total Population in study area:	149	149	149
% population in assessment age-group:	100%	100%	19%
total change	-11	-11	-11
Population weighted Δx (µg/m^3):	-0.07382550	-0.07382550	-0.07382550
Baseline Incidence (per 100,000) (as per Table 4.5)	508	41	1209
Baseline Incidence (per person)	0.00508	0.00041	0.01209
Relative Risk:	0.999861	0.999686	0.999915
Attributable fraction (AF):	-1.4E-04	-3.1E-04	-8.5E-05
Increased number of cases in population:	-0.000105	-0.000019	-0.000029
Risk:	-7.1E-07	-1.3E-07	-1.0E-06
Kingsgrove (North) - Earlwood			
Total Population in study area:	12499	12499	12499
% population in assessment age-group:	100%	100%	19%
total change	-586	-586	-586
Population weighted Δx (µg/m^3):	-0.04688375	-0.04688375	-0.04688375
Baseline Incidence (per 100,000) (as per Table 4.5)	508	41	1209
Baseline Incidence (per person)	0.00508	0.00041	0.01209
Relative Risk:	0.999912	0.999800	0.999946
Attributable fraction (AF):	-8.8E-05	-2.0E-04	-5.4E-05
Increased number of cases in population:	-0.0056	-0.0010	-0.0016
Risk:	-4.5E-07	-8.2E-08	-6.5E-07
Botany LGA			
Total Population in study area:	46677	46677	46677
% population in assessment age-group:	100%	100%	16%
total change	-29098.0	-29098	-29098
Population weighted Δx (µg/m^3):	-0.62339053	-0.62339053	-0.62339053
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.998829	0.997348	0.999283
Attributable fraction (AF):	-1.2E-03	-2.7E-03	-7.2E-04
Increased number of cases in population:	-0.306359	-0.051262	-0.063539
Risk:	-6.6E-06	-1.1E-06	-8.7E-06

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Individual subrubs within LGA			
Banksmeadow			
Total Population in study area:	21	21	21
% population in assessment age-group:	100%	100%	16%
total change	0.2	0.2	0.2
Population weighted Δx (µg/m^3):	0.00952381	0.00952381	0.00952381
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	1.000018	1.000041	1.000011
Attributable fraction (AF):	1.8E-05	4.1E-05	1.1E-05
Increased number of cases in population:	0.0000021	0.00000035	0.00000044
Risk:	1.0E-07	1.7E-08	1.3E-07
Botany			
Total Population in study area:	10780	10780	10780
% population in assessment age-group:	100%	100%	16%
total change	-1474	-1474	-1474
Population weighted Δx (µg/m^3):	-0.13673469	-0.13673469	-0.13673469
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.999743	0.999418	0.999843
Attributable fraction (AF):	-2.6E-04	-5.8E-04	-1.6E-04
Increased number of cases in population:	-0.0155	-0.0026	-0.0032
Risk:	-1.4E-06	-2.4E-07	-1.9E-06
Mascot - Eastlakes			
Total Population in study area:	24409	24409	24409
% population in assessment age-group:	100%	100%	16%
total change	-26416	-26416	-26416
Population weighted Δx (µg/m^3):	-1.08222377	-1.08222377	-1.08222377
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.997967	0.995400	0.998756
Attributable fraction (AF):	-2.0E-03	-4.6E-03	-1.2E-03
Increased number of cases in population:	-0.2782	-0.0466	-0.0577
Risk:	-1.1E-05	-1.9E-06	-1.5E-05
Pagewood - Hillsdale - Daceyville			
Total Population in study area:	11400	11400	11400
% population in assessment age-group:	100%	100%	16%
total change	-1232	-1232	-1232
Population weighted Δx (µg/m^3):	-0.10807018	-0.10807018	-0.10807018
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.999797	0.999540	0.999876
Attributable fraction (AF):	-2.0E-04	-4.6E-04	-1.2E-04
Increased number of cases in population:	-0.0130	-0.0022	-0.0027
Risk:	-1.1E-06	-1.9E-07	-1.5E-06
Port Botany Industrial			
Total Population in study area:	6	6	6
% population in assessment age-group:	100%	100%	2100%
total change	-0.7	-0.7	-0.7
Population weighted Δx (µg/m^3):	-0.11666667	-0.11666667	-0.11666667
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	0.999781	0.999503	0.999866
Attributable fraction (AF):	-2.2E-04	-5.0E-04	-1.3E-04
Increased number of cases in population:	-0.0000074	-0.0000012	-0.000204
Risk:	-1.2E-06	-2.1E-07	-1.6E-06
Sydney Airport			
Total Population in study area:	61	61	61
% population in assessment age-group:	100%	100%	16%
total change	26	26	26
Population weighted Δx (µg/m^3):	0.42622951	0.42622951	0.42622951
Baseline Incidence (per 100,000) (as per Table 4.5)	560	41	1209

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Baseline Incidence (per person)	0.00560	0.00041	0.01209
Relative Risk:	1.000802	1.001817	1.000490
Attributable fraction (AF):	8.0E-04	1.8E-03	4.9E-04
Increased number of cases in population:	0.00027	0.000046	0.000057
Risk:	4.5E-06	7.5E-07	5.9E-06
Kogarah - Rockdale LGA			
Total Population in study area:	102876	102876	102876
% population in assessment age-group:	100%	100%	15%
total change	-12170.0	-12170	-12170
Population weighted Δx (µg/m^3):	-0.11829776	-0.11829776	-0.11829776
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999778	0.999496	0.999864
Attributable fraction (AF):	-2.2E-04	-5.0E-04	-1.4E-04
Increased number of cases in population:	-0.112	-0.0214	-0.0247
Risk:	-1.1E-06	-2.1E-07	-1.6E-06
Individual subrubs within LGA			
Arncliffe - Bardwell Park			
Total Population in study area:	21457	21457	21457
% population in assessment age-group:	100%	100%	15%
total change	-3506	-3506	-3506
Population weighted Δx (µg/m^3):	-0.16339656	-0.16339656	-0.16339656
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999693	0.999304	0.999812
Attributable fraction (AF):	-3.1E-04	-7.0E-04	-1.9E-04
Increased number of cases in population:	-0.0322	-0.0062	-0.00712
Risk:	-1.5E-06	-2.9E-07	-2.3E-06
Bexley			
Total Population in study area:	20419	20419	20419
% population in assessment age-group:	100%	100%	15%
total change	-1175	-1175	-1175
Population weighted Δx (µg/m^3):	-0.05754444	-0.05754444	-0.05754444
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999892	0.999755	0.999934
Attributable fraction (AF):	-1.1E-04	-2.5E-04	-6.6E-05
Increased number of cases in population:	-0.0108	-0.0021	-0.00239
Risk:	-5.3E-07	-1.0E-07	-8.0E-07
Kingsgrove (South) - Bardwell Park			
Total Population in study area:	2879	2879	2879
% population in assessment age-group:	100%	100%	15%
total change	-167	-167	-167
Population weighted Δx (µg/m^3):	-0.05800625	-0.05800625	-0.05800625
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999891	0.999753	0.999933
Attributable fraction (AF):	-1.1E-04	-2.5E-04	-6.7E-05
Increased number of cases in population:	-0.0015	-0.00029	-0.00034
Risk:	-5.3E-07	-1.0E-07	-8.1E-07
Kogarah			
Total Population in study area:	11323	11323	11323
% population in assessment age-group:	100%	100%	15%
total change	-986	-986	-986
Population weighted Δx (µg/m^3):	-0.08707940	-0.08707940	-0.08707940
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999836	0.999629	0.999900
Attributable fraction (AF):	-1.6E-04	-3.7E-04	-1.0E-04
Increased number of cases in population:	-0.0091	-0.00174	-0.00200
Risk:	-8.0E-07	-1.5E-07	-1.2E-06

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Kogarah Bay			
Total Population in study area:	10788	10788	10788
% population in assessment age-group:	100%	100%	15%
total change	-780	-780	-780
Population weighted Δx (µg/m^3):	-0.07230256	-0.07230256	-0.07230256
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999864	0.999692	0.999917
Attributable fraction (AF):	-1.4E-04	-3.1E-04	-8.3E-05
Increased number of cases in population:	-0.0072	-0.00137	-0.00158
Risk:	-6.6E-07	-1.3E-07	-1.0E-06
Monterey - Brighton-le-Sands - Kyeemagh			
Total Population in study area:	13915	13915	13915
% population in assessment age-group:	100%	100%	15%
total change	-2313	-2313	-2313
Population weighted Δx (µg/m^3):	-0.16622350	-0.16622350	-0.16622350
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999688	0.999292	0.999809
Attributable fraction (AF):	-3.1E-04	-7.1E-04	-1.9E-04
Increased number of cases in population:	-0.02123	-0.00407	-0.004696
Risk:	-1.5E-06	-2.9E-07	-2.3E-06
Rockdale - Banksia			
Total Population in study area:	19957	19957	19957
% population in assessment age-group:	100%	100%	15%
total change	-3069	-3069	-3069
Population weighted Δx (µg/m^3):	-0.15378063	-0.15378063	-0.15378063
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999711	0.999345	0.999823
Attributable fraction (AF):	-2.9E-04	-6.6E-04	-1.8E-04
Increased number of cases in population:	-0.02817	-0.00540	-0.006230
Risk:	-1.4E-06	-2.7E-07	-2.1E-06
Sans Souci - Ramsgate			
Total Population in study area:	2036	2036	2036
% population in assessment age-group:	100%	100%	15%
total change	-159	-159	-159
Population weighted Δx (µg/m^3):	-0.07809430	-0.07809430	-0.07809430
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999853	0.999667	0.999910
Attributable fraction (AF):	-1.5E-04	-3.3E-04	-9.0E-05
Increased number of cases in population:	-0.00146	-0.00028	-0.000323
Risk:	-7.2E-07	-1.4E-07	-1.1E-06
Hurstville			
Total Population in study area:	102	102	102
% population in assessment age-group:	100%	100%	15%
total change	-11.7	-11.7	-11.7
Population weighted Δx (µg/m^3):	-0.11470588	-0.11470588	-0.11470588
Baseline Incidence (per 100,000) (as per Table 4.5)	488	41	1209
Baseline Incidence (per person)	0.00488	0.00041	0.01209
Relative Risk:	0.999784	0.999511	0.999868
Attributable fraction (AF):	-2.2E-04	-4.9E-04	-1.3E-04
Increased number of cases in population:	-0.0001	0.0000	-0.00002
Risk:	-1.1E-06	-2.0E-07	-1.6E-06
Eastern Suburbs			
Total Population in study area:	33621	33621	33621
% population in assessment age-group:	100%	100%	14%
total change	-8404.0	-8404	-8404
Population weighted Δx (µg/m^3):	-0.24996282	-0.24996282	-0.24996282
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999530	0.998936	0.999713
Attributable fraction (AF):	-4.7E-04	-1.1E-03	-2.9E-04
Increased number of cases in population:	-0.078	-0.0148	-0.0161
Risk:	-2.3E-06	-4.4E-07	-3.5E-06
Individual subrubs within LGA			
Centennial Park			
Total Population in study area:	0	0	0
Kensington			
Total Population in study area:	14903	14903	14903
% population in assessment age-group:	100%	100%	14%
total change	-4215	-4215	-4215
Population weighted Δx (µg/m^3):	-0.28282896	-0.28282896	-0.28282896
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999468	0.998796	0.999675
Attributable fraction (AF):	-5.3E-04	-1.2E-03	-3.3E-04
Increased number of cases in population:	-0.0390	-0.0074	-0.00809
Risk:	-2.6E-06	-5.0E-07	-3.9E-06
Kingsford			
Total Population in study area:	11769	11769	11769
% population in assessment age-group:	100%	100%	14%
total change	-3443	-3443	-3443
Population weighted Δx (µg/m^3):	-0.29254822	-0.29254822	-0.29254822
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999450	0.998755	0.999664
Attributable fraction (AF):	-5.5E-04	-1.2E-03	-3.4E-04
Increased number of cases in population:	-0.0319	-0.00606	-0.00661
Risk:	-2.7E-06	-5.1E-07	-4.1E-06
Malabar - La Perouse - Chiffley			
Total Population in study area:	3724	3724	3724
% population in assessment age-group:	100%	100%	14%
total change	-233	-233	-233
Population weighted Δx (µg/m^3):	-0.06256713	-0.06256713	-0.06256713
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999882	0.999733	0.999928
Attributable fraction (AF):	-1.2E-04	-2.7E-04	-7.2E-05
Increased number of cases in population:	-0.0022	-0.00041	-0.00045
Risk:	-5.8E-07	-1.1E-07	-8.7E-07
Maroubra (west)			
Total Population in study area:	2951	2951	2951
% population in assessment age-group:	100%	100%	14%
total change	-434	-434	-434
Population weighted Δx (µg/m^3):	-0.14706879	-0.14706879	-0.14706879
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999724	0.999374	0.999831
Attributable fraction (AF):	-2.8E-04	-6.3E-04	-1.7E-04
Increased number of cases in population:	-0.0040	-0.00076	-0.00083
Risk:	-1.4E-06	-2.6E-07	-2.0E-06
Paddington - Moore Park			
Total Population in study area:	189	189	189
% population in assessment age-group:	100%	100%	14%
total change	-80	-80	-80
Population weighted Δx (µg/m^3):	-0.42328042	-0.42328042	-0.42328042
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	0.999205	0.998198	0.999513
Attributable fraction (AF):	-8.0E-04	-1.8E-03	-4.9E-04
Increased number of cases in population:	-0.00074	-0.00014	-0.000154

Health Endpoint:	Mortality - All Causes, Short-term	Mortality - Respiratory, Short-term	Morbidity - Asthma ED Admissions, Short-term
Age Group:	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.12)	0.00188	0.00426	0.00115
Risk:	-3.9E-06	-7.4E-07	-5.9E-06
Randwick (North and South)			
Total Population in study area:	85	85	85
% population in assessment age-group:	100%	100%	14%
total change	1.8	1.8	1.8
Population weighted Δx (µg/m^3):	0.02117647	0.02117647	0.02117647
Baseline Incidence (per 100,000) (as per Table 4.5)	492	41	1209
Baseline Incidence (per person)	0.00492	0.00041	0.01209
Relative Risk:	1.000040	1.000090	1.000024
Attributable fraction (AF):	4.0E-05	9.0E-05	2.4E-05
Increased number of cases in population:	0.000017	0.0000032	0.0000035
Risk:	2.0E-07	3.7E-08	2.9E-07
Total population incidence - All Suburbs	**-0.6546**	**-0.1189**	**-0.1251**

Annexure F : Risk calculations – Particulate matter

Quantification of Effects - $PM_{2.5}$ and PM_{10}
Gateway Road Project: 2026

Air quality indicator:	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	DPM
Endpoint:	**Mortality - All Causes**	**Hospitalisations - Cardiovascular**	**Hospitalisations - Respiratory**	**Mortality - All Causes**	**Mortality - All Causes**	**Mortality - Cardiopulmonary**	**Mortality - Cardiovascular**	**Mortality - Respiratory**	**Morbidity - Asthma ED Admissions**	**Increased risk - lung cancer**
Effect Exposure Duration:	Long-term	Short-term	Short-term	Short-Term	Short-Term	Long-term	Short-Term	Short-Term	Short-Term	Based on WHO
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	All ages	≥ 30 years	All ages	All ages	1-14 years	inhalation unit risk
β (change in effect per 1 µg/m³) (as per Table 6.17)	0.0058	0.0008	0.00041	0.0006	0.00094	0.013	0.00097	0.0019	0.00148	3.40E-05
Annual Baseline Incidence (as per Table 4.5)										(ug/m3)-1
Annual baseline incidence (per 100,000)	1026	9235	3978	457	457	412	127.3	41.3	1209	
Baseline Incidence (per person per year)	0.01026	0.09235	0.03978	0.00457	0.00457	0.00412	0.001273	0.000413	0.01209	

Sensitive Receptors		Change in Annual Average PM10 Concentration (µg/m³)	Change in Annual Average PM2.5 Concentration (µg/m³)	Risk	Risk	Risk	Risk	Risk	Risk	Risk	Risk	Risk	Risk
Impacts from tunnel ventilation outlets													
Grid receptors: maximum regardless of landuse		**1.50**	**1.00**	**6E-05**	**7E-05**	**2E-05**	**4E-06**	**4E-06**	**5E-05**	**1E-06**	**8E-07**	**2E-05**	**3E-05**
Grid receptors: maximum residential		**1.50**	**1.00**	**6E-05**	**7E-05**	**2E-05**	**4E-06**	**4E-06**	**5E-05**	**1E-06**	**8E-07**	**2E-05**	**3E-05**
Grid receptors: maximum childcare		**0.10**	**0.09**	**5E-06**	**7E-06**	**1E-06**	**3E-07**	**4E-07**	**5E-06**	**1E-07**	**7E-08**	**2E-06**	**3E-06**
Grid receptors: maximum school		**0.04**	**0.05**	**3E-06**	**3E-06**	**8E-07**	**1E-07**	**2E-07**	**3E-06**	**6E-08**	**4E-08**	**8E-07**	**2E-06**
Grid receptors: maximum aged care		**-0.01**	**-0.02**	**-1E-06**	**-1E-06**	**-3E-07**	**-3E-08**	**-8E-08**	**-1E-06**	**-2E-08**	**-1E-08**	**-3E-07**	**-6E-07**
Grid receptors: maximum hospital and medical		**0.19**	**0.08**	**5E-06**	**6E-06**	**1E-06**	**5E-07**	**3E-07**	**4E-06**	**1E-07**	**6E-08**	**1E-06**	**3E-06**
Grid receptors: commercial/industrial		**1.40**	**0.85**	**5E-05**	**6E-05**	**1E-05**	**4E-06**	**4E-06**	**5E-05**	**1E-06**	**7E-07**	**2E-05**	**3E-05**
Grid receptors: open space		**0.12**	**0.06**	**4E-06**	**4E-06**	**1E-06**	**3E-07**	**3E-07**	**3E-06**	**7E-08**	**5E-08**	**1E-06**	**2E-06**
Community Receptors													
Aero Kids Early Learning Centre	Childcare	-0.0430	-0.0657	-4E-06	-5E-06	-1E-06	-1E-07	-3E-07	-4E-06	-8E-08	-5E-08	-1E-06	**-2E-06**
Guardian Early Learning Centre	Childcare	0.0401	-0.0426	-3E-06	-3E-06	-7E-07	1E-07	-2E-07	-2E-06	-5E-08	-3E-08	-8E-07	**-1E-06**
Gardeners Road Public School	School	-0.0566	0.1726	1E-05	1E-05	3E-06	-2E-07	7E-07	9E-06	2E-07	1E-07	3E-06	**6E-06**
Botany Public School	School	-0.4079	-0.2149	-1E-05	-2E-05	-4E-06	-1E-06	-9E-07	-1E-05	-3E-07	-2E-07	-4E-06	**-7E-06**
Mascot Public School	School	-0.2205	-0.0248	-1E-06	-2E-06	-4E-07	-6E-07	-1E-07	-1E-06	-3E-08	-2E-08	-4E-07	**-8E-07**
Tempe High School	School	-0.2525	-0.1188	-7E-06	-9E-06	-2E-06	-7E-07	-5E-07	-6E-06	-1E-07	-9E-08	-2E-06	**-4E-06**
JJ Cahill Memorial High School	School	-0.3578	-0.2228	-1E-05	-2E-05	-4E-06	-1E-06	-1E-06	-1E-05	-3E-07	-2E-07	-4E-06	**-8E-06**
St Bernard's Catholic Primary School	School	-0.8408	-0.4458	-3E-05	-3E-05	-7E-06	-2E-06	-2E-06	-2E-05	-6E-07	-3E-07	-8E-06	**-2E-05**
Active Kids Mascot	Childcare	-0.4939	-0.3828	-2E-05	-3E-05	-6E-06	-1E-06	-2E-06	-2E-05	-5E-07	-3E-07	-7E-06	**-1E-05**
Betty Spears Child Care Centre	Childcare	-0.1889	-0.1466	-9E-06	-1E-05	-2E-06	-5E-07	-6E-07	-8E-06	-2E-07	-1E-07	-3E-06	**-5E-06**
Toybox Early Learning	Childcare	-0.2114	-0.2236	-1E-05	-2E-05	-4E-06	-6E-07	-1E-06	-1E-05	-3E-07	-2E-07	-4E-06	**-8E-06**
Mascot Child Care Centre	Childcare	0.0017	-0.1457	-9E-06	-1E-05	-2E-06	5E-09	-6E-07	-8E-06	-2E-07	-1E-07	-3E-06	**-5E-06**
St Theres Catholic Primary School	School	-0.2111	-0.0926	-6E-06	-7E-06	-2E-06	-6E-07	-4E-07	-5E-06	-1E-07	-7E-08	-2E-06	**-3E-06**
St Peters Public School	School	0.0643	-0.1424	-8E-06	-1E-05	-2E-06	2E-07	-6E-07	-8E-06	-2E-07	-1E-07	-3E-06	**-5E-06**
Tillman Park Child Care Centre	Childcare	-0.0731	-0.0460	-3E-06	-3E-06	-8E-07	-2E-07	-2E-07	-2E-06	-6E-08	-4E-08	-8E-07	**-2E-06**
Tempe Public School	School	0.0238	-0.0388	-2E-06	-3E-06	-6E-07	7E-08	-2E-07	-2E-06	-5E-08	-3E-08	-7E-07	**-1E-06**
Pagewood Kindergarten	Childcare	0.0171	0.0800	5E-06	6E-06	1E-06	5E-08	3E-07	4E-06	1E-07	6E-08	1E-06	**3E-06**

Quantification of Effects - $PM_{2.5}$ and PM_{10}
Gateway Road Project: 2026 Cumulative

Air quality indicator:	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	DPM
Endpoint:	**Mortality - All Causes**	**Hospitalisations - Cardiovascular**	**Hospitalisations - Respiratory**	**Mortality - All Causes**	**Mortality - All Causes**	**Mortality - Cardiopulmonary**	**Mortality - Cardiovascular**	**Mortality - Respiratory**	**Morbidity - Asthma ED Admissions**	**Increased risk - lung cancer**
Effect Exposure Duration:	Long-term	Short-term	Short-term	Short-Term	Short-Term	Long-term	Short-Term	Short-Term	Short-Term	Based on WHO
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	All ages	≥ 30 years	All ages	All ages	1-14 years	inhalation unit risk
β (change in effect per 1 µg/m^3) (as per Table 6.17)	0.0058	0.0008	0.00041	0.0006	0.00094	0.013	0.00097	0.0019	0.00148	3.40E-05
Annual Baseline Incidence (as per Table 4.5)										(ug/m3)-1
Annual baseline incidence (per 100,000)	1026	9235	3978	457	457	412	127.3	41.3	1209	
Baseline Incidence (per person per year)	0.01026	0.09235	0.03978	0.00457	0.00457	0.00412	0.001273	0.000413	0.01209	

Sensitive Receptors		Change in Annual Average PM10 Concentration (µg/m^3)	Change in Annual Average PM2.5 Concentration (µg/m^3)	Risk	Risk	Risk	Risk	Risk	Risk	Risk	Risk	Risk	Risk
Impacts from tunnel ventilation outlets													
Grid receptors: maximum regardless of landuse		**1.55**	**1.00**	**6E-05**	**7E-05**	**2E-05**	**4E-06**	**4E-06**	**5E-05**	**1E-06**	**8E-07**	**2E-05**	**3E-05**
Grid receptors: maximum residential		**1.55**	**1.00**	**6E-05**	**7E-05**	**2E-05**	**4E-06**	**4E-06**	**5E-05**	**1E-06**	**8E-07**	**2E-05**	**3E-05**
Grid receptors: maximum childcare		**0.10**	**0.08**	**5E-06**	**6E-06**	**1E-06**	**3E-07**	**3E-07**	**4E-06**	**1E-07**	**6E-08**	**1E-06**	**3E-06**
Grid receptors: maximum school		**0.08**	**0.10**	**6E-06**	**7E-06**	**2E-06**	**2E-07**	**4E-07**	**5E-06**	**1E-07**	**8E-08**	**2E-06**	**3E-06**
Grid receptors: maximum aged care		**-0.06**	**-0.02**	**-1E-06**	**-1E-06**	**-3E-07**	**-2E-07**	**-8E-08**	**-1E-06**	**-2E-08**	**-1E-08**	**-3E-07**	**-6E-07**
Grid receptors: maximum hospital and medical		**0.16**	**0.08**	**5E-06**	**6E-06**	**1E-06**	**4E-07**	**4E-07**	**4E-06**	**1E-07**	**7E-08**	**1E-06**	**3E-06**
Grid receptors: commercial/industrial		**1.40**	**0.87**	**5E-05**	**6E-05**	**1E-05**	**4E-06**	**4E-06**	**5E-05**	**1E-06**	**7E-07**	**2E-05**	**3E-05**
Grid receptors: open space		**0.17**	**0.09**	**5E-06**	**7E-06**	**2E-06**	**5E-07**	**4E-07**	**5E-06**	**1E-07**	**7E-08**	**2E-06**	**3E-06**
Community Receptors													
Aero Kids Early Learning Centre	Childcare	-0.0966	-0.0329	-2E-06	-2E-06	-5E-07	-3E-07	-1E-07	-2E-06	-4E-08	-3E-08	-6E-07	**-1E-06**
Guardian Early Learning Centre	Childcare	0.0992	-0.0798	-5E-06	-6E-06	-1E-06	3E-07	-3E-07	-4E-06	-1E-07	-6E-08	-1E-06	**-3E-06**
Gardeners Road Public School	School	-0.1191	0.0509	3E-06	4E-06	8E-07	-3E-07	2E-07	3E-06	6E-08	4E-08	9E-07	**2E-06**
Botany Public School	School	-0.1602	-0.1073	-6E-06	-8E-06	-2E-06	-4E-07	-5E-07	-6E-06	-1E-07	-8E-08	-2E-06	**-4E-06**
Mascot Public School	School	-0.3361	-0.0639	-4E-06	-5E-06	-1E-06	-9E-07	-3E-07	-3E-06	-8E-08	-5E-08	-1E-06	**-2E-06**
Tempe High School	School	-0.2601	-0.1193	-7E-06	-9E-06	-2E-06	-7E-07	-5E-07	-6E-06	-1E-07	-9E-08	-2E-06	**-4E-06**
JJ Cahill Memorial High School	School	-0.2860	-0.2575	-2E-05	-2E-05	-4E-06	-8E-07	-1E-06	-1E-05	-3E-07	-2E-07	-5E-06	**-9E-06**
St Bernard's Catholic Primary School	School	-0.9318	-0.4872	-3E-05	-4E-05	-8E-06	-3E-06	-2E-06	-3E-05	-6E-07	-4E-07	-9E-06	**-2E-05**
Active Kids Mascot	Childcare	-0.5855	-0.3029	-2E-05	-2E-05	-5E-06	-2E-06	-1E-06	-2E-05	-4E-07	-2E-07	-5E-06	**-1E-05**
Betty Spears Child Care Centre	Childcare	-0.2627	-0.1300	-8E-06	-1E-05	-2E-06	-7E-07	-6E-07	-7E-06	-2E-07	-1E-07	-2E-06	**-4E-06**
Toybox Early Learning	Childcare	-0.3904	-0.1343	-8E-06	-1E-05	-2E-06	-1E-06	-6E-07	-7E-06	-2E-07	-1E-07	-2E-06	**-5E-06**
Mascot Child Care Centre	Childcare	0.0118	-0.1543	-9E-06	-1E-05	-3E-06	3E-08	-7E-07	-8E-06	-2E-07	-1E-07	-3E-06	**-5E-06**
St Theres Catholic Primary School	School	-0.3155	-0.0354	-2E-06	-3E-06	-6E-07	-9E-07	-2E-07	-2E-06	-4E-08	-3E-08	-6E-07	**-1E-06**
St Peters Public School	School	0.0987	-0.1628	-1E-05	-1E-05	-3E-06	3E-07	-7E-07	-9E-06	-2E-07	-1E-07	-3E-06	**-6E-06**
Tillman Park Child Care Centre	Childcare	-0.1467	-0.0334	-2E-06	-2E-06	-5E-07	-4E-07	-1E-07	-2E-06	-4E-08	-3E-08	-6E-07	**-1E-06**
Tempe Public School	School	-0.0489	0.0119	7E-07	9E-07	2E-07	-1E-07	5E-08	6E-07	1E-08	9E-09	2E-07	**4E-07**
Pagewood Kindergarten	Childcare	0.1057	0.0510	3E-06	4E-06	8E-07	3E-07	2E-07	3E-06	6E-08	4E-08	9E-07	**2E-06**

Quantification of Effects - $PM_{2.5}$ and PM_{10}
Gateway Road Project: 2036

Air quality indicator:	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	DPM
Endpoint:	**Mortality - All Causes**	**Hospitalisations - Cardiovascular**	**Hospitalisations - Respiratory**	**Mortality - All Causes**	**Mortality - All Causes**	**Mortality - Cardiopulmonary**	**Mortality - Cardiovascular**	**Mortality - Respiratory**	**Morbidity - Asthma ED Admissions**	**Increased risk - lung cancer**
Effect Exposure Duration:	Long-term	Short-term	Short-term	Short-Term	Short-Term	Long-term	Short-Term	Short-Term	Short-Term	Based on WHO
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	All ages	≥ 30 years	All ages	All ages	1-14 years	inhalation unit risk
β (change in effect per 1 µg/m³) (as per Table 6.17)	0.0058	0.0008	0.00041	0.0006	0.00094	0.013	0.00097	0.0019	0.00148	3.40E-05
Annual Baseline Incidence (as per Table 4.5)										(ug/m3)-1
Annual baseline incidence (per 100,000)	1026	9235	3978	457	457	412	127.3	41.3	1209	
Baseline Incidence (per person per year)	0.01026	0.09235	0.03978	0.00457	0.00457	0.00412	0.001273	0.000413	0.01209	

Sensitive Receptors		**Change in Annual Average PM10 Concentration (µg/m³)**	**Change in Annual Average PM2.5 Concentration (µg/m³)**	**Risk**	**Risk**	**Risk**	**Risk**	**Risk**	**Risk**	**Risk**	**Risk**	**Risk**	**Risk**
Impacts from tunnel ventilation outlets													
Grid receptors: maximum regardless of landuse		**1.70**	**1.20**	**7E-05**	**9E-05**	**2E-05**	**5E-06**	**5E-06**	**6E-05**	**1E-06**	**9E-07**	**2E-05**	**4E-05**
Grid receptors: maximum residential		**1.70**	**1.15**	**7E-05**	**8E-05**	**2E-05**	**5E-06**	**5E-06**	**6E-05**	**1E-06**	**9E-07**	**2E-05**	**4E-05**
Grid receptors: maximum childcare		**0.12**	**0.10**	**6E-06**	**7E-06**	**2E-06**	**3E-07**	**4E-07**	**5E-06**	**1E-07**	**8E-08**	**2E-06**	**3E-06**
Grid receptors: maximum school		**0.20**	**0.09**	**5E-06**	**7E-06**	**1E-06**	**5E-07**	**4E-07**	**5E-06**	**1E-07**	**7E-08**	**2E-06**	**3E-06**
Grid receptors: maximum aged care		**0.05**	**-0.01**	**-7E-07**	**-8E-07**	**-2E-07**	**1E-07**	**-5E-08**	**-6E-07**	**-1E-08**	**-9E-09**	**-2E-07**	**-4E-07**
Grid receptors: maximum hospital and medical		**0.17**	**0.11**	**7E-06**	**8E-06**	**2E-06**	**5E-07**	**5E-07**	**6E-06**	**1E-07**	**9E-08**	**2E-06**	**4E-06**
Grid receptors: commercial/industrial		**1.70**	**1.20**	**7E-05**	**9E-05**	**2E-05**	**5E-06**	**5E-06**	**6E-05**	**1E-06**	**9E-07**	**2E-05**	**4E-05**
Grid receptors: open space		**0.18**	**0.11**	**7E-06**	**8E-06**	**2E-06**	**5E-07**	**5E-07**	**6E-06**	**1E-07**	**9E-08**	**2E-06**	**4E-06**
Community Receptors													
Aero Kids Early Learning Centre	Childcare	-0.0306	0.0189	1E-06	1E-06	3E-07	-8E-08	8E-08	1E-06	2E-08	1E-08	3E-07	**6E-07**
Guardian Early Learning Centre	Childcare	-0.1067	0.1026	6E-06	8E-06	2E-06	-3E-07	4E-07	5E-06	1E-07	8E-08	2E-06	**3E-06**
Gardeners Road Public School	School	-0.0156	0.0801	5E-06	6E-06	1E-06	-4E-08	3E-07	4E-06	1E-07	6E-08	1E-06	**3E-06**
Botany Public School	School	-0.3041	-0.1292	-8E-06	-1E-05	-2E-06	-8E-07	-6E-07	-7E-06	-2E-07	-1E-07	-2E-06	**-4E-06**
Mascot Public School	School	-0.2453	-0.0980	-6E-06	-7E-06	-2E-06	-7E-07	-4E-07	-5E-06	-1E-07	-8E-08	-2E-06	**-3E-06**
Tempe High School	School	-0.3756	-0.2278	-1E-05	-2E-05	-4E-06	-1E-06	-1E-06	-1E-05	-3E-07	-2E-07	-4E-06	**-8E-06**
JJ Cahill Memorial High School	School	-0.1797	-0.1835	-1E-05	-1E-05	-3E-06	-5E-07	-8E-07	-1E-05	-2E-07	-1E-07	-3E-06	**-6E-06**
St Bernard's Catholic Primary School	School	-0.4667	-0.5502	-3E-05	-4E-05	-9E-06	-1E-06	-2E-06	-3E-05	-7E-07	-4E-07	-1E-05	**-2E-05**
Active Kids Mascot	Childcare	-0.4753	-0.3642	-2E-05	-3E-05	-6E-06	-1E-06	-2E-06	-2E-05	-4E-07	-3E-07	-7E-06	**-1E-05**
Betty Spears Child Care Centre	Childcare	-0.3848	-0.2691	-2E-05	-2E-05	-4E-06	-1E-06	-1E-06	-1E-05	-3E-07	-2E-07	-5E-06	**-9E-06**
Toybox Early Learning	Childcare	0.1284	-0.0881	-5E-06	-7E-06	-1E-06	4E-07	-4E-07	-5E-06	-1E-07	-7E-08	-2E-06	**-3E-06**
Mascot Child Care Centre	Childcare	-0.2926	-0.0148	-9E-07	-1E-06	-2E-07	-8E-07	-6E-08	-8E-07	-2E-08	-1E-08	-3E-07	**-5E-07**
St Theres Catholic Primary School	School	-0.0516	-0.1204	-7E-06	-9E-06	-2E-06	-1E-07	-5E-07	-6E-06	-1E-07	-9E-08	-2E-06	**-4E-06**
St Peters Public School	School	0.1096	-0.0185	-1E-06	-1E-06	-3E-07	3E-07	-8E-08	-1E-06	-2E-08	-1E-08	-3E-07	**-6E-07**
Tillman Park Child Care Centre	Childcare	-0.1005	0.0154	9E-07	1E-06	3E-07	-3E-07	7E-08	8E-07	2E-08	1E-08	3E-07	**5E-07**
Tempe Public School	School	-0.0415	0.0441	3E-06	3E-06	7E-07	-1E-07	2E-07	2E-06	5E-08	3E-08	8E-07	**2E-06**
Pagewood Kindergarten	Childcare	0.0906	0.0068	4E-07	5E-07	1E-07	2E-07	3E-08	4E-07	8E-09	5E-09	1E-07	**2E-07**

Quantification of Effects - $PM_{2.5}$ and PM_{10}
Gateway Road Project: 2036 Cumulative

Air quality indicator:	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	$PM_{2.5}$	DPM
Endpoint:	**Mortality - All Causes**	**Hospitalisations - Cardiovascular**	**Hospitalisations - Respiratory**	**Mortality - All Causes**	**Mortality - All Causes**	**Mortality - Cardiopulmonary**	**Mortality - Cardiovascular**	**Mortality - Respiratory**	**Morbidity - Asthma ED Admissions**	**Increased risk - lung cancer**
Effect Exposure Duration:	Long-term	Short-term	Short-term	Short-Term	Short-Term	Long-term	Short-Term	Short-Term	Short-Term	Based on WHO
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	All ages	≥ 30 years	All ages	All ages	1-14 years	inhalation unit risk
β (change in effect per 1 µg/m^3) (as per Table 6.17)	0.0058	0.0008	0.00041	0.0006	0.00094	0.013	0.00097	0.0019	0.00148	3.40E-05
Annual Baseline Incidence (as per Table 4.5)										(ug/m3)-1
Annual baseline incidence (per 100,000)	1026	9235	3978	457	457	412	127.3	41.3	1209	
Baseline Incidence (per person per year)	0.01026	0.09235	0.03978	0.00457	0.00457	0.00412	0.001273	0.000413	0.01209	

Sensitive Receptors		Change in Annual Average PM10 Concentration (µg/m^3)	Change in Annual Average PM2.5 Concentration (µg/m^3)	Risk	Risk	Risk	Risk	Risk	Risk	Risk	Risk	Risk	Risk
Impacts from tunnel ventilation outlets													
Grid receptors: maximum regardless of landuse		**1.90**	**1.26**	**7E-05**	**9E-05**	**2E-05**	**5E-06**	**5E-06**	**7E-05**	**2E-06**	**1E-06**	**2E-05**	**4E-05**
Grid receptors: maximum residential		**1.82**	**1.20**	**7E-05**	**9E-05**	**2E-05**	**5E-06**	**5E-06**	**6E-05**	**1E-06**	**9E-07**	**2E-05**	**4E-05**
Grid receptors: maximum childcare		**0.12**	**0.08**	**5E-06**	**6E-06**	**1E-06**	**3E-07**	**3E-07**	**4E-06**	**1E-07**	**6E-08**	**1E-06**	**3E-06**
Grid receptors: maximum school		**0.15**	**0.08**	**5E-06**	**6E-06**	**1E-06**	**4E-07**	**4E-07**	**4E-06**	**1E-07**	**7E-08**	**1E-06**	**3E-06**
Grid receptors: maximum aged care		**-0.03**	**-0.02**	**-1E-06**	**-1E-06**	**-3E-07**	**-7E-08**	**-9E-08**	**-1E-06**	**-2E-08**	**-2E-08**	**-4E-07**	**-7E-07**
Grid receptors: maximum hospital and medical		**0.20**	**0.07**	**4E-06**	**5E-06**	**1E-06**	**5E-07**	**3E-07**	**4E-06**	**9E-08**	**6E-08**	**1E-06**	**3E-06**
Grid receptors: commercial/industrial		**1.90**	**1.26**	**7E-05**	**9E-05**	**2E-05**	**5E-06**	**5E-06**	**7E-05**	**2E-06**	**1E-06**	**2E-05**	**4E-05**
Grid receptors: open space		**0.22**	**0.16**	**1E-05**	**1E-05**	**3E-06**	**6E-07**	**7E-07**	**9E-06**	**2E-07**	**1E-07**	**3E-06**	**5E-06**
Community Receptors													
Aero Kids Early Learning Centre	Childcare	-0.2247	-0.0183	-1E-06	-1E-06	-3E-07	-6E-07	-8E-08	-1E-06	-2E-08	-1E-08	-3E-07	**-6E-07**
Guardian Early Learning Centre	Childcare	-0.0212	0.0301	2E-06	2E-06	5E-07	-6E-08	1E-07	2E-06	4E-08	2E-08	5E-07	**1E-06**
Gardeners Road Public School	School	-0.0687	-0.1632	-1E-05	-1E-05	-3E-06	-2E-07	-7E-07	-9E-06	-2E-07	-1E-07	-3E-06	**-6E-06**
Botany Public School	School	-0.3834	-0.2533	-2E-05	-2E-05	-4E-06	-1E-06	-1E-06	-1E-05	-3E-07	-2E-07	-5E-06	**-9E-06**
Mascot Public School	School	-0.2718	-0.0976	-6E-06	-7E-06	-2E-06	-7E-07	-4E-07	-5E-06	-1E-07	-8E-08	-2E-06	**-3E-06**
Tempe High School	School	-0.2416	-0.2142	-1E-05	-2E-05	-3E-06	-7E-07	-9E-07	-1E-05	-3E-07	-2E-07	-4E-06	**-7E-06**
JJ Cahill Memorial High School	School	-0.1778	-0.2110	-1E-05	-2E-05	-3E-06	-5E-07	-9E-07	-1E-05	-3E-07	-2E-07	-4E-06	**-7E-06**
St Bernard's Catholic Primary School	School	-0.5787	-0.6642	-4E-05	-5E-05	-1E-05	-2E-06	-3E-06	-4E-05	-8E-07	-5E-07	-1E-05	**-2E-05**
Active Kids Mascot	Childcare	-0.3893	-0.2930	-2E-05	-2E-05	-5E-06	-1E-06	-1E-06	-2E-05	-4E-07	-2E-07	-5E-06	**-1E-05**
Betty Spears Child Care Centre	Childcare	-0.4314	-0.3190	-2E-05	-2E-05	-5E-06	-1E-06	-1E-06	-2E-05	-4E-07	-3E-07	-6E-06	**-1E-05**
Toybox Early Learning	Childcare	0.0945	-0.0424	-3E-06	-3E-06	-7E-07	3E-07	-2E-07	-2E-06	-5E-08	-3E-08	-8E-07	**-1E-06**
Mascot Child Care Centre	Childcare	-0.3526	-0.1729	-1E-05	-1E-05	-3E-06	-1E-06	-7E-07	-9E-06	-2E-07	-1E-07	-3E-06	**-6E-06**
St Theres Catholic Primary School	School	-0.1825	-0.2383	-1E-05	-2E-05	-4E-06	-5E-07	-1E-06	-1E-05	-3E-07	-2E-07	-4E-06	**-8E-06**
St Peters Public School	School	-0.1124	-0.0552	-3E-06	-4E-06	-9E-07	-3E-07	-2E-07	-3E-06	-7E-08	-4E-08	-1E-06	**-2E-06**
Tillman Park Child Care Centre	Childcare	-0.1052	0.0084	5E-07	6E-07	1E-07	-3E-07	4E-08	4E-07	1E-08	7E-09	2E-07	**3E-07**
Tempe Public School	School	-0.1178	0.0316	2E-06	2E-06	5E-07	-3E-07	1E-07	2E-06	4E-08	2E-08	6E-07	**1E-06**
Pagewood Kindergarten	Childcare	0.0854	0.0896	5E-06	7E-06	1E-06	2E-07	4E-07	5E-06	1E-07	7E-08	2E-06	**3E-06**

Annexure G: Population incidence calculations – Particulate matter

Assessment of Increased Incidence - $PM_{2.5}$
Gateway Road Project: 2026

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Inner West (including Strathfield - Burwood - Ashfield LGA)								
Total Population in study area:	62688	62688	62688	62688	62688	62688	62688	62688
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-595.6	-595.6	-595.6	-595.6	-595.6	-595.6	-595.6	-595.6
Population weighted Δx (µg/m^3):	-0.00950102	-0.00950102	-0.00950102	-0.00950102	-0.00950102	-0.00950102	-0.00950102	-0.00950102
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999945	0.999992	0.999996	0.999991	0.999876	0.999991	0.999982	0.999986
Attributable fraction (AF):	-5.5E-05	-7.6E-06	-3.9E-06	-8.9E-06	-1.2E-04	-9.2E-06	-1.8E-05	-1.4E-05
Increased number of cases in population:	-0.023	-0.0054	-0.0012	-0.0029	-0.020	-0.00079	-0.00047	-0.0015
Risk:	-5.7E-07	-7.0E-07	-1.5E-07	-4.7E-08	-5.1E-07	-1.3E-08	-7.5E-09	-1.7E-07
Individual subrubs within LGA								
Marrickville								
Total Population in study area:	26542	26542	26542	26542	26542	26542	26542	26542
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-217	-217	-217	-217	-217	-217	-217	-217
Population weighted Δx (µg/m^3):	-0.00817572	-0.00817572	-0.00817572	-0.00817572	-0.00817572	-0.00817572	-0.00817572	-0.00817572
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999953	0.999993	0.999997	0.999992	0.999894	0.999992	0.999984	0.999988
Attributable fraction (AF):	-4.7E-05	-6.5E-06	-3.4E-06	-7.7E-06	-1.1E-04	-7.9E-06	-1.6E-05	-1.2E-05
Increased number of cases in population:	-0.008239	-0.0019559	-0.00043179	-0.0010644	-0.007416	-0.00028774	-0.00017028	-0.0005475
Risk:	-4.9E-07	-6.0E-07	-1.3E-07	-4.0E-08	-4.4E-07	-1.1E-08	-6.4E-09	-1.5E-07
Petersham - Stanmore								
Total Population in study area:	4922	4922	4922	4922	4922	4922	4922	4922
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-62.8	-62.8	-62.8	-62.8	-62.8	-62.8	-62.8	-62.8
Population weighted Δx (µg/m^3):	-0.01275904	-0.01275904	-0.01275904	-0.01275904	-0.01275904	-0.01275904	-0.01275904	-0.01275904
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999926	0.999990	0.999995	0.999988	0.999834	0.999988	0.999976	0.999981
Attributable fraction (AF):	-7.4E-05	-1.0E-05	-5.2E-06	-1.2E-05	-1.7E-04	-1.2E-05	-2.4E-05	-1.9E-05
Increased number of cases in population:	-0.0024	-0.00057	-0.000125	-0.000308	-0.00215	-0.000083	-0.000049	-0.000158
Risk:	-7.6E-07	-9.4E-07	-2.1E-07	-6.3E-08	-6.8E-07	-1.7E-08	-1.0E-08	-2.3E-07
Sydenham - Tempe - St Peters								
Total Population in study area:	7829	7829	7829	7829	7829	7829	7829	7829
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-179	-179	-179	-179	-179	-179	-179	-179
Population weighted Δx (µg/m^3):	-0.02286371	-0.02286371	-0.02286371	-0.02286371	-0.02286371	-0.02286371	-0.02286371	-0.02286371
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999867	0.999982	0.999991	0.999979	0.999703	0.999978	0.999957	0.999966
Attributable fraction (AF):	-1.3E-04	-1.8E-05	-9.4E-06	-2.1E-05	-3.0E-04	-2.2E-05	-4.3E-05	-3.4E-05
Increased number of cases in population:	-0.0068	-0.00161	-0.00036	-0.00088	-0.0061	-0.000237	-0.000140	-0.00045
Risk:	-1.4E-06	-1.7E-06	-3.7E-07	-1.1E-07	-1.2E-06	-3.0E-08	-1.8E-08	-4.1E-07
Ashfield								
Total Population in study area:	1979	1979	1979	1979	1979	1979	1979	1979
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-1	-1	-1	-1	-1	-1	-1	-1
Population weighted Δx (µg/m^3):	-0.00050531	-0.00050531	-0.00050531	-0.00050531	-0.00050531	-0.00050531	-0.00050531	-0.00050531
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999997	1.000000	1.000000	1.000000	0.999993	1.000000	0.999999	0.999999
Attributable fraction (AF):	-2.9E-06	-4.0E-07	-2.1E-07	-4.7E-07	-6.6E-06	-4.9E-07	-9.6E-07	-7.5E-07
Increased number of cases in population:	-0.000038	-0.0000090	-0.00000199	-0.0000049	-0.000034	-0.00000133	-0.00000078	-0.0000025
Risk:	-3.0E-08	-3.7E-08	-8.2E-09	-2.5E-09	-2.7E-08	-6.7E-10	-4.0E-10	-9.0E-09
Canterbury (North) - Ashbury								
Total Population in study area:	7538	7538	7538	7538	7538	7538	7538	7538
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-55.8	-55.8	-55.8	-55.8	-55.8	-55.8	-55.8	-55.8
Population weighted Δx (µg/m^3):	-0.00740249	-0.00740249	-0.00740249	-0.00740249	-0.00740249	-0.00740249	-0.00740249	-0.00740249
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999957	0.999994	0.999997	0.999993	0.999904	0.999993	0.999986	0.999989
Attributable fraction (AF):	-4.3E-05	-5.9E-06	-3.0E-06	-7.0E-06	-9.6E-05	-7.2E-06	-1.4E-05	-1.1E-05
Increased number of cases in population:	-0.0021	-0.00050	-0.000111	-0.000274	-0.00191	-0.000074	-0.000044	-0.000141
Risk:	-4.4E-07	-5.5E-07	-1.2E-07	-3.6E-08	-4.0E-07	-9.8E-09	-5.8E-09	-1.3E-07
Dulwich Hill - Lewisham								
Total Population in study area:	13640	13640	13640	13640	13640	13640	13640	13640
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-77	-77	-77	-77	-77	-77	-77	-77
Population weighted Δx (µg/m^3):	-0.00564516	-0.00564516	-0.00564516	-0.00564516	-0.00564516	-0.00564516	-0.00564516	-0.00564516
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999967	0.999995	0.999998	0.999995	0.999927	0.999995	0.999989	0.999992
Attributable fraction (AF):	-3.3E-05	-4.5E-06	-2.3E-06	-5.3E-06	-7.3E-05	-5.5E-06	-1.1E-05	-8.4E-06
Increased number of cases in population:	-0.0029	-0.00069	-0.00015	-0.00038	-0.0026	-0.000102	-0.000060	-0.00019
Risk:	-3.4E-07	-4.2E-07	-9.2E-08	-2.8E-08	-3.0E-07	-7.5E-09	-4.4E-09	-1.0E-07
Haberfield - Summer Hill								
Total Population in study area:	238	238	238	238	238	238	238	238
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5
Population weighted Δx (µg/m^3):	-0.01050420	-0.01050420	-0.01050420	-0.01050420	-0.01050420	-0.01050420	-0.01050420	-0.01050420
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999939	0.999992	0.999996	0.999990	0.999863	0.999990	0.999980	0.999984
Attributable fraction (AF):	-6.1E-05	-8.4E-06	-4.3E-06	-9.9E-06	-1.4E-04	-1.0E-05	-2.0E-05	-1.6E-05
Increased number of cases in population:	-0.00009492	-0.00002253	-0.000004974	-0.00001226	-0.00008543	-0.000003315	-0.000001962	-0.00000631
Risk:	-6.3E-07	-7.8E-07	-1.7E-07	-5.2E-08	-5.6E-07	-1.4E-08	-8.2E-09	-1.9E-07

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Sydney Inner City LGA								
Total Population in study area:	47106	47106	47106	47106	47106	47106	47106	47106
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-1626	-1626	-1626	-1626	-1626	-1626	-1626	-1626
Population weighted Δx (µg/m^3):	-0.03451790	-0.03451790	-0.03451790	-0.03451790	-0.03451790	-0.03451790	-0.03451790	-0.03451790
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999800	0.999972	0.999986	0.999968	0.999551	0.999967	0.999934	0.999949
Attributable fraction (AF):	-2.0E-04	-2.8E-05	-1.4E-05	-3.2E-05	-4.5E-04	-3.3E-05	-6.6E-05	-5.1E-05
Increased number of cases in population:	-0.056	-0.0099	-0.0022	-0.0069	-0.050	-0.0018	-0.0013	-0.0017
Risk:	-2.1E-06	-2.6E-06	-5.6E-07	-1.5E-07	-1.8E-06	-3.8E-08	-2.7E-08	-6.2E-07
Individual subrubs within LGA								
Erskinville - Alexandria								
Total Population in study area:	14292	14292	14292	14292	14292	14292	14292	14292
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-348.4	-348.4	-348.4	-348.4	-348.4	-348.4	-348.4	-348.4
Population weighted Δx (µg/m^3):	-0.02437727	-0.02437727	-0.02437727	-0.02437727	-0.02437727	-0.02437727	-0.02437727	-0.02437727
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999859	0.999980	0.999990	0.999977	0.999683	0.999976	0.999954	0.999964
Attributable fraction (AF):	-1.4E-04	-2.0E-05	-1.0E-05	-2.3E-05	-3.2E-04	-2.4E-05	-4.6E-05	-3.6E-05
Increased number of cases in population:	-0.0119	-0.00211	-0.000466	-0.00149	-0.0108	-0.000383	-0.000273	-0.000368
Risk:	-1.5E-06	-1.8E-06	-4.0E-07	-1.0E-07	-1.3E-06	-2.7E-08	-1.9E-08	-4.4E-07
Newtown - Camperdown - Darlington								
Total Population in study area:	6910	6910	6910	6910	6910	6910	6910	6910
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-112.4	-112.4	-112.4	-112.4	-112.4	-112.4	-112.4	-112.4
Population weighted Δx (µg/m^3):	-0.01626628	-0.01626628	-0.01626628	-0.01626628	-0.01626628	-0.01626628	-0.01626628	-0.01626628
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999906	0.999987	0.999993	0.999985	0.999789	0.999984	0.999969	0.999976
Attributable fraction (AF):	-9.4E-05	-1.3E-05	-6.7E-06	-1.5E-05	-2.1E-04	-1.6E-05	-3.1E-05	-2.4E-05
Increased number of cases in population:	-0.0039	-0.00068	-0.000150	-0.00048	-0.00347	-0.000123	-0.000088	-0.000119
Risk:	-9.7E-07	-1.2E-06	-2.7E-07	-6.9E-08	-8.7E-07	-1.8E-08	-1.3E-08	-2.9E-07
Waterloo - Beaconsfield								
Total Population in study area:	25904	25904	25904	25904	25904	25904	25904	25904
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-1165	-1165	-1165	-1165	-1165	-1165	-1165	-1165
Population weighted Δx (µg/m^3):	-0.04497375	-0.04497375	-0.04497375	-0.04497375	-0.04497375	-0.04497375	-0.04497375	-0.04497375
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999739	0.999964	0.999982	0.999958	0.999416	0.999956	0.999915	0.999933
Attributable fraction (AF):	-2.6E-04	-3.6E-05	-1.8E-05	-4.2E-05	-5.8E-04	-4.4E-05	-8.5E-05	-6.7E-05
Increased number of cases in population:	-0.0399	-0.00706	-0.00156	-0.00497	-0.0360	-0.00128	-0.00091	-0.001230
Risk:	-2.7E-06	-3.3E-06	-7.3E-07	-1.9E-07	-2.4E-06	-4.9E-08	-3.5E-08	-8.0E-07
Canterbury LGA								
Total Population in study area:	12648	12648	12648	12648	12648	12648	12648	12648
% population in assessment age-group:	58%	14%	14%	100%	58%	100%	100%	19%
total change	-59.00	-59	-59	-59	-59	-59	-59	-59
Population weighted Δx (µg/m^3):	-0.00466477	-0.00466477	-0.00466477	-0.00466477	-0.00466477	-0.00466477	-0.00466477	-0.00466477
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	508.3	412.0	143.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00508	0.00412	0.00144	0.00041	0.01209
Relative Risk:	0.999973	0.999996	0.999998	0.999996	0.999939	0.999995	0.999991	0.999993
Attributable fraction (AF):	-2.7E-05	-3.7E-06	-1.9E-06	-4.4E-06	-6.1E-05	-4.5E-06	-8.9E-06	-6.9E-06
Increased number of cases in population:	-0.0021	-0.00061	-0.00013	-0.00028	-0.0018	-0.000082	-0.000046	-0.00020
Risk:	-2.8E-07	-3.4E-07	-7.6E-08	-2.2E-08	-2.5E-07	-6.5E-09	-3.7E-09	-8.3E-08
Individual subrubs within LGA								
Canterbury (South) - Campsie								
Total Population in study area:	149	149	149	149	149	149	149	149
% population in assessment age-group:	58%	14%	14%	100%	58%	100%	100%	19%
total change	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92	-0.92
Population weighted Δx (µg/m^3):	-0.00617450	-0.00617450	-0.00617450	-0.00617450	-0.00617450	-0.00617450	-0.00617450	-0.00617450
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	508.3	412.0	143.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00508	0.00412	0.00144	0.00041	0.01209
Relative Risk:	0.999964	0.999995	0.999997	0.999994	0.999920	0.999994	0.999988	0.999991
Attributable fraction (AF):	-3.6E-05	-4.9E-06	-2.5E-06	-5.8E-06	-8.0E-05	-6.0E-06	-1.2E-05	-9.1E-06
Increased number of cases in population:	-0.0000320	-0.0000094	-0.0000021	-0.0000044	-0.0000288	-0.0000013	-0.0000007	-0.0000032
Risk:	-3.7E-07	-4.6E-07	-1.0E-07	-3.0E-08	-3.3E-07	-8.6E-09	-4.8E-09	-1.1E-07
Kingsgrove (North) - Earlwood								
Total Population in study area:	12499	12499	12499	12499	12499	12499	12499	12499
% population in assessment age-group:	58%	14%	14%	100%	58%	100%	100%	19%
total change	-58	-58	-58	-58	-58	-58	-58	-58
Population weighted Δx (µg/m^3):	-0.00464037	-0.00464037	-0.00464037	-0.00464037	-0.00464037	-0.00464037	-0.00464037	-0.00464037
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	508.3	412.0	143.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00508	0.00412	0.00144	0.00041	0.01209
Relative Risk:	0.999973	0.999996	0.999998	0.999996	0.999940	0.999995	0.999991	0.999993
Attributable fraction (AF):	-2.7E-05	-3.7E-06	-1.9E-06	-4.4E-06	-6.0E-05	-4.5E-06	-8.8E-06	-6.9E-06
Increased number of cases in population:	-0.00202	-0.000596	-0.000131	-0.000277	-0.00181	-0.0000808	-0.0000455	-0.000199
Risk:	-2.8E-07	-3.4E-07	-7.6E-08	-2.2E-08	-2.5E-07	-6.5E-09	-3.6E-09	-8.3E-08
Botany LGA								
Total Population in study area:	46677	46677	46677	46677	46677	46677	46677	46677
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-4862	-4862	-4862	-4862	-4862	-4862	-4862	-4862
Population weighted Δx (µg/m^3):	-0.10416265	-0.10416265	-0.10416265	-0.10416265	-0.10416265	-0.10416265	-0.10416265	-0.10416265
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999396	0.999917	0.999957	0.999902	0.998647	0.999899	0.999802	0.999846
Attributable fraction (AF):	-6.0E-04	-8.3E-05	-4.3E-05	-9.8E-05	-1.4E-03	-1.0E-04	-2.0E-04	-1.5E-04
Increased number of cases in population:	-0.17	-0.047	-0.010	-0.026	-0.16	-0.0063	-0.0038	-0.014
Risk:	-6.2E-06	-7.7E-06	-1.7E-06	-5.5E-07	-5.6E-06	-1.4E-07	-8.2E-08	-1.9E-06

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Individual subrubs within LGA								
Banksmeadow								
Total Population in study area:	21	21	21	21	21	21	21	21
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Population weighted Δx (µg/m^3):	0.00095238	0.00095238	0.00095238	0.00095238	0.00095238	0.00095238	0.00095238	0.00095238
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	1.000006	1.000001	1.000000	1.000001	1.000012	1.000001	1.000002	1.000001
Attributable fraction (AF):	5.5E-06	7.6E-07	3.9E-07	9.0E-07	1.2E-05	9.2E-07	1.8E-06	1.4E-06
Increased number of cases in population:	0.00000071	0.00000019	0.000000042	0.00000011	0.00000064	0.000000026	0.000000016	0.000000056
Risk:	5.7E-08	7.0E-08	1.6E-08	5.0E-09	5.1E-08	1.2E-09	7.5E-10	1.7E-08
Botany								
Total Population in study area:	10780	10780	10780	10780	10780	10780	10780	10780
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-181.7	-181.7	-181.7	-181.7	-181.7	-181.7	-181.7	-181.7
Population weighted Δx (µg/m^3):	-0.01685529	-0.01685529	-0.01685529	-0.01685529	-0.01685529	-0.01685529	-0.01685529	-0.01685529
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999902	0.999987	0.999993	0.999984	0.999781	0.999984	0.999968	0.999975
Attributable fraction (AF):	-9.8E-05	-1.3E-05	-6.9E-06	-1.6E-05	-2.2E-04	-1.6E-05	-3.2E-05	-2.5E-05
Increased number of cases in population:	-0.0065	-0.0017	-0.00039	-0.0010	-0.0058	-0.00024	-0.00014	-0.0005
Risk:	-1.0E-06	-1.2E-06	-2.7E-07	-8.9E-08	-9.0E-07	-2.2E-08	-1.3E-08	-3.0E-07
Mascot - Eastlakes								
Total Population in study area:	24409	24409	24409	24409	24409	24409	24409	24409
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-4454.7	-4454.7	-4454.7	-4454.7	-4454.7	-4454.7	-4454.7	-4454.7
Population weighted Δx (µg/m^3):	-0.18250236	-0.18250236	-0.18250236	-0.18250236	-0.18250236	-0.18250236	-0.18250236	-0.18250236
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.998942	0.999854	0.999925	0.999828	0.997630	0.999823	0.999653	0.999730
Attributable fraction (AF):	-1.1E-03	-1.5E-04	-7.5E-05	-1.7E-04	-2.4E-03	-1.8E-04	-3.5E-04	-2.7E-04
Increased number of cases in population:	-0.1586	-0.0428	-0.0094	-0.0234	-0.1428	-0.0058	-0.0035	-0.0125
Risk:	-1.1E-05	-1.3E-05	-3.0E-06	-9.6E-07	-9.8E-06	-2.4E-07	-1.4E-07	-3.3E-06
Pagewood - Hillsdale - Daceyville								
Total Population in study area:	11400	11400	11400	11400	11400	11400	11400	11400
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-232.6	-232.6	-232.6	-232.6	-232.6	-232.6	-232.6	-232.6
Population weighted Δx (µg/m^3):	-0.02040351	-0.02040351	-0.02040351	-0.02040351	-0.02040351	-0.02040351	-0.02040351	-0.02040351
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999882	0.999984	0.999992	0.999981	0.999735	0.999980	0.999961	0.999970
Attributable fraction (AF):	-1.2E-04	-1.6E-05	-8.4E-06	-1.9E-05	-2.7E-04	-2.0E-05	-3.9E-05	-3.0E-05
Increased number of cases in population:	-0.00828	-0.00223	-0.000493	-0.001224	-0.007451	-0.000302	-0.0001825	-0.000653
Risk:	-1.2E-06	-1.5E-06	-3.3E-07	-1.1E-07	-1.1E-06	-2.6E-08	-1.6E-08	-3.7E-07
Port Botany Industrial								
Total Population in study area:	6	6	6	6	6	6	6	6
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Population weighted Δx (µg/m^3):	0.02000000	0.02000000	0.02000000	0.02000000	0.02000000	0.02000000	0.02000000	0.02000000
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	1.000116	1.000016	1.000008	1.000019	1.000260	1.000019	1.000038	1.000030
Attributable fraction (AF):	1.2E-04	1.6E-05	8.2E-06	1.9E-05	2.6E-04	1.9E-05	3.8E-05	3.0E-05
Increased number of cases in population:	0.0000043	0.0000012	0.00000025	0.00000063	0.00000384	0.00000016	0.000000094	0.00000034
Risk:	1.2E-06	1.5E-06	3.3E-07	1.1E-07	1.1E-06	2.6E-08	1.6E-08	3.6E-07
Sydney Airport								
Total Population in study area:	61	61	61	61	61	61	61	61
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
Population weighted Δx (µg/m^3):	0.11311475	0.11311475	0.11311475	0.11311475	0.11311475	0.11311475	0.11311475	0.11311475
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	1.000656	1.000090	1.000046	1.000106	1.001472	1.000110	1.000215	1.000167
Attributable fraction (AF):	6.6E-04	9.0E-05	4.6E-05	1.1E-04	1.5E-03	1.1E-04	2.1E-04	1.7E-04
Increased number of cases in population:	0.000245	0.000066	0.0000146	0.000036	0.000221	0.0000090	0.0000054	0.0000194
Risk:	6.7E-06	8.4E-06	1.8E-06	6.0E-07	6.1E-06	1.5E-07	8.9E-08	2.0E-06
Kogarah - Rockdale LGA								
Total Population in study area:	102876	102876	102876	102876	102876	102876	102876	102876
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-602.2	-602.2	-602.2	-602.2	-602.2	-602.2	-602.2	-602.2
Population weighted Δx (µg/m^3):	-0.00585365	-0.00585365	-0.00585365	-0.00585365	-0.00585365	-0.00585365	-0.00585365	-0.00585365
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999966	0.999995	0.999998	0.999994	0.999924	0.999994	0.999989	0.999991
Attributable fraction (AF):	-3.4E-05	-4.7E-06	-2.4E-06	-5.5E-06	-7.6E-05	-5.7E-06	-1.1E-05	-8.7E-06
Increased number of cases in population:	-0.022	-0.0068	-0.0015	-0.0028	-0.020	-0.00082	-0.00047	-0.0016
Risk:	-3.5E-07	-4.3E-07	-9.5E-08	-2.7E-08	-3.1E-07	-8.0E-09	-4.6E-09	-1.0E-07
Individual subrubs within LGA								
Arncliffe - Bardwell Park								
Total Population in study area:	21457	21457	21457	21457	21457	21457	21457	21457
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-382.4	-382.4	-382.4	-382.4	-382.4	-382.4	-382.4	-382.4
Population weighted Δx (µg/m^3):	-0.01782169	-0.01782169	-0.01782169	-0.01782169	-0.01782169	-0.01782169	-0.01782169	-0.01782169
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999897	0.999986	0.999993	0.999983	0.999768	0.999983	0.999966	0.999974
Attributable fraction (AF):	-1.0E-04	-1.4E-05	-7.3E-06	-1.7E-05	-2.3E-04	-1.7E-05	-3.4E-05	-2.6E-05
Increased number of cases in population:	-0.0140	-0.0043	-0.00095	-0.00175	-0.0126	-0.00052	-0.00030	-0.00100
Risk:	-1.1E-06	-1.3E-06	-2.9E-07	-8.2E-08	-9.5E-07	-2.4E-08	-1.4E-08	-3.2E-07
Bexley								
Total Population in study area:	20419	20419	20419	20419	20419	20419	20419	20419

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-136	-136	-136	-136	-136	-136	-136	-136
Population weighted Δx (µg/m^3):	-0.00666046	-0.00666046	-0.00666046	-0.00666046	-0.00666046	-0.00666046	-0.00666046	-0.00666046
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999961	0.999995	0.999997	0.999994	0.999913	0.999994	0.999987	0.999990
Attributable fraction (AF):	-3.9E-05	-5.3E-06	-2.7E-06	-6.3E-06	-8.7E-05	-6.5E-06	-1.3E-05	-9.9E-06
Increased number of cases in population:	-0.0050	-0.0015	-0.00034	-0.00062	-0.0045	-0.000185	-0.000107	-0.00036
Risk:	-4.0E-07	-4.9E-07	-1.1E-07	-3.1E-08	-3.6E-07	-9.1E-09	-5.2E-09	-1.2E-07
Kingsgrove (South) - Bardwell Park								
Total Population in study area:	2879	2879	2879	2879	2879	2879	2879	2879
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-26.7	-26.7	-26.7	-26.7	-26.7	-26.7	-26.7	-26.7
Population weighted Δx (µg/m^3):	-0.00927405	-0.00927405	-0.00927405	-0.00927405	-0.00927405	-0.00927405	-0.00927405	-0.00927405
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999946	0.999993	0.999996	0.999991	0.999879	0.999991	0.999982	0.999986
Attributable fraction (AF):	-5.4E-05	-7.4E-06	-3.8E-06	-8.7E-06	-1.2E-04	-9.0E-06	-1.8E-05	-1.4E-05
Increased number of cases in population:	-0.00098	-0.000302	-0.000067	-0.000123	-0.00088	-0.0000364	-0.0000210	-0.000070
Risk:	-5.5E-07	-6.9E-07	-1.5E-07	-4.3E-08	-5.0E-07	-1.3E-08	-7.3E-09	-1.7E-07
Kogarah								
Total Population in study area:	11323	11323	11323	11323	11323	11323	11323	11323
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8
Population weighted Δx (µg/m^3):	0.00731255	0.00731255	0.00731255	0.00731255	0.00731255	0.00731255	0.00731255	0.00731255
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000042	1.000006	1.000003	1.000007	1.000095	1.000007	1.000014	1.000011
Attributable fraction (AF):	4.2E-05	5.9E-06	3.0E-06	6.9E-06	9.5E-05	7.1E-06	1.4E-05	1.1E-05
Increased number of cases in population:	0.0030	0.00094	0.00021	0.00038	0.0027	0.00011	0.000065	0.00022
Risk:	4.4E-07	5.4E-07	1.2E-07	3.4E-08	3.9E-07	1.0E-08	5.7E-09	1.3E-07
Kogarah Bay								
Total Population in study area:	10788	10788	10788	10788	10788	10788	10788	10788
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-78.5	-78.5	-78.5	-78.5	-78.5	-78.5	-78.5	-78.5
Population weighted Δx (µg/m^3):	-0.00727660	-0.00727660	-0.00727660	-0.00727660	-0.00727660	-0.00727660	-0.00727660	-0.00727660
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999958	0.999994	0.999997	0.999993	0.999905	0.999993	0.999986	0.999989
Attributable fraction (AF):	-4.2E-05	-5.8E-06	-3.0E-06	-6.8E-06	-9.5E-05	-7.1E-06	-1.4E-05	-1.1E-05
Increased number of cases in population:	-0.003	-0.00089	-0.00020	-0.0004	-0.0026	-0.00011	-0.000062	-0.00021
Risk:	-4.3E-07	-5.4E-07	-1.2E-07	-3.3E-08	-3.9E-07	-9.9E-09	-5.7E-09	-1.3E-07
Monterey - Brighton-le-Sands - Kyeemagh								
Total Population in study area:	13915	13915	13915	13915	13915	13915	13915	13915
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	45.5	45.5	45.5	45.5	45.5	45.5	45.5	45.5
Population weighted Δx (µg/m^3):	0.00326985	0.00326985	0.00326985	0.00326985	0.00326985	0.00326985	0.00326985	0.00326985
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000019	1.000003	1.000001	1.000003	1.000043	1.000003	1.000006	1.000005
Attributable fraction (AF):	1.9E-05	2.6E-06	1.3E-06	3.1E-06	4.3E-05	3.2E-06	6.2E-06	4.8E-06
Increased number of cases in population:	0.0017	0.0005	0.00011	0.00021	0.0015	0.00006	0.00004	0.00012
Risk:	1.9E-07	2.4E-07	5.3E-08	1.5E-08	1.8E-07	4.5E-09	2.6E-09	5.9E-08
Rockdale - Banksia								
Total Population in study area:	19957	19957	19957	19957	19957	19957	19957	19957
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-115.8	-115.8	-115.8	-115.8	-115.8	-115.8	-115.8	-115.8
Population weighted Δx (µg/m^3):	-0.00580248	-0.00580248	-0.00580248	-0.00580248	-0.00580248	-0.00580248	-0.00580248	-0.00580248
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999966	0.999995	0.999998	0.999995	0.999925	0.999994	0.999989	0.999991
Attributable fraction (AF):	-3.4E-05	-4.6E-06	-2.4E-06	-5.5E-06	-7.5E-05	-5.6E-06	-1.1E-05	-8.6E-06
Increased number of cases in population:	-0.004	-0.0013	-0.00029	-0.0005	-0.0038	-0.00016	-0.00009	-0.00030
Risk:	-3.5E-07	-4.3E-07	-9.5E-08	-2.7E-08	-3.1E-07	-7.9E-09	-4.6E-09	-1.0E-07
Sans Souci - Ramsgate								
Total Population in study area:	2036	2036	2036	2036	2036	2036	2036	2036
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	10.6	10.6	10.6	10.6	10.6	10.6	10.6	10.6
Population weighted Δx (µg/m^3):	0.00520629	0.00520629	0.00520629	0.00520629	0.00520629	0.00520629	0.00520629	0.00520629
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000030	1.000004	1.000002	1.000005	1.000068	1.000005	1.000010	1.000008
Attributable fraction (AF):	3.0E-05	4.2E-06	2.1E-06	4.9E-06	6.8E-05	5.1E-06	9.9E-06	7.7E-06
Increased number of cases in population:	0.00039	0.00012	0.000026	0.000049	0.00035	0.000014	0.0000083	0.000028
Risk:	3.1E-07	3.8E-07	8.5E-08	2.4E-08	2.8E-07	7.1E-09	4.1E-09	9.3E-08
Hurstville								
Total Population in study area:	102	102	102	102	102	102	102	102
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5
Population weighted Δx (µg/m^3):	-0.01470588	-0.01470588	-0.01470588	-0.01470588	-0.01470588	-0.01470588	-0.01470588	-0.01470588
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999915	0.999988	0.999994	0.999986	0.999809	0.999986	0.999972	0.999978
Attributable fraction (AF):	-8.5E-05	-1.2E-05	-6.0E-06	-1.4E-05	-1.9E-04	-1.4E-05	-2.8E-05	-2.2E-05
Increased number of cases in population:	-0.000055	-0.000017	-0.0000037	-0.0000069	-0.000049	-0.0000020	-0.0000012	-0.0000039
Risk:	-8.8E-07	-1.1E-06	-2.4E-07	-6.7E-08	-7.9E-07	-2.0E-08	-1.2E-08	-2.6E-07
Eastern Suburbs								
Total Population in study area:	33621	33621	33621	33621	33621	33621	33621	33621
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-1025.00	-1025	-1025	-1025	-1025	-1025	-1025	-1025
Population weighted Δx (µg/m^3):	-0.03048690	-0.03048690	-0.03048690	-0.03048690	-0.03048690	-0.03048690	-0.03048690	-0.03048690
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	492.2	412.0	132.3	41.3	1209.0

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999823	0.999976	0.999988	0.999971	0.999604	0.999970	0.999942	0.999955
Attributable fraction (AF):	-1.8E-04	-2.4E-05	-1.2E-05	-2.9E-05	-4.0E-04	-3.0E-05	-5.8E-05	-4.5E-05
Increased number of cases in population:	-0.036	-0.010	-0.0022	-0.0047	-0.032	-0.0013	-0.00080	-0.0025
Risk:	-1.8E-06	-2.3E-06	-5.0E-07	-1.4E-07	-1.6E-06	-3.9E-08	-2.4E-08	-5.5E-07
Individual subrubs within LGA								
Kensington								
Total Population in study area:	14903	14903	14903	14903	14903	14903	14903	14903
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-597	-597	-597	-597	-597	-597	-597	-597
Population weighted Δx (µg/m^3):	-0.04005905	-0.04005905	-0.04005905	-0.04005905	-0.04005905	-0.04005905	-0.04005905	-0.04005905
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999768	0.999968	0.999984	0.999962	0.999479	0.999961	0.999924	0.999941
Attributable fraction (AF):	-2.3E-04	-3.2E-05	-1.6E-05	-3.8E-05	-5.2E-04	-3.9E-05	-7.6E-05	-5.9E-05
Increased number of cases in population:	-0.020892	-0.0059103	-0.0013048	-0.0027622	-0.018806	-0.0007662	-0.00046848	-0.0014742
Risk:	-2.4E-06	-3.0E-06	-6.5E-07	-1.9E-07	-2.1E-06	-5.1E-08	-3.1E-08	-7.2E-07
Kingsford								
Total Population in study area:	11769	11769	11769	11769	11769	11769	11769	11769
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-318.7	-318.7	-318.7	-318.7	-318.7	-318.7	-318.7	-318.7
Population weighted Δx (µg/m^3):	-0.02707962	-0.02707962	-0.02707962	-0.02707962	-0.02707962	-0.02707962	-0.02707962	-0.02707962
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999843	0.999978	0.999989	0.999975	0.999648	0.999974	0.999949	0.999960
Attributable fraction (AF):	-1.6E-04	-2.2E-05	-1.1E-05	-2.5E-05	-3.5E-04	-2.6E-05	-5.1E-05	-4.0E-05
Increased number of cases in population:	-0.01115	-0.003155	-0.000697	-0.001475	-0.01004	-0.000409	-0.0002501	-0.000787
Risk:	-1.6E-06	-2.0E-06	-4.4E-07	-1.3E-07	-1.5E-06	-3.5E-08	-2.1E-08	-4.8E-07
Malabar - La Perouse - Chiffley								
Total Population in study area:	3724	3724	3724	3724	3724	3724	3724	3724
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-56.5	-56.5	-56.5	-56.5	-56.5	-56.5	-56.5	-56.5
Population weighted Δx (µg/m^3):	-0.01517186	-0.01517186	-0.01517186	-0.01517186	-0.01517186	-0.01517186	-0.01517186	-0.01517186
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999912	0.999988	0.999994	0.999986	0.999803	0.999985	0.999971	0.999978
Attributable fraction (AF):	-8.8E-05	-1.2E-05	-6.2E-06	-1.4E-05	-2.0E-04	-1.5E-05	-2.9E-05	-2.2E-05
Increased number of cases in population:	-0.001977	-0.0005593	-0.0001235	-0.0002614	-0.001780	-0.0000725	-0.00004434	-0.0001395
Risk:	-9.0E-07	-1.1E-06	-2.5E-07	-7.0E-08	-8.1E-07	-1.9E-08	-1.2E-08	-2.7E-07
Maroubra (west)								
Total Population in study area:	2951	2951	2951	2951	2951	2951	2951	2951
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-43	-43	-43	-43	-43	-43	-43	-43
Population weighted Δx (µg/m^3):	-0.01457133	-0.01457133	-0.01457133	-0.01457133	-0.01457133	-0.01457133	-0.01457133	-0.01457133
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999915	0.999988	0.999994	0.999986	0.999811	0.999986	0.999972	0.999978
Attributable fraction (AF):	-8.5E-05	-1.2E-05	-6.0E-06	-1.4E-05	-1.9E-04	-1.4E-05	-2.8E-05	-2.2E-05
Increased number of cases in population:	-0.00150	-0.000426	-0.000094	-0.000199	-0.00135	-0.000055	-0.0000337	-0.000106
Risk:	-8.7E-07	-1.1E-06	-2.4E-07	-6.7E-08	-7.8E-07	-1.9E-08	-1.1E-08	-2.6E-07
Paddington - Moore Park								
Total Population in study area:	189	189	189	189	189	189	189	189
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-9.7	-9.7	-9.7	-9.7	-9.7	-9.7	-9.7	-9.7
Population weighted Δx (µg/m^3):	-0.05132275	-0.05132275	-0.05132275	-0.05132275	-0.05132275	-0.05132275	-0.05132275	-0.05132275
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999702	0.999959	0.999979	0.999952	0.999333	0.999950	0.999902	0.999924
Attributable fraction (AF):	-3.0E-04	-4.1E-05	-2.1E-05	-4.8E-05	-6.7E-04	-5.0E-05	-9.8E-05	-7.6E-05
Increased number of cases in population:	-0.000339	-0.0000960	-0.0000212	-0.0000449	-0.000306	-0.0000124	-0.00000761	-0.0000240
Risk:	-3.1E-06	-3.8E-06	-8.4E-07	-2.4E-07	-2.7E-06	-6.6E-08	-4.0E-08	-9.2E-07
Randwick (North and South)								
Total Population in study area:	85	85	85	85	85	85	85	85
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Population weighted Δx (µg/m^3):	0.00352941	0.00352941	0.00352941	0.00352941	0.00352941	0.00352941	0.00352941	0.00352941
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	1.000020	1.000003	1.000001	1.000003	1.000046	1.000003	1.000007	1.000005
Attributable fraction (AF):	2.0E-05	2.8E-06	1.4E-06	3.3E-06	4.6E-05	3.4E-06	6.7E-06	5.2E-06
Increased number of cases in population:	0.000010	0.0000030	0.00000066	0.0000014	0.0000094	0.00000038	0.00000024	0.00000074
Risk:	2.1E-07	2.6E-07	5.8E-08	1.6E-08	1.9E-07	4.5E-09	2.8E-09	6.3E-08
Total population incidence - All Suburbs	**-0.31**	**-0.079**	**-0.018**	**-0.043**	**-0.28**	**-0.011**	**-0.0069**	**-0.021**

Assessment of Increased Incidence - $PM_{2.5}$
Gateway Road Project: 2026 Cumulative

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Inner West (including Strathfield - Burwood - Ashfield LGA)								
Total Population in study area:	62688	62688	62688	62688	62688	62688	62688	62688
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-656.6	-656.6	-656.6	-656.6	-656.6	-656.6	-656.6	-656.6
Population weighted Δx (µg/m^3):	-0.01047409	-0.01047409	-0.01047409	-0.01047409	-0.01047409	-0.01047409	-0.01047409	-0.01047409
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999939	0.999992	0.999996	0.999990	0.999864	0.999990	0.999980	0.999984
Attributable fraction (AF):	-6.1E-05	-8.4E-06	-4.3E-06	-9.8E-06	-1.4E-04	-1.0E-05	-2.0E-05	-1.6E-05
Increased number of cases in population:	-0.025	-0.0059	-0.0013	-0.0032	-0.022	-0.00087	-0.00052	-0.0017
Risk:	-6.2E-07	-7.7E-07	-1.7E-07	-5.1E-08	-5.6E-07	-1.4E-08	-8.2E-09	-1.9E-07
Individual subrubs within LGA								
Marrickville								
Total Population in study area:	26542	26542	26542	26542	26542	26542	26542	26542
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-196	-196	-196	-196	-196	-196	-196	-196
Population weighted Δx (µg/m^3):	-0.00738452	-0.00738452	-0.00738452	-0.00738452	-0.00738452	-0.00738452	-0.00738452	-0.00738452
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999957	0.999994	0.999997	0.999993	0.999904	0.999993	0.999986	0.999989
Attributable fraction (AF):	-4.3E-05	-5.9E-06	-3.0E-06	-6.9E-06	-9.6E-05	-7.2E-06	-1.4E-05	-1.1E-05
Increased number of cases in population:	-0.007442	-0.0017666	-0.00039000	-0.0009614	-0.006698	-0.00025989	-0.00015380	-0.0004945
Risk:	-4.4E-07	-5.5E-07	-1.2E-07	-3.6E-08	-4.0E-07	-9.8E-09	-5.8E-09	-1.3E-07
Petersham - Stanmore								
Total Population in study area:	4922	4922	4922	4922	4922	4922	4922	4922
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-78	-78	-78	-78	-78	-78	-78	-78
Population weighted Δx (µg/m^3):	-0.01584722	-0.01584722	-0.01584722	-0.01584722	-0.01584722	-0.01584722	-0.01584722	-0.01584722
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999908	0.999987	0.999994	0.999985	0.999794	0.999985	0.999970	0.999977
Attributable fraction (AF):	-9.2E-05	-1.3E-05	-6.5E-06	-1.5E-05	-2.1E-04	-1.5E-05	-3.0E-05	-2.3E-05
Increased number of cases in population:	-0.0030	-0.00070	-0.000155	-0.000383	-0.00267	-0.000103	-0.000061	-0.000197
Risk:	-9.4E-07	-1.2E-06	-2.6E-07	-7.8E-08	-8.5E-07	-2.1E-08	-1.2E-08	-2.8E-07
Sydenham - Tempe - St Peters								
Total Population in study area:	7829	7829	7829	7829	7829	7829	7829	7829
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-262	-262	-262	-262	-262	-262	-262	-262
Population weighted Δx (µg/m^3):	-0.03346532	-0.03346532	-0.03346532	-0.03346532	-0.03346532	-0.03346532	-0.03346532	-0.03346532
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999806	0.999973	0.999986	0.999969	0.999565	0.999968	0.999936	0.999950
Attributable fraction (AF):	-1.9E-04	-2.7E-05	-1.4E-05	-3.1E-05	-4.4E-04	-3.2E-05	-6.4E-05	-5.0E-05
Increased number of cases in population:	-0.0099	-0.00236	-0.00052	-0.00129	-0.0090	-0.000347	-0.000206	-0.00066
Risk:	-2.0E-06	-2.5E-06	-5.5E-07	-1.6E-07	-1.8E-06	-4.4E-08	-2.6E-08	-6.0E-07
Ashfield								
Total Population in study area:	1979	1979	1979	1979	1979	1979	1979	1979
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-5.6	-5.6	-5.6	-5.6	-5.6	-5.6	-5.6	-5.6
Population weighted Δx (µg/m^3):	-0.00282971	-0.00282971	-0.00282971	-0.00282971	-0.00282971	-0.00282971	-0.00282971	-0.00282971
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999984	0.999998	0.999999	0.999997	0.999963	0.999997	0.999995	0.999996
Attributable fraction (AF):	-1.6E-05	-2.3E-06	-1.2E-06	-2.7E-06	-3.7E-05	-2.7E-06	-5.4E-06	-4.2E-06
Increased number of cases in population:	-0.000213	-0.0000505	-0.00001114	-0.0000275	-0.000191	-0.00000743	-0.00000439	-0.0000141
Risk:	-1.7E-07	-2.1E-07	-4.6E-08	-1.4E-08	-1.5E-07	-3.8E-09	-2.2E-09	-5.1E-08
Canterbury (North) - Ashbury								
Total Population in study area:	7538	7538	7538	7538	7538	7538	7538	7538
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-51	-51	-51	-51	-51	-51	-51	-51
Population weighted Δx (µg/m^3):	-0.00676572	-0.00676572	-0.00676572	-0.00676572	-0.00676572	-0.00676572	-0.00676572	-0.00676572
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999961	0.999995	0.999997	0.999994	0.999912	0.999993	0.999987	0.999990
Attributable fraction (AF):	-3.9E-05	-5.4E-06	-2.8E-06	-6.4E-06	-8.8E-05	-6.6E-06	-1.3E-05	-1.0E-05
Increased number of cases in population:	-0.0019	-0.00046	-0.000101	-0.000250	-0.00174	-0.000068	-0.000040	-0.000129
Risk:	-4.0E-07	-5.0E-07	-1.1E-07	-3.3E-08	-3.6E-07	-9.0E-09	-5.3E-09	-1.2E-07
Dulwich Hill - Lewisham								
Total Population in study area:	13640	13640	13640	13640	13640	13640	13640	13640
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-61	-61	-61	-61	-61	-61	-61	-61
Population weighted Δx (µg/m^3):	-0.00447214	-0.00447214	-0.00447214	-0.00447214	-0.00447214	-0.00447214	-0.00447214	-0.00447214
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999974	0.999996	0.999998	0.999996	0.999942	0.999996	0.999992	0.999993
Attributable fraction (AF):	-2.6E-05	-3.6E-06	-1.8E-06	-4.2E-06	-5.8E-05	-4.3E-06	-8.5E-06	-6.6E-06
Increased number of cases in population:	-0.0023	-0.00055	-0.00012	-0.00030	-0.0021	-0.000081	-0.000048	-0.00015
Risk:	-2.7E-07	-3.3E-07	-7.3E-08	-2.2E-08	-2.4E-07	-5.9E-09	-3.5E-09	-8.0E-08
Haberfield - Summer Hill								
Total Population in study area:	238	238	238	238	238	238	238	238
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9
Population weighted Δx (µg/m^3):	-0.01218487	-0.01218487	-0.01218487	-0.01218487	-0.01218487	-0.01218487	-0.01218487	-0.01218487
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999929	0.999990	0.999995	0.999989	0.999842	0.999988	0.999977	0.999982
Attributable fraction (AF):	-7.1E-05	-9.7E-06	-5.0E-06	-1.1E-05	-1.6E-04	-1.2E-05	-2.3E-05	-1.8E-05
Increased number of cases in population:	-0.00011011	-0.00002614	-0.000005770	-0.00001422	-0.00009910	-0.000003845	-0.000002276	-0.00000732
Risk:	-7.3E-07	-9.0E-07	-2.0E-07	-6.0E-08	-6.5E-07	-1.6E-08	-9.6E-09	-2.2E-07

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Sydney Inner City LGA								
Total Population in study area:	47106	47106	47106	47106	47106	47106	47106	47106
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-1839	-1839	-1839	-1839	-1839	-1839	-1839	-1839
Population weighted Δx (µg/m^3):	-0.03903961	-0.03903961	-0.03903961	-0.03903961	-0.03903961	-0.03903961	-0.03903961	-0.03903961
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999774	0.999969	0.999984	0.999963	0.999493	0.999962	0.999926	0.999942
Attributable fraction (AF):	-2.3E-04	-3.1E-05	-1.6E-05	-3.7E-05	-5.1E-04	-3.8E-05	-7.4E-05	-5.8E-05
Increased number of cases in population:	-0.063	-0.011	-0.0025	-0.0078	-0.057	-0.0020	-0.0014	-0.0019
Risk:	-2.3E-06	-2.9E-06	-6.4E-07	-1.7E-07	-2.1E-06	-4.3E-08	-3.1E-08	-7.0E-07
Individual subrubs within LGA								
Erskinville - Alexandria								
Total Population in study area:	14292	14292	14292	14292	14292	14292	14292	14292
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-348.4	-348.4	-348.4	-348.4	-348.4	-348.4	-348.4	-348.4
Population weighted Δx (µg/m^3):	-0.02437727	-0.02437727	-0.02437727	-0.02437727	-0.02437727	-0.02437727	-0.02437727	-0.02437727
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999859	0.999980	0.999990	0.999977	0.999683	0.999976	0.999954	0.999964
Attributable fraction (AF):	-1.4E-04	-2.0E-05	-1.0E-05	-2.3E-05	-3.2E-04	-2.4E-05	-4.6E-05	-3.6E-05
Increased number of cases in population:	-0.0119	-0.00211	-0.000466	-0.00149	-0.0108	-0.000383	-0.000273	-0.000368
Risk:	-1.5E-06	-1.8E-06	-4.0E-07	-1.0E-07	-1.3E-06	-2.7E-08	-1.9E-08	-4.4E-07
Newtown - Camperdown - Darlington								
Total Population in study area:	6910	6910	6910	6910	6910	6910	6910	6910
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-144	-144	-144	-144	-144	-144	-144	-144
Population weighted Δx (µg/m^3):	-0.02083936	-0.02083936	-0.02083936	-0.02083936	-0.02083936	-0.02083936	-0.02083936	-0.02083936
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999879	0.999983	0.999991	0.999980	0.999729	0.999980	0.999960	0.999969
Attributable fraction (AF):	-1.2E-04	-1.7E-05	-8.5E-06	-2.0E-05	-2.7E-04	-2.0E-05	-4.0E-05	-3.1E-05
Increased number of cases in population:	-0.0049	-0.00087	-0.000193	-0.00061	-0.00444	-0.000158	-0.000113	-0.000152
Risk:	-1.2E-06	-1.5E-06	-3.4E-07	-8.9E-08	-1.1E-06	-2.3E-08	-1.6E-08	-3.7E-07
Waterloo - Beaconsfield								
Total Population in study area:	25904	25904	25904	25904	25904	25904	25904	25904
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-1346.6	-1346.6	-1346.6	-1346.6	-1346.6	-1346.6	-1346.6	-1346.6
Population weighted Δx (µg/m^3):	-0.05198425	-0.05198425	-0.05198425	-0.05198425	-0.05198425	-0.05198425	-0.05198425	-0.05198425
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999699	0.999958	0.999979	0.999951	0.999324	0.999950	0.999901	0.999923
Attributable fraction (AF):	-3.0E-04	-4.2E-05	-2.1E-05	-4.9E-05	-6.8E-04	-5.0E-05	-9.9E-05	-7.7E-05
Increased number of cases in population:	-0.0462	-0.00816	-0.00180	-0.00574	-0.0416	-0.00148	-0.00106	-0.001422
Risk:	-3.1E-06	-3.8E-06	-8.5E-07	-2.2E-07	-2.8E-06	-5.7E-08	-4.1E-08	-9.3E-07
Canterbury LGA								
Total Population in study area:	12648	12648	12648	12648	12648	12648	12648	12648
% population in assessment age-group:	58%	14%	14%	100%	58%	100%	100%	19%
total change	-92.00	-92	-92	-92	-92	-92	-92	-92
Population weighted Δx (µg/m^3):	-0.00727388	-0.00727388	-0.00727388	-0.00727388	-0.00727388	-0.00727388	-0.00727388	-0.00727388
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	508.3	412.0	143.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00508	0.00412	0.00144	0.00041	0.01209
Relative Risk:	0.999958	0.999994	0.999997	0.999993	0.999905	0.999993	0.999986	0.999989
Attributable fraction (AF):	-4.2E-05	-5.8E-06	-3.0E-06	-6.8E-06	-9.5E-05	-7.1E-06	-1.4E-05	-1.1E-05
Increased number of cases in population:	-0.0032	-0.00094	-0.00021	-0.00044	-0.0029	-0.00013	-0.000072	-0.00032
Risk:	-4.3E-07	-5.4E-07	-1.2E-07	-3.5E-08	-3.9E-07	-1.0E-08	-5.7E-09	-1.3E-07
Individual subrubs within LGA								
Canterbury (South) - Campsie								
Total Population in study area:	149	149	149	149	149	149	149	149
% population in assessment age-group:	58%	14%	14%	100%	58%	100%	100%	19%
total change	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3
Population weighted Δx (µg/m^3):	-0.00872483	-0.00872483	-0.00872483	-0.00872483	-0.00872483	-0.00872483	-0.00872483	-0.00872483
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	508.3	412.0	143.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00508	0.00412	0.00144	0.00041	0.01209
Relative Risk:	0.999949	0.999993	0.999996	0.999992	0.999887	0.999992	0.999983	0.999987
Attributable fraction (AF):	-5.1E-05	-7.0E-06	-3.6E-06	-8.2E-06	-1.1E-04	-8.5E-06	-1.7E-05	-1.3E-05
Increased number of cases in population:	-0.0000452	-0.0000134	-0.0000029	-0.0000062	-0.0000407	-0.0000018	-0.0000010	-0.0000045
Risk:	-5.2E-07	-6.4E-07	-1.4E-07	-4.2E-08	-4.7E-07	-1.2E-08	-6.8E-09	-1.6E-07
Kingsgrove (North) - Earlwood								
Total Population in study area:	12499	12499	12499	12499	12499	12499	12499	12499
% population in assessment age-group:	58%	14%	14%	100%	58%	100%	100%	19%
total change	-90.5	-90.5	-90.5	-90.5	-90.5	-90.5	-90.5	-90.5
Population weighted Δx (µg/m^3):	-0.00724058	-0.00724058	-0.00724058	-0.00724058	-0.00724058	-0.00724058	-0.00724058	-0.00724058
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	508.3	412.0	143.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00508	0.00412	0.00144	0.00041	0.01209
Relative Risk:	0.999958	0.999994	0.999997	0.999993	0.999906	0.999993	0.999986	0.999989
Attributable fraction (AF):	-4.2E-05	-5.8E-06	-3.0E-06	-6.8E-06	-9.4E-05	-7.0E-06	-1.4E-05	-1.1E-05
Increased number of cases in population:	-0.00315	-0.000929	-0.000205	-0.000432	-0.00283	-0.0001261	-0.0000710	-0.000311
Risk:	-4.3E-07	-5.3E-07	-1.2E-07	-3.5E-08	-3.9E-07	-1.0E-08	-5.7E-09	-1.3E-07
Botany LGA								
Total Population in study area:	46677	46677	46677	46677	46677	46677	46677	46677
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-5030	-5030	-5030	-5030	-5030	-5030	-5030	-5030
Population weighted Δx (µg/m^3):	-0.10776185	-0.10776185	-0.10776185	-0.10776185	-0.10776185	-0.10776185	-0.10776185	-0.10776185
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999375	0.999914	0.999956	0.999899	0.998600	0.999895	0.999795	0.999841
Attributable fraction (AF):	-6.3E-04	-8.6E-05	-4.4E-05	-1.0E-04	-1.4E-03	-1.0E-04	-2.0E-04	-1.6E-04
Increased number of cases in population:	-0.18	-0.048	-0.011	-0.026	-0.16	-0.0065	-0.0039	-0.014
Risk:	-6.4E-06	-8.0E-06	-1.8E-06	-5.7E-07	-5.8E-06	-1.4E-07	-8.5E-08	-1.9E-06

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Individual subrubs within LGA								
Banksmeadow								
Total Population in study area:	21	21	21	21	21	21	21	21
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
Population weighted Δx (µg/m^3):	0.03238095	0.03238095	0.03238095	0.03238095	0.03238095	0.03238095	0.03238095	0.03238095
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	1.000188	1.000026	1.000013	1.000030	1.000421	1.000031	1.000062	1.000048
Attributable fraction (AF):	1.9E-04	2.6E-05	1.3E-05	3.0E-05	4.2E-04	3.1E-05	6.2E-05	4.8E-05
Increased number of cases in population:	0.000024	0.0000065	0.00000144	0.0000036	0.0000218	0.00000088	0.00000053	0.0000019
Risk:	1.9E-06	2.4E-06	5.3E-07	1.7E-07	1.7E-06	4.2E-08	2.5E-08	5.8E-07
Botany								
Total Population in study area:	10780	10780	10780	10780	10780	10780	10780	10780
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-272	-272	-272	-272	-272	-272	-272	-272
Population weighted Δx (µg/m^3):	-0.02523191	-0.02523191	-0.02523191	-0.02523191	-0.02523191	-0.02523191	-0.02523191	-0.02523191
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999854	0.999980	0.999990	0.999976	0.999672	0.999976	0.999952	0.999963
Attributable fraction (AF):	-1.5E-04	-2.0E-05	-1.0E-05	-2.4E-05	-3.3E-04	-2.4E-05	-4.8E-05	-3.7E-05
Increased number of cases in population:	-0.0097	-0.0026	-0.00058	-0.0014	-0.0087	-0.00035	-0.00021	-0.0008
Risk:	-1.5E-06	-1.9E-06	-4.1E-07	-1.3E-07	-1.4E-06	-3.3E-08	-2.0E-08	-4.5E-07
Mascot - Eastlakes								
Total Population in study area:	24409	24409	24409	24409	24409	24409	24409	24409
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-4567.6	-4567.6	-4567.6	-4567.6	-4567.6	-4567.6	-4567.6	-4567.6
Population weighted Δx (µg/m^3):	-0.18712770	-0.18712770	-0.18712770	-0.18712770	-0.18712770	-0.18712770	-0.18712770	-0.18712770
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.998915	0.999850	0.999923	0.999824	0.997570	0.999819	0.999645	0.999723
Attributable fraction (AF):	-1.1E-03	-1.5E-04	-7.7E-05	-1.8E-04	-2.4E-03	-1.8E-04	-3.6E-04	-2.8E-04
Increased number of cases in population:	-0.1626	-0.0439	-0.0097	-0.0240	-0.1465	-0.0059	-0.0036	-0.0128
Risk:	-1.1E-05	-1.4E-05	-3.1E-06	-9.8E-07	-1.0E-05	-2.4E-07	-1.5E-07	-3.3E-06
Pagewood - Hillsdale - Daceyville								
Total Population in study area:	11400	11400	11400	11400	11400	11400	11400	11400
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-193.9	-193.9	-193.9	-193.9	-193.9	-193.9	-193.9	-193.9
Population weighted Δx (µg/m^3):	-0.01700877	-0.01700877	-0.01700877	-0.01700877	-0.01700877	-0.01700877	-0.01700877	-0.01700877
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999901	0.999986	0.999993	0.999984	0.999779	0.999984	0.999968	0.999975
Attributable fraction (AF):	-9.9E-05	-1.4E-05	-7.0E-06	-1.6E-05	-2.2E-04	-1.6E-05	-3.2E-05	-2.5E-05
Increased number of cases in population:	-0.00690	-0.00186	-0.000411	-0.001020	-0.006211	-0.000252	-0.0001522	-0.000545
Risk:	-1.0E-06	-1.3E-06	-2.8E-07	-8.9E-08	-9.1E-07	-2.2E-08	-1.3E-08	-3.0E-07
Port Botany Industrial								
Total Population in study area:	6	6	6	6	6	6	6	6
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Population weighted Δx (µg/m^3):	0.01166667	0.01166667	0.01166667	0.01166667	0.01166667	0.01166667	0.01166667	0.01166667
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	1.000068	1.000009	1.000005	1.000011	1.000152	1.000011	1.000022	1.000017
Attributable fraction (AF):	6.8E-05	9.3E-06	4.8E-06	1.1E-05	1.5E-04	1.1E-05	2.2E-05	1.7E-05
Increased number of cases in population:	0.0000025	0.00000067	0.00000015	0.00000037	0.0000022	0.000000091	0.000000055	0.00000020
Risk:	6.9E-07	8.6E-07	1.9E-07	6.1E-08	6.2E-07	1.5E-08	9.2E-09	2.1E-07
Sydney Airport								
Total Population in study area:	61	61	61	61	61	61	61	61
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
Population weighted Δx (µg/m^3):	0.07213115	0.07213115	0.07213115	0.07213115	0.07213115	0.07213115	0.07213115	0.07213115
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	1.000418	1.000058	1.000030	1.000068	1.000938	1.000070	1.000137	1.000107
Attributable fraction (AF):	4.2E-04	5.8E-05	3.0E-05	6.8E-05	9.4E-04	7.0E-05	1.4E-04	1.1E-04
Increased number of cases in population:	0.000157	0.000042	0.0000093	0.000023	0.000141	0.0000057	0.0000035	0.0000124
Risk:	4.3E-06	5.3E-06	1.2E-06	3.8E-07	3.9E-06	9.4E-08	5.7E-08	1.3E-06
Kogarah - Rockdale LGA								
Total Population in study area:	102876	102876	102876	102876	102876	102876	102876	102876
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	854.4	854.4	854.4	854.4	854.4	854.4	854.4	854.4
Population weighted Δx (µg/m^3):	0.00830514	0.00830514	0.00830514	0.00830514	0.00830514	0.00830514	0.00830514	0.00830514
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000048	1.000007	1.000003	1.000008	1.000108	1.000008	1.000016	1.000012
Attributable fraction (AF):	4.8E-05	6.6E-06	3.4E-06	7.8E-06	1.1E-04	8.1E-06	1.6E-05	1.2E-05
Increased number of cases in population:	0.031	0.0097	0.0021	0.0039	0.028	0.0012	0.00067	0.0022
Risk:	4.9E-07	6.1E-07	1.4E-07	3.8E-08	4.4E-07	1.1E-08	6.5E-09	1.5E-07
Individual subrubs within LGA								
Arncliffe - Bardwell Park								
Total Population in study area:	21457	21457	21457	21457	21457	21457	21457	21457
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-296.3	-296.3	-296.3	-296.3	-296.3	-296.3	-296.3	-296.3
Population weighted Δx (µg/m^3):	-0.01380901	-0.01380901	-0.01380901	-0.01380901	-0.01380901	-0.01380901	-0.01380901	-0.01380901
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999920	0.999989	0.999994	0.999987	0.999820	0.999987	0.999974	0.999980
Attributable fraction (AF):	-8.0E-05	-1.1E-05	-5.7E-06	-1.3E-05	-1.8E-04	-1.3E-05	-2.6E-05	-2.0E-05
Increased number of cases in population:	-0.0108	-0.0033	-0.00074	-0.00136	-0.0098	-0.00040	-0.00023	-0.00077
Risk:	-8.2E-07	-1.0E-06	-2.3E-07	-6.3E-08	-7.4E-07	-1.9E-08	-1.1E-08	-2.5E-07
Bexley								
Total Population in study area:	20419	20419	20419	20419	20419	20419	20419	20419

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9
Population weighted Δx (µg/m^3):	0.00170919	0.00170919	0.00170919	0.00170919	0.00170919	0.00170919	0.00170919	0.00170919
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000010	1.000001	1.000001	1.000002	1.000022	1.000002	1.000003	1.000003
Attributable fraction (AF):	9.9E-06	1.4E-06	7.0E-07	1.6E-06	2.2E-05	1.7E-06	3.2E-06	2.5E-06
Increased number of cases in population:	0.0013	0.0004	0.00009	0.00016	0.0011	0.000048	0.000027	0.00009
Risk:	1.0E-07	1.3E-07	2.8E-08	7.8E-09	9.2E-08	2.3E-09	1.3E-09	3.1E-08
Kingsgrove (South) - Bardwell Park								
Total Population in study area:	2879	2879	2879	2879	2879	2879	2879	2879
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-42.1	-42.1	-42.1	-42.1	-42.1	-42.1	-42.1	-42.1
Population weighted Δx (µg/m^3):	-0.01462313	-0.01462313	-0.01462313	-0.01462313	-0.01462313	-0.01462313	-0.01462313	-0.01462313
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999915	0.999988	0.999994	0.999986	0.999810	0.999986	0.999972	0.999978
Attributable fraction (AF):	-8.5E-05	-1.2E-05	-6.0E-06	-1.4E-05	-1.9E-04	-1.4E-05	-2.8E-05	-2.2E-05
Increased number of cases in population:	-0.00154	-0.000476	-0.000105	-0.000193	-0.00139	-0.0000574	-0.0000330	-0.000110
Risk:	-8.7E-07	-1.1E-06	-2.4E-07	-6.7E-08	-7.8E-07	-2.0E-08	-1.1E-08	-2.6E-07
Kogarah								
Total Population in study area:	11323	11323	11323	11323	11323	11323	11323	11323
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	660.8	660.8	660.8	660.8	660.8	660.8	660.8	660.8
Population weighted Δx (µg/m^3):	0.05835909	0.05835909	0.05835909	0.05835909	0.05835909	0.05835909	0.05835909	0.05835909
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000339	1.000047	1.000024	1.000055	1.000759	1.000057	1.000111	1.000086
Attributable fraction (AF):	3.4E-04	4.7E-05	2.4E-05	5.5E-05	7.6E-04	5.7E-05	1.1E-04	8.6E-05
Increased number of cases in population:	0.024	0.0075	0.0016	0.0030	0.022	0.00090	0.00052	0.0017
Risk:	3.5E-06	4.3E-06	9.5E-07	2.7E-07	3.1E-06	8.0E-08	4.6E-08	1.0E-06
Kogarah Bay								
Total Population in study area:	10788	10788	10788	10788	10788	10788	10788	10788
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	145.5	145.5	145.5	145.5	145.5	145.5	145.5	145.5
Population weighted Δx (µg/m^3):	0.01348721	0.01348721	0.01348721	0.01348721	0.01348721	0.01348721	0.01348721	0.01348721
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000078	1.000011	1.000006	1.000013	1.000175	1.000013	1.000026	1.000020
Attributable fraction (AF):	7.8E-05	1.1E-05	5.5E-06	1.3E-05	1.8E-04	1.3E-05	2.6E-05	2.0E-05
Increased number of cases in population:	0.005	0.002	0.00036	0.0007	0.0048	0.00020	0.00011	0.0004
Risk:	8.0E-07	1.0E-06	2.2E-07	6.2E-08	7.2E-07	1.8E-08	1.1E-08	2.4E-07
Monterey - Brighton-le-Sands - Kyeemagh								
Total Population in study area:	13915	13915	13915	13915	13915	13915	13915	13915
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	214.5	214.5	214.5	214.5	214.5	214.5	214.5	214.5
Population weighted Δx (µg/m^3):	0.01541502	0.01541502	0.01541502	0.01541502	0.01541502	0.01541502	0.01541502	0.01541502
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000089	1.000012	1.000006	1.000014	1.000200	1.000015	1.000029	1.000023
Attributable fraction (AF):	8.9E-05	1.2E-05	6.3E-06	1.4E-05	2.0E-04	1.5E-05	2.9E-05	2.3E-05
Increased number of cases in population:	0.0078	0.0024	0.00054	0.00098	0.0071	0.00029	0.00017	0.00056
Risk:	9.2E-07	1.1E-06	2.5E-07	7.1E-08	8.3E-07	2.1E-08	1.2E-08	2.8E-07
Rockdale - Banksia								
Total Population in study area:	19957	19957	19957	19957	19957	19957	19957	19957
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	81.3	81.3	81.3	81.3	81.3	81.3	81.3	81.3
Population weighted Δx (µg/m^3):	0.00407376	0.00407376	0.00407376	0.00407376	0.00407376	0.00407376	0.00407376	0.00407376
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000024	1.000003	1.000002	1.000004	1.000053	1.000004	1.000008	1.000006
Attributable fraction (AF):	2.4E-05	3.3E-06	1.7E-06	3.8E-06	5.3E-05	4.0E-06	7.7E-06	6.0E-06
Increased number of cases in population:	0.003	0.0009	0.00020	0.0004	0.0027	0.00011	0.00006	0.00021
Risk:	2.4E-07	3.0E-07	6.6E-08	1.9E-08	2.2E-07	5.6E-09	3.2E-09	7.3E-08
Sans Souci - Ramsgate								
Total Population in study area:	2036	2036	2036	2036	2036	2036	2036	2036
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	54.3	54.3	54.3	54.3	54.3	54.3	54.3	54.3
Population weighted Δx (µg/m^3):	0.02666994	0.02666994	0.02666994	0.02666994	0.02666994	0.02666994	0.02666994	0.02666994
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000155	1.000021	1.000011	1.000025	1.000347	1.000026	1.000051	1.000039
Attributable fraction (AF):	1.5E-04	2.1E-05	1.1E-05	2.5E-05	3.5E-04	2.6E-05	5.1E-05	3.9E-05
Increased number of cases in population:	0.002	0.0006	0.00014	0.0002	0.0018	0.00007	0.00004	0.00014
Risk:	1.6E-06	2.0E-06	4.3E-07	1.2E-07	1.4E-06	3.6E-08	2.1E-08	4.8E-07
Hurstville								
Total Population in study area:	102	102	102	102	102	102	102	102
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Population weighted Δx (µg/m^3):	0.01470588	0.01470588	0.01470588	0.01470588	0.01470588	0.01470588	0.01470588	0.01470588
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000085	1.000012	1.000006	1.000014	1.000191	1.000014	1.000028	1.000022
Attributable fraction (AF):	8.5E-05	1.2E-05	6.0E-06	1.4E-05	1.9E-04	1.4E-05	2.8E-05	2.2E-05
Increased number of cases in population:	0.000055	0.0000170	0.0000037	0.0000069	0.0000494	0.0000020	0.00000118	0.0000039
Risk:	8.8E-07	1.1E-06	2.4E-07	6.7E-08	7.9E-07	2.0E-08	1.2E-08	2.6E-07
Eastern Suburbs								
Total Population in study area:	33621	33621	33621	33621	33621	33621	33621	33621
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-864.50	-864.5	-864.5	-864.5	-864.5	-864.5	-864.5	-864.5
Population weighted Δx (µg/m^3):	-0.02571310	-0.02571310	-0.02571310	-0.02571310	-0.02571310	-0.02571310	-0.02571310	-0.02571310
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	492.2	412.0	132.3	41.3	1209.0

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999851	0.999979	0.999989	0.999976	0.999666	0.999975	0.999951	0.999962
Attributable fraction (AF):	-1.5E-04	-2.1E-05	-1.1E-05	-2.4E-05	-3.3E-04	-2.5E-05	-4.9E-05	-3.8E-05
Increased number of cases in population:	-0.030	-0.0086	-0.0019	-0.0040	-0.027	-0.0011	-0.00068	-0.0021
Risk:	-1.5E-06	-1.9E-06	-4.2E-07	-1.2E-07	-1.4E-06	-3.3E-08	-2.0E-08	-4.6E-07
Individual subrubs within LGA								
Kensington								
Total Population in study area:	14903	14903	14903	14903	14903	14903	14903	14903
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-496.7	-496.7	-496.7	-496.7	-496.7	-496.7	-496.7	-496.7
Population weighted Δx (µg/m^3):	-0.03332886	-0.03332886	-0.03332886	-0.03332886	-0.03332886	-0.03332886	-0.03332886	-0.03332886
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999807	0.999973	0.999986	0.999969	0.999567	0.999968	0.999937	0.999951
Attributable fraction (AF):	-1.9E-04	-2.7E-05	-1.4E-05	-3.1E-05	-4.3E-04	-3.2E-05	-6.3E-05	-4.9E-05
Increased number of cases in population:	-0.017382	-0.0049174	-0.0010856	-0.0022981	-0.015646	-0.0006374	-0.00038977	-0.0012265
Risk:	-2.0E-06	-2.5E-06	-5.4E-07	-1.5E-07	-1.8E-06	-4.3E-08	-2.6E-08	-6.0E-07
Kingsford								
Total Population in study area:	11769	11769	11769	11769	11769	11769	11769	11769
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-317.4	-317.4	-317.4	-317.4	-317.4	-317.4	-317.4	-317.4
Population weighted Δx (µg/m^3):	-0.02696916	-0.02696916	-0.02696916	-0.02696916	-0.02696916	-0.02696916	-0.02696916	-0.02696916
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999844	0.999978	0.999989	0.999975	0.999649	0.999974	0.999949	0.999960
Attributable fraction (AF):	-1.6E-04	-2.2E-05	-1.1E-05	-2.5E-05	-3.5E-04	-2.6E-05	-5.1E-05	-4.0E-05
Increased number of cases in population:	-0.01111	-0.003142	-0.000694	-0.001469	-0.01000	-0.000407	-0.0002491	-0.000784
Risk:	-1.6E-06	-2.0E-06	-4.4E-07	-1.2E-07	-1.4E-06	-3.5E-08	-2.1E-08	-4.8E-07
Malabar - La Perouse - Chiffley								
Total Population in study area:	3724	3724	3724	3724	3724	3724	3724	3724
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-19.7	-19.7	-19.7	-19.7	-19.7	-19.7	-19.7	-19.7
Population weighted Δx (µg/m^3):	-0.00529001	-0.00529001	-0.00529001	-0.00529001	-0.00529001	-0.00529001	-0.00529001	-0.00529001
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999969	0.999996	0.999998	0.999995	0.999931	0.999995	0.999990	0.999992
Attributable fraction (AF):	-3.1E-05	-4.2E-06	-2.2E-06	-5.0E-06	-6.9E-05	-5.1E-06	-1.0E-05	-7.8E-06
Increased number of cases in population:	-0.000689	-0.0001950	-0.0000431	-0.0000911	-0.000620	-0.0000253	-0.00001546	-0.0000486
Risk:	-3.1E-07	-3.9E-07	-8.6E-08	-2.4E-08	-2.8E-07	-6.8E-09	-4.2E-09	-9.5E-08
Maroubra (west)								
Total Population in study area:	2951	2951	2951	2951	2951	2951	2951	2951
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-30	-30	-30	-30	-30	-30	-30	-30
Population weighted Δx (µg/m^3):	-0.01016605	-0.01016605	-0.01016605	-0.01016605	-0.01016605	-0.01016605	-0.01016605	-0.01016605
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999941	0.999992	0.999996	0.999990	0.999868	0.999990	0.999981	0.999985
Attributable fraction (AF):	-5.9E-05	-8.1E-06	-4.2E-06	-9.6E-06	-1.3E-04	-9.9E-06	-1.9E-05	-1.5E-05
Increased number of cases in population:	-0.00105	-0.000297	-0.000066	-0.000139	-0.00094	-0.000038	-0.0000235	-0.000074
Risk:	-6.0E-07	-7.5E-07	-1.7E-07	-4.7E-08	-5.4E-07	-1.3E-08	-8.0E-09	-1.8E-07
Paddington - Moore Park								
Total Population in study area:	189	189	189	189	189	189	189	189
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Population weighted Δx (µg/m^3):	0.00740741	0.00740741	0.00740741	0.00740741	0.00740741	0.00740741	0.00740741	0.00740741
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	1.000043	1.000006	1.000003	1.000007	1.000096	1.000007	1.000014	1.000011
Attributable fraction (AF):	4.3E-05	5.9E-06	3.0E-06	7.0E-06	9.6E-05	7.2E-06	1.4E-05	1.1E-05
Increased number of cases in population:	0.000049	0.0000139	0.0000031	0.0000065	0.000044	0.0000018	0.00000110	0.0000035
Risk:	4.4E-07	5.5E-07	1.2E-07	3.4E-08	4.0E-07	9.5E-09	5.8E-09	1.3E-07
Randwick (North and South)								
Total Population in study area:	85	85	85	85	85	85	85	85
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-1.7	-1.7	-1.7	-1.7	-1.7	-1.7	-1.7	-1.7
Population weighted Δx (µg/m^3):	-0.02000000	-0.02000000	-0.02000000	-0.02000000	-0.02000000	-0.02000000	-0.02000000	-0.02000000
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999884	0.999984	0.999992	0.999981	0.999740	0.999981	0.999962	0.999970
Attributable fraction (AF):	-1.2E-04	-1.6E-05	-8.2E-06	-1.9E-05	-2.6E-04	-1.9E-05	-3.8E-05	-3.0E-05
Increased number of cases in population:	-0.000059	-0.000017	-0.0000037	-0.0000079	-0.000054	-0.0000022	-0.0000013	-0.0000042
Risk:	-1.2E-06	-1.5E-06	-3.3E-07	-9.3E-08	-1.1E-06	-2.6E-08	-1.6E-08	-3.6E-07
Total population incidence - All Suburbs	**-0.27**	**-0.065**	**-0.014**	**-0.038**	**-0.24**	**-0.0095**	**-0.0060**	**-0.018**

Assessment of Increased Incidence - $PM_{2.5}$
Gateway Road Project: 2036

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Inner West (including Strathfield - Burwood - Ashfield LGA)								
Total Population in study area:	62688	62688	62688	62688	62688	62688	62688	62688
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-554.7	-554.7	-554.7	-554.7	-554.7	-554.7	-554.7	-554.7
Population weighted Δx (µg/m^3):	-0.00884858	-0.00884858	-0.00884858	-0.00884858	-0.00884858	-0.00884858	-0.00884858	-0.00884858
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999949	0.999993	0.999996	0.999992	0.999885	0.999991	0.999983	0.999987
Attributable fraction (AF):	-5.1E-05	-7.1E-06	-3.6E-06	-8.3E-06	-1.2E-04	-8.6E-06	-1.7E-05	-1.3E-05
Increased number of cases in population:	-0.021	-0.0050	-0.0011	-0.0027	-0.019	-0.00074	-0.00044	-0.0014
Risk:	-5.3E-07	-6.5E-07	-1.4E-07	-4.3E-08	-4.7E-07	-1.2E-08	-6.9E-09	-1.6E-07
Individual subrubs within LGA								
Marrickville								
Total Population in study area:	26542	26542	26542	26542	26542	26542	26542	26542
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-295	-295	-295	-295	-295	-295	-295	-295
Population weighted Δx (µg/m^3):	-0.01111446	-0.01111446	-0.01111446	-0.01111446	-0.01111446	-0.01111446	-0.01111446	-0.01111446
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999936	0.999991	0.999995	0.999990	0.999856	0.999989	0.999979	0.999984
Attributable fraction (AF):	-6.4E-05	-8.9E-06	-4.6E-06	-1.0E-05	-1.4E-04	-1.1E-05	-2.1E-05	-1.6E-05
Increased number of cases in population:	-0.011200	-0.0026590	-0.00058699	-0.0014470	-0.010081	-0.00039117	-0.00023149	-0.0007443
Risk:	-6.6E-07	-8.2E-07	-1.8E-07	-5.5E-08	-6.0E-07	-1.5E-08	-8.7E-09	-2.0E-07
Petersham - Stanmore								
Total Population in study area:	4922	4922	4922	4922	4922	4922	4922	4922
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-63.7	-63.7	-63.7	-63.7	-63.7	-63.7	-63.7	-63.7
Population weighted Δx (µg/m^3):	-0.01294189	-0.01294189	-0.01294189	-0.01294189	-0.01294189	-0.01294189	-0.01294189	-0.01294189
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999925	0.999990	0.999995	0.999988	0.999832	0.999987	0.999975	0.999981
Attributable fraction (AF):	-7.5E-05	-1.0E-05	-5.3E-06	-1.2E-05	-1.7E-04	-1.3E-05	-2.5E-05	-1.9E-05
Increased number of cases in population:	-0.0024	-0.00057	-0.000127	-0.000312	-0.00218	-0.000084	-0.000050	-0.000161
Risk:	-7.7E-07	-9.6E-07	-2.1E-07	-6.3E-08	-6.9E-07	-1.7E-08	-1.0E-08	-2.3E-07
Sydenham - Tempe - St Peters								
Total Population in study area:	7829	7829	7829	7829	7829	7829	7829	7829
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-79	-79	-79	-79	-79	-79	-79	-79
Population weighted Δx (µg/m^3):	-0.01009069	-0.01009069	-0.01009069	-0.01009069	-0.01009069	-0.01009069	-0.01009069	-0.01009069
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999941	0.999992	0.999996	0.999991	0.999869	0.999990	0.999981	0.999985
Attributable fraction (AF):	-5.9E-05	-8.1E-06	-4.1E-06	-9.5E-06	-1.3E-04	-9.8E-06	-1.9E-05	-1.5E-05
Increased number of cases in population:	-0.0030	-0.00071	-0.00016	-0.00039	-0.0027	-0.000105	-0.000062	-0.00020
Risk:	-6.0E-07	-7.5E-07	-1.6E-07	-4.9E-08	-5.4E-07	-1.3E-08	-7.9E-09	-1.8E-07
Ashfield								
Total Population in study area:	1979	1979	1979	1979	1979	1979	1979	1979
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-14	-14	-14	-14	-14	-14	-14	-14
Population weighted Δx (µg/m^3):	-0.00707428	-0.00707428	-0.00707428	-0.00707428	-0.00707428	-0.00707428	-0.00707428	-0.00707428
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999959	0.999994	0.999997	0.999993	0.999908	0.999993	0.999987	0.999990
Attributable fraction (AF):	-4.1E-05	-5.7E-06	-2.9E-06	-6.6E-06	-9.2E-05	-6.9E-06	-1.3E-05	-1.0E-05
Increased number of cases in population:	-0.000532	-0.0001262	-0.00002786	-0.0000687	-0.000478	-0.00001856	-0.00001099	-0.0000353
Risk:	-4.2E-07	-5.2E-07	-1.2E-07	-3.5E-08	-3.8E-07	-9.4E-09	-5.6E-09	-1.3E-07
Canterbury (North) - Ashbury								
Total Population in study area:	7538	7538	7538	7538	7538	7538	7538	7538
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-58.6	-58.6	-58.6	-58.6	-58.6	-58.6	-58.6	-58.6
Population weighted Δx (µg/m^3):	-0.00777395	-0.00777395	-0.00777395	-0.00777395	-0.00777395	-0.00777395	-0.00777395	-0.00777395
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999955	0.999994	0.999997	0.999993	0.999899	0.999992	0.999985	0.999988
Attributable fraction (AF):	-4.5E-05	-6.2E-06	-3.2E-06	-7.3E-06	-1.0E-04	-7.5E-06	-1.5E-05	-1.2E-05
Increased number of cases in population:	-0.0022	-0.00053	-0.000117	-0.000287	-0.00200	-0.000078	-0.000046	-0.000148
Risk:	-4.6E-07	-5.7E-07	-1.3E-07	-3.8E-08	-4.2E-07	-1.0E-08	-6.1E-09	-1.4E-07
Dulwich Hill - Lewisham								
Total Population in study area:	13640	13640	13640	13640	13640	13640	13640	13640
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-42.3	-42.3	-42.3	-42.3	-42.3	-42.3	-42.3	-42.3
Population weighted Δx (µg/m^3):	-0.00310117	-0.00310117	-0.00310117	-0.00310117	-0.00310117	-0.00310117	-0.00310117	-0.00310117
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999982	0.999998	0.999999	0.999997	0.999960	0.999997	0.999994	0.999995
Attributable fraction (AF):	-1.8E-05	-2.5E-06	-1.3E-06	-2.9E-06	-4.0E-05	-3.0E-06	-5.9E-06	-4.6E-06
Increased number of cases in population:	-0.0016	-0.00038	-0.00008	-0.00021	-0.0014	-0.000056	-0.000033	-0.00011
Risk:	-1.8E-07	-2.3E-07	-5.1E-08	-1.5E-08	-1.7E-07	-4.1E-09	-2.4E-09	-5.5E-08
Haberfield - Summer Hill								
Total Population in study area:	238	238	238	238	238	238	238	238
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4
Population weighted Δx (µg/m^3):	-0.00588235	-0.00588235	-0.00588235	-0.00588235	-0.00588235	-0.00588235	-0.00588235	-0.00588235
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999966	0.999995	0.999998	0.999994	0.999924	0.999994	0.999989	0.999991
Attributable fraction (AF):	-3.4E-05	-4.7E-06	-2.4E-06	-5.5E-06	-7.6E-05	-5.7E-06	-1.1E-05	-8.7E-06
Increased number of cases in population:	-0.00005315	-0.00001262	-0.000002786	-0.00000687	-0.00004784	-0.000001856	-0.000001099	-0.00000353
Risk:	-3.5E-07	-4.3E-07	-9.6E-08	-2.9E-08	-3.2E-07	-7.8E-09	-4.6E-09	-1.1E-07

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Sydney Inner City LGA								
Total Population in study area:	47106	47106	47106	47106	47106	47106	47106	47106
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-1677	-1677	-1677	-1677	-1677	-1677	-1677	-1677
Population weighted Δx (µg/m^3):	-0.03560056	-0.03560056	-0.03560056	-0.03560056	-0.03560056	-0.03560056	-0.03560056	-0.03560056
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999794	0.999972	0.999985	0.999967	0.999537	0.999965	0.999932	0.999947
Attributable fraction (AF):	-2.1E-04	-2.8E-05	-1.5E-05	-3.3E-05	-4.6E-04	-3.5E-05	-6.8E-05	-5.3E-05
Increased number of cases in population:	-0.057	-0.010	-0.0022	-0.0072	-0.052	-0.0018	-0.0013	-0.0018
Risk:	-2.1E-06	-2.6E-06	-5.8E-07	-1.5E-07	-1.9E-06	-3.9E-08	-2.8E-08	-6.4E-07
Individual subrubs within LGA								
Erskinville - Alexandria								
Total Population in study area:	14292	14292	14292	14292	14292	14292	14292	14292
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-346.6	-346.6	-346.6	-346.6	-346.6	-346.6	-346.6	-346.6
Population weighted Δx (µg/m^3):	-0.02425133	-0.02425133	-0.02425133	-0.02425133	-0.02425133	-0.02425133	-0.02425133	-0.02425133
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999859	0.999981	0.999990	0.999977	0.999685	0.999976	0.999954	0.999964
Attributable fraction (AF):	-1.4E-04	-1.9E-05	-9.9E-06	-2.3E-05	-3.2E-04	-2.4E-05	-4.6E-05	-3.6E-05
Increased number of cases in population:	-0.0119	-0.00210	-0.000464	-0.00148	-0.0107	-0.000381	-0.000272	-0.000366
Risk:	-1.4E-06	-1.8E-06	-4.0E-07	-1.0E-07	-1.3E-06	-2.7E-08	-1.9E-08	-4.3E-07
Newtown - Camperdown - Darlington								
Total Population in study area:	6910	6910	6910	6910	6910	6910	6910	6910
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-84	-84	-84	-84	-84	-84	-84	-84
Population weighted Δx (µg/m^3):	-0.01215630	-0.01215630	-0.01215630	-0.01215630	-0.01215630	-0.01215630	-0.01215630	-0.01215630
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999929	0.999990	0.999995	0.999989	0.999842	0.999988	0.999977	0.999982
Attributable fraction (AF):	-7.1E-05	-9.7E-06	-5.0E-06	-1.1E-05	-1.6E-04	-1.2E-05	-2.3E-05	-1.8E-05
Increased number of cases in population:	-0.0029	-0.00051	-0.000112	-0.00036	-0.00259	-0.000092	-0.000066	-0.000089
Risk:	-7.2E-07	-9.0E-07	-2.0E-07	-5.2E-08	-6.5E-07	-1.3E-08	-9.5E-09	-2.2E-07
Waterloo - Beaconsfield								
Total Population in study area:	25904	25904	25904	25904	25904	25904	25904	25904
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-1246.2	-1246.2	-1246.2	-1246.2	-1246.2	-1246.2	-1246.2	-1246.2
Population weighted Δx (µg/m^3):	-0.04810840	-0.04810840	-0.04810840	-0.04810840	-0.04810840	-0.04810840	-0.04810840	-0.04810840
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999721	0.999962	0.999980	0.999955	0.999375	0.999953	0.999909	0.999929
Attributable fraction (AF):	-2.8E-04	-3.8E-05	-2.0E-05	-4.5E-05	-6.3E-04	-4.7E-05	-9.1E-05	-7.1E-05
Increased number of cases in population:	-0.0427	-0.00755	-0.00167	-0.00532	-0.0385	-0.00137	-0.00098	-0.001316
Risk:	-2.9E-06	-3.6E-06	-7.8E-07	-2.1E-07	-2.6E-06	-5.3E-08	-3.8E-08	-8.6E-07
Canterbury LGA								
Total Population in study area:	12648	12648	12648	12648	12648	12648	12648	12648
% population in assessment age-group:	58%	14%	14%	100%	58%	100%	100%	19%
total change	-125.80	-125.8	-125.8	-125.8	-125.8	-125.8	-125.8	-125.8
Population weighted Δx (µg/m^3):	-0.00994624	-0.00994624	-0.00994624	-0.00994624	-0.00994624	-0.00994624	-0.00994624	-0.00994624
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	508.3	412.0	143.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00508	0.00412	0.00144	0.00041	0.01209
Relative Risk:	0.999942	0.999992	0.999996	0.999991	0.999871	0.999990	0.999981	0.999985
Attributable fraction (AF):	-5.8E-05	-8.0E-06	-4.1E-06	-9.3E-06	-1.3E-04	-9.6E-06	-1.9E-05	-1.5E-05
Increased number of cases in population:	-0.0044	-0.0013	-0.00029	-0.00060	-0.0039	-0.00018	-0.000099	-0.00043
Risk:	-5.9E-07	-7.3E-07	-1.6E-07	-4.8E-08	-5.3E-07	-1.4E-08	-7.8E-09	-1.8E-07
Individual subrubs within LGA								
Canterbury (South) - Campsie								
Total Population in study area:	149	149	149	149	149	149	149	149
% population in assessment age-group:	58%	14%	14%	100%	58%	100%	100%	19%
total change	-6	-6	-6	-6	-6	-6	-6	-6
Population weighted Δx (µg/m^3):	-0.04026846	-0.04026846	-0.04026846	-0.04026846	-0.04026846	-0.04026846	-0.04026846	-0.04026846
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	508.3	412.0	143.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00508	0.00412	0.00144	0.00041	0.01209
Relative Risk:	0.999766	0.999968	0.999983	0.999962	0.999477	0.999961	0.999923	0.999940
Attributable fraction (AF):	-2.3E-04	-3.2E-05	-1.7E-05	-3.8E-05	-5.2E-04	-3.9E-05	-7.7E-05	-6.0E-05
Increased number of cases in population:	-0.0002085	-0.0000616	-0.0000136	-0.0000287	-0.0001877	-0.0000084	-0.0000047	-0.0000206
Risk:	-2.4E-06	-3.0E-06	-6.6E-07	-1.9E-07	-2.2E-06	-5.6E-08	-3.2E-08	-7.2E-07
Kingsgrove (North) - Earlwood								
Total Population in study area:	12499	12499	12499	12499	12499	12499	12499	12499
% population in assessment age-group:	58%	14%	14%	100%	58%	100%	100%	19%
total change	-119.7	-119.7	-119.7	-119.7	-119.7	-119.7	-119.7	-119.7
Population weighted Δx (µg/m^3):	-0.00957677	-0.00957677	-0.00957677	-0.00957677	-0.00957677	-0.00957677	-0.00957677	-0.00957677
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	508.3	412.0	143.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00508	0.00412	0.00144	0.00041	0.01209
Relative Risk:	0.999944	0.999992	0.999996	0.999991	0.999876	0.999991	0.999982	0.999986
Attributable fraction (AF):	-5.6E-05	-7.7E-06	-3.9E-06	-9.0E-06	-1.2E-04	-9.3E-06	-1.8E-05	-1.4E-05
Increased number of cases in population:	-0.00416	-0.001229	-0.000271	-0.000572	-0.00374	-0.0001667	-0.0000939	-0.000411
Risk:	-5.7E-07	-7.1E-07	-1.6E-07	-4.6E-08	-5.1E-07	-1.3E-08	-7.5E-09	-1.7E-07
Botany LGA								
Total Population in study area:	46677	46677	46677	46677	46677	46677	46677	46677
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-4250	-4250	-4250	-4250	-4250	-4250	-4250	-4250
Population weighted Δx (µg/m^3):	-0.09105127	-0.09105127	-0.09105127	-0.09105127	-0.09105127	-0.09105127	-0.09105127	-0.09105127
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999472	0.999927	0.999963	0.999914	0.998817	0.999912	0.999827	0.999865
Attributable fraction (AF):	-5.3E-04	-7.3E-05	-3.7E-05	-8.6E-05	-1.2E-03	-8.8E-05	-1.7E-04	-1.3E-04
Increased number of cases in population:	-0.15	-0.041	-0.0090	-0.022	-0.14	-0.0055	-0.0033	-0.012
Risk:	-5.4E-06	-6.7E-06	-1.5E-06	-4.8E-07	-4.9E-06	-1.2E-07	-7.1E-08	-1.6E-06

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Individual subrubs within LGA								
Banksmeadow								
Total Population in study area:	21	21	21	21	21	21	21	21
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37	-0.37
Population weighted Δx (µg/m^3):	-0.01761905	-0.01761905	-0.01761905	-0.01761905	-0.01761905	-0.01761905	-0.01761905	-0.01761905
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999898	0.999986	0.999993	0.999983	0.999771	0.999983	0.999967	0.999974
Attributable fraction (AF):	-1.0E-04	-1.4E-05	-7.2E-06	-1.7E-05	-2.3E-04	-1.7E-05	-3.3E-05	-2.6E-05
Increased number of cases in population:	-0.000013	-0.0000036	-0.00000078	-0.0000019	-0.0000119	-0.00000048	-0.00000029	-0.0000010
Risk:	-1.0E-06	-1.3E-06	-2.9E-07	-9.3E-08	-9.4E-07	-2.3E-08	-1.4E-08	-3.2E-07
Botany								
Total Population in study area:	10780	10780	10780	10780	10780	10780	10780	10780
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-90.2	-90.2	-90.2	-90.2	-90.2	-90.2	-90.2	-90.2
Population weighted Δx (µg/m^3):	-0.00836735	-0.00836735	-0.00836735	-0.00836735	-0.00836735	-0.00836735	-0.00836735	-0.00836735
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999951	0.999993	0.999997	0.999992	0.999891	0.999992	0.999984	0.999988
Attributable fraction (AF):	-4.9E-05	-6.7E-06	-3.4E-06	-7.9E-06	-1.1E-04	-8.1E-06	-1.6E-05	-1.2E-05
Increased number of cases in population:	-0.0032	-0.00087	-0.00019	-0.00047	-0.0029	-0.00012	-0.000071	-0.00025
Risk:	-5.0E-07	-6.2E-07	-1.4E-07	-4.4E-08	-4.5E-07	-1.1E-08	-6.6E-09	-1.5E-07
Mascot - Eastlakes								
Total Population in study area:	24409	24409	24409	24409	24409	24409	24409	24409
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-4005.2	-4005.2	-4005.2	-4005.2	-4005.2	-4005.2	-4005.2	-4005.2
Population weighted Δx (µg/m^3):	-0.16408702	-0.16408702	-0.16408702	-0.16408702	-0.16408702	-0.16408702	-0.16408702	-0.16408702
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999049	0.999869	0.999933	0.999846	0.997869	0.999841	0.999688	0.999757
Attributable fraction (AF):	-9.5E-04	-1.3E-04	-6.7E-05	-1.5E-04	-2.1E-03	-1.6E-04	-3.1E-04	-2.4E-04
Increased number of cases in population:	-0.1426	-0.0385	-0.0085	-0.0211	-0.1284	-0.0052	-0.0031	-0.0113
Risk:	-9.8E-06	-1.2E-05	-2.7E-06	-8.6E-07	-8.8E-06	-2.1E-07	-1.3E-07	-2.9E-06
Pagewood - Hillsdale - Daceyville								
Total Population in study area:	11400	11400	11400	11400	11400	11400	11400	11400
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-156	-156	-156	-156	-156	-156	-156	-156
Population weighted Δx (µg/m^3):	-0.01368421	-0.01368421	-0.01368421	-0.01368421	-0.01368421	-0.01368421	-0.01368421	-0.01368421
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999921	0.999989	0.999994	0.999987	0.999822	0.999987	0.999974	0.999980
Attributable fraction (AF):	-7.9E-05	-1.1E-05	-5.6E-06	-1.3E-05	-1.8E-04	-1.3E-05	-2.6E-05	-2.0E-05
Increased number of cases in population:	-0.00555	-0.00150	-0.000331	-0.000821	-0.004997	-0.000202	-0.0001224	-0.000438
Risk:	-8.1E-07	-1.0E-06	-2.2E-07	-7.2E-08	-7.3E-07	-1.8E-08	-1.1E-08	-2.4E-07
Port Botany Industrial								
Total Population in study area:	6	6	6	6	6	6	6	6
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05
Population weighted Δx (µg/m^3):	-0.00833333	-0.00833333	-0.00833333	-0.00833333	-0.00833333	-0.00833333	-0.00833333	-0.00833333
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999952	0.999993	0.999997	0.999992	0.999892	0.999992	0.999984	0.999988
Attributable fraction (AF):	-4.8E-05	-6.7E-06	-3.4E-06	-7.8E-06	-1.1E-04	-8.1E-06	-1.6E-05	-1.2E-05
Increased number of cases in population:	-0.0000018	-0.00000048	-0.00000011	-0.00000026	-0.0000016	-0.000000065	-0.000000039	-0.00000014
Risk:	-5.0E-07	-6.2E-07	-1.4E-07	-4.4E-08	-4.5E-07	-1.1E-08	-6.5E-09	-1.5E-07
Sydney Airport								
Total Population in study area:	61	61	61	61	61	61	61	61
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Population weighted Δx (µg/m^3):	0.02786885	0.02786885	0.02786885	0.02786885	0.02786885	0.02786885	0.02786885	0.02786885
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	1.000162	1.000022	1.000011	1.000026	1.000362	1.000027	1.000053	1.000041
Attributable fraction (AF):	1.6E-04	2.2E-05	1.1E-05	2.6E-05	3.6E-04	2.7E-05	5.3E-05	4.1E-05
Increased number of cases in population:	0.000060	0.000016	0.0000036	0.000009	0.000054	0.0000022	0.0000013	0.0000048
Risk:	1.7E-06	2.1E-06	4.5E-07	1.5E-07	1.5E-06	3.6E-08	2.2E-08	5.0E-07
Kogarah - Rockdale LGA								
Total Population in study area:	102876	102876	102876	102876	102876	102876	102876	102876
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-373.3	-373.3	-373.3	-373.3	-373.3	-373.3	-373.3	-373.3
Population weighted Δx (µg/m^3):	-0.00362864	-0.00362864	-0.00362864	-0.00362864	-0.00362864	-0.00362864	-0.00362864	-0.00362864
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999979	0.999997	0.999999	0.999997	0.999953	0.999996	0.999993	0.999995
Attributable fraction (AF):	-2.1E-05	-2.9E-06	-1.5E-06	-3.4E-06	-4.7E-05	-3.5E-06	-6.9E-06	-5.4E-06
Increased number of cases in population:	-0.014	-0.0042	-0.00093	-0.0017	-0.012	-0.00051	-0.00029	-0.0010
Risk:	-2.2E-07	-2.7E-07	-5.9E-08	-1.7E-08	-1.9E-07	-4.9E-09	-2.8E-09	-6.5E-08
Individual subrubs within LGA								
Arncliffe - Bardwell Park								
Total Population in study area:	21457	21457	21457	21457	21457	21457	21457	21457
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-505.3	-505.3	-505.3	-505.3	-505.3	-505.3	-505.3	-505.3
Population weighted Δx (µg/m^3):	-0.02354942	-0.02354942	-0.02354942	-0.02354942	-0.02354942	-0.02354942	-0.02354942	-0.02354942
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999863	0.999981	0.999990	0.999978	0.999694	0.999977	0.999955	0.999965
Attributable fraction (AF):	-1.4E-04	-1.9E-05	-9.7E-06	-2.2E-05	-3.1E-04	-2.3E-05	-4.5E-05	-3.5E-05
Increased number of cases in population:	-0.0185	-0.0057	-0.00126	-0.00232	-0.0166	-0.00069	-0.00040	-0.00132
Risk:	-1.4E-06	-1.7E-06	-3.8E-07	-1.1E-07	-1.3E-06	-3.2E-08	-1.8E-08	-4.2E-07
Bexley								
Total Population in study area:	20419	20419	20419	20419	20419	20419	20419	20419

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-87	-87	-87	-87	-87	-87	-87	-87
Population weighted Δx (µg/m^3):	-0.00426074	-0.00426074	-0.00426074	-0.00426074	-0.00426074	-0.00426074	-0.00426074	-0.00426074
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999975	0.999997	0.999998	0.999996	0.999945	0.999996	0.999992	0.999994
Attributable fraction (AF):	-2.5E-05	-3.4E-06	-1.7E-06	-4.0E-06	-5.5E-05	-4.1E-06	-8.1E-06	-6.3E-06
Increased number of cases in population:	-0.0032	-0.0010	-0.00022	-0.00040	-0.0029	-0.000119	-0.000068	-0.00023
Risk:	-2.5E-07	-3.1E-07	-6.9E-08	-2.0E-08	-2.3E-07	-5.8E-09	-3.3E-09	-7.6E-08
Kingsgrove (South) - Bardwell Park								
Total Population in study area:	2879	2879	2879	2879	2879	2879	2879	2879
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-25.3	-25.3	-25.3	-25.3	-25.3	-25.3	-25.3	-25.3
Population weighted Δx (µg/m^3):	-0.00878777	-0.00878777	-0.00878777	-0.00878777	-0.00878777	-0.00878777	-0.00878777	-0.00878777
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999949	0.999993	0.999996	0.999992	0.999886	0.999991	0.999983	0.999987
Attributable fraction (AF):	-5.1E-05	-7.0E-06	-3.6E-06	-8.3E-06	-1.1E-04	-8.5E-06	-1.7E-05	-1.3E-05
Increased number of cases in population:	-0.00093	-0.000286	-0.000063	-0.000116	-0.00083	-0.0000345	-0.0000199	-0.000066
Risk:	-5.2E-07	-6.5E-07	-1.4E-07	-4.0E-08	-4.7E-07	-1.2E-08	-6.9E-09	-1.6E-07
Kogarah								
Total Population in study area:	11323	11323	11323	11323	11323	11323	11323	11323
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	86.8	86.8	86.8	86.8	86.8	86.8	86.8	86.8
Population weighted Δx (µg/m^3):	0.00766581	0.00766581	0.00766581	0.00766581	0.00766581	0.00766581	0.00766581	0.00766581
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000044	1.000006	1.000003	1.000007	1.000100	1.000007	1.000015	1.000011
Attributable fraction (AF):	4.4E-05	6.1E-06	3.1E-06	7.2E-06	1.0E-04	7.4E-06	1.5E-05	1.1E-05
Increased number of cases in population:	0.003	0.0010	0.0002	0.0004	0.003	0.00012	0.00007	0.0002
Risk:	4.6E-07	5.7E-07	1.3E-07	3.5E-08	4.1E-07	1.0E-08	6.0E-09	1.4E-07
Kogarah Bay								
Total Population in study area:	10788	10788	10788	10788	10788	10788	10788	10788
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Population weighted Δx (µg/m^3):	0.00045421	0.00045421	0.00045421	0.00045421	0.00045421	0.00045421	0.00045421	0.00045421
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000003	1.000000	1.000000	1.000000	1.000006	1.000000	1.000001	1.000001
Attributable fraction (AF):	2.6E-06	3.6E-07	1.9E-07	4.3E-07	5.9E-06	4.4E-07	8.6E-07	6.7E-07
Increased number of cases in population:	0.00018	0.000055	0.0000122	0.000022	0.00016	0.0000067	0.0000038	0.000013
Risk:	2.7E-08	3.4E-08	7.4E-09	2.1E-09	2.4E-08	6.2E-10	3.6E-10	8.1E-09
Monterey - Brighton-le-Sands - Kyeemagh								
Total Population in study area:	13915	13915	13915	13915	13915	13915	13915	13915
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	126	126	126	126	126	126	126	126
Population weighted Δx (µg/m^3):	0.00905498	0.00905498	0.00905498	0.00905498	0.00905498	0.00905498	0.00905498	0.00905498
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000053	1.000007	1.000004	1.000009	1.000118	1.000009	1.000017	1.000013
Attributable fraction (AF):	5.3E-05	7.2E-06	3.7E-06	8.5E-06	1.2E-04	8.8E-06	1.7E-05	1.3E-05
Increased number of cases in population:	0.0046	0.0014	0.00031	0.00058	0.0042	0.00017	0.00010	0.00033
Risk:	5.4E-07	6.7E-07	1.5E-07	4.2E-08	4.8E-07	1.2E-08	7.1E-09	1.6E-07
Rockdale - Banksia								
Total Population in study area:	19957	19957	19957	19957	19957	19957	19957	19957
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	28.5	28.5	28.5	28.5	28.5	28.5	28.5	28.5
Population weighted Δx (µg/m^3):	0.00142807	0.00142807	0.00142807	0.00142807	0.00142807	0.00142807	0.00142807	0.00142807
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000008	1.000001	1.000001	1.000001	1.000019	1.000001	1.000003	1.000002
Attributable fraction (AF):	8.3E-06	1.1E-06	5.9E-07	1.3E-06	1.9E-05	1.4E-06	2.7E-06	2.1E-06
Increased number of cases in population:	0.0010	0.00032	0.000071	0.00013	0.00094	0.000039	0.000022	0.000074
Risk:	8.5E-08	1.1E-07	2.3E-08	6.6E-09	7.6E-08	1.9E-09	1.1E-09	2.6E-08
Sans Souci - Ramsgate								
Total Population in study area:	2036	2036	2036	2036	2036	2036	2036	2036
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1
Population weighted Δx (µg/m^3):	-0.00054028	-0.00054028	-0.00054028	-0.00054028	-0.00054028	-0.00054028	-0.00054028	-0.00054028
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999997	1.000000	1.000000	0.999999	0.999993	0.999999	0.999999	0.999999
Attributable fraction (AF):	-3.1E-06	-4.3E-07	-2.2E-07	-5.1E-07	-7.0E-06	-5.2E-07	-1.0E-06	-8.0E-07
Increased number of cases in population:	-0.000040	-0.000012	-0.0000027	-0.0000050	-0.000036	-0.0000015	-0.00000086	-0.0000029
Risk:	-3.2E-08	-4.0E-08	-8.8E-09	-2.5E-09	-2.9E-08	-7.4E-10	-4.2E-10	-9.7E-09
Hurstville								
Total Population in study area:	102	102	102	102	102	102	102	102
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Population weighted Δx (µg/m^3):	-0.00294118	-0.00294118	-0.00294118	-0.00294118	-0.00294118	-0.00294118	-0.00294118	-0.00294118
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999983	0.999998	0.999999	0.999997	0.999962	0.999997	0.999994	0.999996
Attributable fraction (AF):	-1.7E-05	-2.4E-06	-1.2E-06	-2.8E-06	-3.8E-05	-2.9E-06	-5.6E-06	-4.4E-06
Increased number of cases in population:	-0.0000110	-0.0000034	-0.00000075	-0.0000014	-0.0000099	-0.00000041	-0.00000024	-0.00000078
Risk:	-1.8E-07	-2.2E-07	-4.8E-08	-1.3E-08	-1.6E-07	-4.0E-09	-2.3E-09	-5.3E-08
Eastern Suburbs								
Total Population in study area:	33621	33621	33621	33621	33621	33621	33621	33621
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-1163.50	-1163.5	-1163.5	-1163.5	-1163.5	-1163.5	-1163.5	-1163.5
Population weighted Δx (µg/m^3):	-0.03460635	-0.03460635	-0.03460635	-0.03460635	-0.03460635	-0.03460635	-0.03460635	-0.03460635
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	492.2	412.0	132.3	41.3	1209.0

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999799	0.999972	0.999986	0.999967	0.999550	0.999966	0.999934	0.999949
Attributable fraction (AF):	-2.0E-04	-2.8E-05	-1.4E-05	-3.3E-05	-4.5E-04	-3.4E-05	-6.6E-05	-5.1E-05
Increased number of cases in population:	-0.041	-0.012	-0.0025	-0.0054	-0.037	-0.0015	-0.00091	-0.0029
Risk:	-2.1E-06	-2.6E-06	-5.6E-07	-1.6E-07	-1.9E-06	-4.4E-08	-2.7E-08	-6.2E-07
Individual subrubs within LGA								
Kensington								
Total Population in study area:	14903	14903	14903	14903	14903	14903	14903	14903
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-579	-579	-579	-579	-579	-579	-579	-579
Population weighted Δx (µg/m^3):	-0.03885124	-0.03885124	-0.03885124	-0.03885124	-0.03885124	-0.03885124	-0.03885124	-0.03885124
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999775	0.999969	0.999984	0.999963	0.999495	0.999962	0.999926	0.999943
Attributable fraction (AF):	-2.3E-04	-3.1E-05	-1.6E-05	-3.7E-05	-5.1E-04	-3.8E-05	-7.4E-05	-5.8E-05
Increased number of cases in population:	-0.020262	-0.0057321	-0.0012654	-0.0026789	-0.018239	-0.0007431	-0.00045436	-0.0014297
Risk:	-2.3E-06	-2.9E-06	-6.3E-07	-1.8E-07	-2.1E-06	-5.0E-08	-3.0E-08	-7.0E-07
Kingsford								
Total Population in study area:	11769	11769	11769	11769	11769	11769	11769	11769
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-517.9	-517.9	-517.9	-517.9	-517.9	-517.9	-517.9	-517.9
Population weighted Δx (µg/m^3):	-0.04400544	-0.04400544	-0.04400544	-0.04400544	-0.04400544	-0.04400544	-0.04400544	-0.04400544
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999745	0.999965	0.999982	0.999959	0.999428	0.999957	0.999916	0.999935
Attributable fraction (AF):	-2.6E-04	-3.5E-05	-1.8E-05	-4.1E-05	-5.7E-04	-4.3E-05	-8.4E-05	-6.5E-05
Increased number of cases in population:	-0.01812	-0.005127	-0.001132	-0.002396	-0.01632	-0.000665	-0.0004064	-0.001279
Risk:	-2.6E-06	-3.3E-06	-7.2E-07	-2.0E-07	-2.4E-06	-5.6E-08	-3.5E-08	-7.9E-07
Malabar - La Perouse - Chiffley								
Total Population in study area:	3724	3724	3724	3724	3724	3724	3724	3724
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	7	7	7	7	7	7	7	7
Population weighted Δx (µg/m^3):	0.00187970	0.00187970	0.00187970	0.00187970	0.00187970	0.00187970	0.00187970	0.00187970
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	1.000011	1.000002	1.000001	1.000002	1.000024	1.000002	1.000004	1.000003
Attributable fraction (AF):	1.1E-05	1.5E-06	7.7E-07	1.8E-06	2.4E-05	1.8E-06	3.6E-06	2.8E-06
Increased number of cases in population:	0.000245	0.0000693	0.0000153	0.0000324	0.000220	0.0000090	0.00000549	0.0000173
Risk:	1.1E-07	1.4E-07	3.1E-08	8.7E-09	1.0E-07	2.4E-09	1.5E-09	3.4E-08
Maroubra (west)								
Total Population in study area:	2951	2951	2951	2951	2951	2951	2951	2951
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-65.3	-65.3	-65.3	-65.3	-65.3	-65.3	-65.3	-65.3
Population weighted Δx (µg/m^3):	-0.02212809	-0.02212809	-0.02212809	-0.02212809	-0.02212809	-0.02212809	-0.02212809	-0.02212809
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999872	0.999982	0.999991	0.999979	0.999712	0.999979	0.999958	0.999967
Attributable fraction (AF):	-1.3E-04	-1.8E-05	-9.1E-06	-2.1E-05	-2.9E-04	-2.1E-05	-4.2E-05	-3.3E-05
Increased number of cases in population:	-0.00229	-0.000646	-0.000143	-0.000302	-0.00206	-0.000084	-0.0000512	-0.000161
Risk:	-1.3E-06	-1.6E-06	-3.6E-07	-1.0E-07	-1.2E-06	-2.8E-08	-1.7E-08	-4.0E-07
Paddington - Moore Park								
Total Population in study area:	189	189	189	189	189	189	189	189
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-5	-5	-5	-5	-5	-5	-5	-5
Population weighted Δx (µg/m^3):	-0.02645503	-0.02645503	-0.02645503	-0.02645503	-0.02645503	-0.02645503	-0.02645503	-0.02645503
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999847	0.999979	0.999989	0.999975	0.999656	0.999974	0.999950	0.999961
Attributable fraction (AF):	-1.5E-04	-2.1E-05	-1.1E-05	-2.5E-05	-3.4E-04	-2.6E-05	-5.0E-05	-3.9E-05
Increased number of cases in population:	-0.000175	-0.0000495	-0.0000109	-0.0000231	-0.000157	-0.0000064	-0.00000392	-0.0000123
Risk:	-1.6E-06	-2.0E-06	-4.3E-07	-1.2E-07	-1.4E-06	-3.4E-08	-2.1E-08	-4.7E-07
Randwick (North and South)								
Total Population in study area:	85	85	85	85	85	85	85	85
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9
Population weighted Δx (µg/m^3):	-0.03411765	-0.03411765	-0.03411765	-0.03411765	-0.03411765	-0.03411765	-0.03411765	-0.03411765
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999802	0.999973	0.999986	0.999968	0.999557	0.999967	0.999935	0.999950
Attributable fraction (AF):	-2.0E-04	-2.7E-05	-1.4E-05	-3.2E-05	-4.4E-04	-3.3E-05	-6.5E-05	-5.0E-05
Increased number of cases in population:	-0.00010	-0.000029	-0.0000063	-0.000013	-0.000091	-0.0000037	-0.0000023	-0.0000072
Risk:	-2.0E-06	-2.5E-06	-5.6E-07	-1.6E-07	-1.8E-06	-4.4E-08	-2.7E-08	-6.1E-07
Total population incidence - All Suburbs	**-0.29**	**-0.073**	**-0.016**	**-0.040**	**-0.26**	**-0.010**	**-0.0064**	**-0.019**

Assessment of Increased Incidence - $PM_{2.5}$
Gateway Road Project: 2036 Cumulative

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Inner West (including Strathfield - Burwood - Ashfield LGA)								
Total Population in study area:	62688	62688	62688	62688	62688	62688	62688	62688
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-736.9	-736.9	-736.9	-736.9	-736.9	-736.9	-736.9	-736.9
Population weighted Δx (µg/m^3):	-0.01175504	-0.01175504	-0.01175504	-0.01175504	-0.01175504	-0.01175504	-0.01175504	-0.01175504
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999932	0.999991	0.999995	0.999989	0.999847	0.999989	0.999978	0.999983
Attributable fraction (AF):	-6.8E-05	-9.4E-06	-4.8E-06	-1.1E-05	-1.5E-04	-1.1E-05	-2.2E-05	-1.7E-05
Increased number of cases in population:	-0.028	-0.0066	-0.0015	-0.0036	-0.025	-0.00098	-0.00058	-0.0019
Risk:	-7.0E-07	-8.7E-07	-1.9E-07	-5.8E-08	-6.3E-07	-1.6E-08	-9.2E-09	-2.1E-07
Individual subrubs within LGA								
Marrickville								
Total Population in study area:	26542	26542	26542	26542	26542	26542	26542	26542
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-268	-268	-268	-268	-268	-268	-268	-268
Population weighted Δx (µg/m^3):	-0.01009720	-0.01009720	-0.01009720	-0.01009720	-0.01009720	-0.01009720	-0.01009720	-0.01009720
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999941	0.999992	0.999996	0.999991	0.999869	0.999990	0.999981	0.999985
Attributable fraction (AF):	-5.9E-05	-8.1E-06	-4.1E-06	-9.5E-06	-1.3E-04	-9.8E-06	-1.9E-05	-1.5E-05
Increased number of cases in population:	-0.010175	-0.0024156	-0.00053327	-0.0013145	-0.009159	-0.00035537	-0.00021030	-0.0006762
Risk:	-6.0E-07	-7.5E-07	-1.6E-07	-5.0E-08	-5.4E-07	-1.3E-08	-7.9E-09	-1.8E-07
Petersham - Stanmore								
Total Population in study area:	4922	4922	4922	4922	4922	4922	4922	4922
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-56.3	-56.3	-56.3	-56.3	-56.3	-56.3	-56.3	-56.3
Population weighted Δx (µg/m^3):	-0.01143844	-0.01143844	-0.01143844	-0.01143844	-0.01143844	-0.01143844	-0.01143844	-0.01143844
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999934	0.999991	0.999995	0.999989	0.999851	0.999989	0.999978	0.999983
Attributable fraction (AF):	-6.6E-05	-9.2E-06	-4.7E-06	-1.1E-05	-1.5E-04	-1.1E-05	-2.2E-05	-1.7E-05
Increased number of cases in population:	-0.0021	-0.00051	-0.000112	-0.000276	-0.00192	-0.000075	-0.000044	-0.000142
Risk:	-6.8E-07	-8.5E-07	-1.9E-07	-5.6E-08	-6.1E-07	-1.5E-08	-9.0E-09	-2.0E-07
Sydenham - Tempe - St Peters								
Total Population in study area:	7829	7829	7829	7829	7829	7829	7829	7829
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-193.6	-193.6	-193.6	-193.6	-193.6	-193.6	-193.6	-193.6
Population weighted Δx (µg/m^3):	-0.02472857	-0.02472857	-0.02472857	-0.02472857	-0.02472857	-0.02472857	-0.02472857	-0.02472857
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999857	0.999980	0.999990	0.999977	0.999679	0.999976	0.999953	0.999963
Attributable fraction (AF):	-1.4E-04	-2.0E-05	-1.0E-05	-2.3E-05	-3.2E-04	-2.4E-05	-4.7E-05	-3.7E-05
Increased number of cases in population:	-0.0074	-0.00175	-0.00039	-0.00095	-0.0066	-0.000257	-0.000152	-0.00049
Risk:	-1.5E-06	-1.8E-06	-4.0E-07	-1.2E-07	-1.3E-06	-3.3E-08	-1.9E-08	-4.4E-07
Ashfield								
Total Population in study area:	1979	1979	1979	1979	1979	1979	1979	1979
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-16.7	-16.7	-16.7	-16.7	-16.7	-16.7	-16.7	-16.7
Population weighted Δx (µg/m^3):	-0.00843861	-0.00843861	-0.00843861	-0.00843861	-0.00843861	-0.00843861	-0.00843861	-0.00843861
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999951	0.999993	0.999997	0.999992	0.999890	0.999992	0.999984	0.999988
Attributable fraction (AF):	-4.9E-05	-6.8E-06	-3.5E-06	-7.9E-06	-1.1E-04	-8.2E-06	-1.6E-05	-1.2E-05
Increased number of cases in population:	-0.000634	-0.0001505	-0.00003323	-0.0000819	-0.000571	-0.00002214	-0.00001310	-0.0000421
Risk:	-5.0E-07	-6.2E-07	-1.4E-07	-4.1E-08	-4.5E-07	-1.1E-08	-6.6E-09	-1.5E-07
Canterbury (North) - Ashbury								
Total Population in study area:	7538	7538	7538	7538	7538	7538	7538	7538
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-99	-99	-99	-99	-99	-99	-99	-99
Population weighted Δx (µg/m^3):	-0.01313346	-0.01313346	-0.01313346	-0.01313346	-0.01313346	-0.01313346	-0.01313346	-0.01313346
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999924	0.999989	0.999995	0.999988	0.999829	0.999987	0.999975	0.999981
Attributable fraction (AF):	-7.6E-05	-1.1E-05	-5.4E-06	-1.2E-05	-1.7E-04	-1.3E-05	-2.5E-05	-1.9E-05
Increased number of cases in population:	-0.0038	-0.00089	-0.000197	-0.000486	-0.00338	-0.000131	-0.000078	-0.000250
Risk:	-7.8E-07	-9.7E-07	-2.1E-07	-6.4E-08	-7.0E-07	-1.7E-08	-1.0E-08	-2.3E-07
Dulwich Hill - Lewisham								
Total Population in study area:	13640	13640	13640	13640	13640	13640	13640	13640
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-101	-101	-101	-101	-101	-101	-101	-101
Population weighted Δx (µg/m^3):	-0.00740469	-0.00740469	-0.00740469	-0.00740469	-0.00740469	-0.00740469	-0.00740469	-0.00740469
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999957	0.999994	0.999997	0.999993	0.999904	0.999993	0.999986	0.999989
Attributable fraction (AF):	-4.3E-05	-5.9E-06	-3.0E-06	-7.0E-06	-9.6E-05	-7.2E-06	-1.4E-05	-1.1E-05
Increased number of cases in population:	-0.0038	-0.00091	-0.00020	-0.00050	-0.0035	-0.000134	-0.000079	-0.00025
Risk:	-4.4E-07	-5.5E-07	-1.2E-07	-3.6E-08	-4.0E-07	-9.8E-09	-5.8E-09	-1.3E-07
Haberfield - Summer Hill								
Total Population in study area:	238	238	238	238	238	238	238	238
% population in assessment age-group:	64%	12%	12%	100%	64%	100%	100%	14%
total change	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8
Population weighted Δx (µg/m^3):	-0.00756303	-0.00756303	-0.00756303	-0.00756303	-0.00756303	-0.00756303	-0.00756303	-0.00756303
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	521.8	412.0	136.7	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00522	0.00412	0.00137	0.00041	0.01209
Relative Risk:	0.999956	0.999994	0.999997	0.999993	0.999902	0.999993	0.999986	0.999989
Attributable fraction (AF):	-4.4E-05	-6.1E-06	-3.1E-06	-7.1E-06	-9.8E-05	-7.3E-06	-1.4E-05	-1.1E-05
Increased number of cases in population:	-0.00006834	-0.00001622	-0.000003582	-0.00000883	-0.00006151	-0.000002387	-0.000001412	-0.00000454
Risk:	-4.5E-07	-5.6E-07	-1.2E-07	-3.7E-08	-4.1E-07	-1.0E-08	-5.9E-09	-1.4E-07

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Sydney Inner City LGA								
Total Population in study area:	47106	47106	47106	47106	47106	47106	47106	47106
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-2728	-2728	-2728	-2728	-2728	-2728	-2728	-2728
Population weighted Δx (µg/m^3):	-0.05791194	-0.05791194	-0.05791194	-0.05791194	-0.05791194	-0.05791194	-0.05791194	-0.05791194
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999664	0.999954	0.999976	0.999946	0.999247	0.999944	0.999890	0.999914
Attributable fraction (AF):	-3.4E-04	-4.6E-05	-2.4E-05	-5.4E-05	-7.5E-04	-5.6E-05	-1.1E-04	-8.6E-05
Increased number of cases in population:	-0.094	-0.017	-0.0036	-0.012	-0.084	-0.0030	-0.0021	-0.0029
Risk:	-3.4E-06	-4.3E-06	-9.4E-07	-2.5E-07	-3.1E-06	-6.4E-08	-4.5E-08	-1.0E-06
Individual subrubs within LGA								
Erskinville - Alexandria								
Total Population in study area:	14292	14292	14292	14292	14292	14292	14292	14292
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-362.9	-362.9	-362.9	-362.9	-362.9	-362.9	-362.9	-362.9
Population weighted Δx (µg/m^3):	-0.02539183	-0.02539183	-0.02539183	-0.02539183	-0.02539183	-0.02539183	-0.02539183	-0.02539183
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999853	0.999980	0.999990	0.999976	0.999670	0.999975	0.999952	0.999962
Attributable fraction (AF):	-1.5E-04	-2.0E-05	-1.0E-05	-2.4E-05	-3.3E-04	-2.5E-05	-4.8E-05	-3.8E-05
Increased number of cases in population:	-0.0124	-0.00220	-0.000485	-0.00155	-0.0112	-0.000398	-0.000285	-0.000383
Risk:	-1.5E-06	-1.9E-06	-4.1E-07	-1.1E-07	-1.4E-06	-2.8E-08	-2.0E-08	-4.5E-07
Newtown - Camperdown - Darlington								
Total Population in study area:	6910	6910	6910	6910	6910	6910	6910	6910
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-35	-35	-35	-35	-35	-35	-35	-35
Population weighted Δx (µg/m^3):	-0.00506512	-0.00506512	-0.00506512	-0.00506512	-0.00506512	-0.00506512	-0.00506512	-0.00506512
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999971	0.999996	0.999998	0.999995	0.999934	0.999995	0.999990	0.999993
Attributable fraction (AF):	-2.9E-05	-4.1E-06	-2.1E-06	-4.8E-06	-6.6E-05	-4.9E-06	-9.6E-06	-7.5E-06
Increased number of cases in population:	-0.0012	-0.00021	-0.000047	-0.00015	-0.00108	-0.000038	-0.000027	-0.000037
Risk:	-3.0E-07	-3.7E-07	-8.3E-08	-2.2E-08	-2.7E-07	-5.6E-09	-4.0E-09	-9.1E-08
Waterloo - Beaconsfield								
Total Population in study area:	25904	25904	25904	25904	25904	25904	25904	25904
% population in assessment age-group:	58%	8%	8%	100%	58%	100%	100%	6%
total change	-2330	-2330	-2330	-2330	-2330	-2330	-2330	-2330
Population weighted Δx (µg/m^3):	-0.08994750	-0.08994750	-0.08994750	-0.08994750	-0.08994750	-0.08994750	-0.08994750	-0.08994750
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	453.8	412.0	113.2	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00454	0.00412	0.00113	0.00041	0.01209
Relative Risk:	0.999478	0.999928	0.999963	0.999915	0.998831	0.999913	0.999829	0.999867
Attributable fraction (AF):	-5.2E-04	-7.2E-05	-3.7E-05	-8.5E-05	-1.2E-03	-8.7E-05	-1.7E-04	-1.3E-04
Increased number of cases in population:	-0.0799	-0.01412	-0.00312	-0.00994	-0.0719	-0.00256	-0.00183	-0.002460
Risk:	-5.4E-06	-6.6E-06	-1.5E-06	-3.8E-07	-4.8E-06	-9.9E-08	-7.1E-08	-1.6E-06
Canterbury LGA								
Total Population in study area:	12648	12648	12648	12648	12648	12648	12648	12648
% population in assessment age-group:	58%	14%	14%	100%	58%	100%	100%	19%
total change	-95.30	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3	-95.3
Population weighted Δx (µg/m^3):	-0.00753479	-0.00753479	-0.00753479	-0.00753479	-0.00753479	-0.00753479	-0.00753479	-0.00753479
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	508.3	412.0	143.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00508	0.00412	0.00144	0.00041	0.01209
Relative Risk:	0.999956	0.999994	0.999997	0.999993	0.999902	0.999993	0.999986	0.999989
Attributable fraction (AF):	-4.4E-05	-6.0E-06	-3.1E-06	-7.1E-06	-9.8E-05	-7.3E-06	-1.4E-05	-1.1E-05
Increased number of cases in population:	-0.0033	-0.00098	-0.00022	-0.00046	-0.0030	-0.00013	-0.000075	-0.00033
Risk:	-4.5E-07	-5.6E-07	-1.2E-07	-3.6E-08	-4.0E-07	-1.0E-08	-5.9E-09	-1.3E-07
Individual subrubs within LGA								
Canterbury (South) - Campsie								
Total Population in study area:	149	149	149	149	149	149	149	149
% population in assessment age-group:	58%	14%	14%	100%	58%	100%	100%	19%
total change	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65	-0.65
Population weighted Δx (µg/m^3):	-0.00436242	-0.00436242	-0.00436242	-0.00436242	-0.00436242	-0.00436242	-0.00436242	-0.00436242
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	508.3	412.0	143.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00508	0.00412	0.00144	0.00041	0.01209
Relative Risk:	0.999975	0.999997	0.999998	0.999996	0.999943	0.999996	0.999992	0.999994
Attributable fraction (AF):	-2.5E-05	-3.5E-06	-1.8E-06	-4.1E-06	-5.7E-05	-4.2E-06	-8.3E-06	-6.5E-06
Increased number of cases in population:	-0.0000226	-0.0000067	-0.0000015	-0.0000031	-0.0000203	-0.0000009	-0.0000005	-0.0000022
Risk:	-2.6E-07	-3.2E-07	-7.1E-08	-2.1E-08	-2.3E-07	-6.1E-09	-3.4E-09	-7.8E-08
Kingsgrove (North) - Earlwood								
Total Population in study area:	12499	12499	12499	12499	12499	12499	12499	12499
% population in assessment age-group:	58%	14%	14%	100%	58%	100%	100%	19%
total change	-94.7	-94.7	-94.7	-94.7	-94.7	-94.7	-94.7	-94.7
Population weighted Δx (µg/m^3):	-0.00757661	-0.00757661	-0.00757661	-0.00757661	-0.00757661	-0.00757661	-0.00757661	-0.00757661
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	508.3	412.0	143.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00508	0.00412	0.00144	0.00041	0.01209
Relative Risk:	0.999956	0.999994	0.999997	0.999993	0.999902	0.999993	0.999986	0.999989
Attributable fraction (AF):	-4.4E-05	-6.1E-06	-3.1E-06	-7.1E-06	-9.9E-05	-7.3E-06	-1.4E-05	-1.1E-05
Increased number of cases in population:	-0.00329	-0.000973	-0.000215	-0.000452	-0.00296	-0.0001319	-0.0000743	-0.000325
Risk:	-4.5E-07	-5.6E-07	-1.2E-07	-3.6E-08	-4.1E-07	-1.1E-08	-5.9E-09	-1.4E-07
Botany LGA								
Total Population in study area:	46677	46677	46677	46677	46677	46677	46677	46677
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-5726	-5726	-5726	-5726	-5726	-5726	-5726	-5726
Population weighted Δx (µg/m^3):	-0.12267284	-0.12267284	-0.12267284	-0.12267284	-0.12267284	-0.12267284	-0.12267284	-0.12267284
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999289	0.999902	0.999950	0.999885	0.998407	0.999881	0.999767	0.999818
Attributable fraction (AF):	-7.1E-04	-9.8E-05	-5.0E-05	-1.2E-04	-1.6E-03	-1.2E-04	-2.3E-04	-1.8E-04
Increased number of cases in population:	-0.20	-0.055	-0.012	-0.030	-0.18	-0.007	-0.0045	-0.016
Risk:	-7.3E-06	-9.1E-06	-2.0E-06	-6.5E-07	-6.6E-06	-1.6E-07	-9.6E-08	-2.2E-06

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Individual subrubs within LGA								
Banksmeadow								
Total Population in study area:	21	21	21	21	21	21	21	21
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1
Population weighted Δx (µg/m^3):	-0.05238095	-0.05238095	-0.05238095	-0.05238095	-0.05238095	-0.05238095	-0.05238095	-0.05238095
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999696	0.999958	0.999979	0.999951	0.999319	0.999949	0.999900	0.999922
Attributable fraction (AF):	-3.0E-04	-4.2E-05	-2.1E-05	-4.9E-05	-6.8E-04	-5.1E-05	-1.0E-04	-7.8E-05
Increased number of cases in population:	-0.000039	-0.0000106	-0.0000023	-0.0000058	-0.000035	-0.0000014	-0.00000086	-0.0000031
Risk:	-3.1E-06	-3.9E-06	-8.5E-07	-2.8E-07	-2.8E-06	-6.8E-08	-4.1E-08	-9.4E-07
Botany								
Total Population in study area:	10780	10780	10780	10780	10780	10780	10780	10780
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-500	-500	-500	-500	-500	-500	-500	-500
Population weighted Δx (µg/m^3):	-0.04638219	-0.04638219	-0.04638219	-0.04638219	-0.04638219	-0.04638219	-0.04638219	-0.04638219
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999731	0.999963	0.999981	0.999956	0.999397	0.999955	0.999912	0.999931
Attributable fraction (AF):	-2.7E-04	-3.7E-05	-1.9E-05	-4.4E-05	-6.0E-04	-4.5E-05	-8.8E-05	-6.9E-05
Increased number of cases in population:	-0.0178	-0.0048	-0.00106	-0.0026	-0.0160	-0.00065	-0.00039	-0.0014
Risk:	-2.8E-06	-3.4E-06	-7.6E-07	-2.4E-07	-2.5E-06	-6.0E-08	-3.6E-08	-8.3E-07
Mascot - Eastlakes								
Total Population in study area:	24409	24409	24409	24409	24409	24409	24409	24409
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-5011	-5011	-5011	-5011	-5011	-5011	-5011	-5011
Population weighted Δx (µg/m^3):	-0.20529313	-0.20529313	-0.20529313	-0.20529313	-0.20529313	-0.20529313	-0.20529313	-0.20529313
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.998810	0.999836	0.999916	0.999807	0.997335	0.999801	0.999610	0.999696
Attributable fraction (AF):	-1.2E-03	-1.6E-04	-8.4E-05	-1.9E-04	-2.7E-03	-2.0E-04	-3.9E-04	-3.0E-04
Increased number of cases in population:	-0.1784	-0.0481	-0.0106	-0.0264	-0.1607	-0.0065	-0.0039	-0.0141
Risk:	-1.2E-05	-1.5E-05	-3.3E-06	-1.1E-06	-1.1E-05	-2.7E-07	-1.6E-07	-3.7E-06
Pagewood - Hillsdale - Daceyville								
Total Population in study area:	11400	11400	11400	11400	11400	11400	11400	11400
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-314	-314	-314	-314	-314	-314	-314	-314
Population weighted Δx (µg/m^3):	-0.02754386	-0.02754386	-0.02754386	-0.02754386	-0.02754386	-0.02754386	-0.02754386	-0.02754386
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999840	0.999978	0.999989	0.999974	0.999642	0.999973	0.999948	0.999959
Attributable fraction (AF):	-1.6E-04	-2.2E-05	-1.1E-05	-2.6E-05	-3.6E-04	-2.7E-05	-5.2E-05	-4.1E-05
Increased number of cases in population:	-0.01117	-0.00302	-0.000666	-0.001652	-0.010059	-0.000408	-0.0002464	-0.000882
Risk:	-1.6E-06	-2.0E-06	-4.5E-07	-1.4E-07	-1.5E-06	-3.6E-08	-2.2E-08	-4.9E-07
Port Botany Industrial								
Total Population in study area:	6	6	6	6	6	6	6	6
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
Population weighted Δx (µg/m^3):	-0.05000000	-0.05000000	-0.05000000	-0.05000000	-0.05000000	-0.05000000	-0.05000000	-0.05000000
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999710	0.999960	0.999980	0.999953	0.999350	0.999952	0.999905	0.999926
Attributable fraction (AF):	-2.9E-04	-4.0E-05	-2.1E-05	-4.7E-05	-6.5E-04	-4.9E-05	-9.5E-05	-7.4E-05
Increased number of cases in population:	-0.000011	-0.0000029	-0.00000064	-0.0000016	-0.000010	-0.00000039	-0.00000024	-0.00000084
Risk:	-3.0E-06	-3.7E-06	-8.2E-07	-2.6E-07	-2.7E-06	-6.5E-08	-3.9E-08	-8.9E-07
Sydney Airport								
Total Population in study area:	61	61	61	61	61	61	61	61
% population in assessment age-group:	60%	13%	13%	100%	60%	100%	100%	16%
total change	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22
Population weighted Δx (µg/m^3):	-0.00360656	-0.00360656	-0.00360656	-0.00360656	-0.00360656	-0.00360656	-0.00360656	-0.00360656
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	559.7	412.0	133.8	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00560	0.00412	0.00134	0.00041	0.01209
Relative Risk:	0.999979	0.999997	0.999999	0.999997	0.999953	0.999997	0.999993	0.999995
Attributable fraction (AF):	-2.1E-05	-2.9E-06	-1.5E-06	-3.4E-06	-4.7E-05	-3.5E-06	-6.9E-06	-5.3E-06
Increased number of cases in population:	-0.000008	-0.000002	-0.0000005	-0.000001	-0.000007	-0.0000003	-0.0000002	-0.0000006
Risk:	-2.1E-07	-2.7E-07	-5.9E-08	-1.9E-08	-1.9E-07	-4.7E-09	-2.8E-09	-6.5E-08
Kogarah - Rockdale LGA								
Total Population in study area:	102876	102876	102876	102876	102876	102876	102876	102876
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-465.0	-465	-465	-465	-465	-465	-465	-465
Population weighted Δx (µg/m^3):	-0.00452000	-0.00452000	-0.00452000	-0.00452000	-0.00452000	-0.00452000	-0.00452000	-0.00452000
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999974	0.999996	0.999998	0.999996	0.999941	0.999996	0.999991	0.999993
Attributable fraction (AF):	-2.6E-05	-3.6E-06	-1.9E-06	-4.2E-06	-5.9E-05	-4.4E-06	-8.6E-06	-6.7E-06
Increased number of cases in population:	-0.017	-0.0053	-0.0012	-0.0021	-0.015	-0.00063	-0.00036	-0.0012
Risk:	-2.7E-07	-3.3E-07	-7.4E-08	-2.1E-08	-2.4E-07	-6.2E-09	-3.5E-09	-8.1E-08
Individual subrubs within LGA								
Arncliffe - Bardwell Park								
Total Population in study area:	21457	21457	21457	21457	21457	21457	21457	21457
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-554.8	-554.8	-554.8	-554.8	-554.8	-554.8	-554.8	-554.8
Population weighted Δx (µg/m^3):	-0.02585636	-0.02585636	-0.02585636	-0.02585636	-0.02585636	-0.02585636	-0.02585636	-0.02585636
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999850	0.999979	0.999989	0.999976	0.999664	0.999975	0.999951	0.999962
Attributable fraction (AF):	-1.5E-04	-2.1E-05	-1.1E-05	-2.4E-05	-3.4E-04	-2.5E-05	-4.9E-05	-3.8E-05
Increased number of cases in population:	-0.0203	-0.0063	-0.00138	-0.00255	-0.0183	-0.00076	-0.00044	-0.00145
Risk:	-1.5E-06	-1.9E-06	-4.2E-07	-1.2E-07	-1.4E-06	-3.5E-08	-2.0E-08	-4.6E-07
Bexley								
Total Population in study area:	20419	20419	20419	20419	20419	20419	20419	20419

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-73	-73	-73	-73	-73	-73	-73	-73
Population weighted Δx (µg/m^3):	-0.00357510	-0.00357510	-0.00357510	-0.00357510	-0.00357510	-0.00357510	-0.00357510	-0.00357510
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999979	0.999997	0.999999	0.999997	0.999954	0.999997	0.999993	0.999995
Attributable fraction (AF):	-2.1E-05	-2.9E-06	-1.5E-06	-3.4E-06	-4.6E-05	-3.5E-06	-6.8E-06	-5.3E-06
Increased number of cases in population:	-0.0027	-0.0008	-0.00018	-0.00034	-0.0024	-0.000100	-0.000057	-0.00019
Risk:	-2.1E-07	-2.6E-07	-5.8E-08	-1.6E-08	-1.9E-07	-4.9E-09	-2.8E-09	-6.4E-08
Kingsgrove (South) - Bardwell Park								
Total Population in study area:	2879	2879	2879	2879	2879	2879	2879	2879
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5	-12.5
Population weighted Δx (µg/m^3):	-0.00434179	-0.00434179	-0.00434179	-0.00434179	-0.00434179	-0.00434179	-0.00434179	-0.00434179
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999975	0.999997	0.999998	0.999996	0.999944	0.999996	0.999992	0.999994
Attributable fraction (AF):	-2.5E-05	-3.5E-06	-1.8E-06	-4.1E-06	-5.6E-05	-4.2E-06	-8.2E-06	-6.4E-06
Increased number of cases in population:	-0.00046	-0.000141	-0.000031	-0.000057	-0.00041	-0.0000170	-0.0000098	-0.000033
Risk:	-2.6E-07	-3.2E-07	-7.1E-08	-2.0E-08	-2.3E-07	-5.9E-09	-3.4E-09	-7.8E-08
Kogarah								
Total Population in study area:	11323	11323	11323	11323	11323	11323	11323	11323
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	395.4	395.4	395.4	395.4	395.4	395.4	395.4	395.4
Population weighted Δx (µg/m^3):	0.03492007	0.03492007	0.03492007	0.03492007	0.03492007	0.03492007	0.03492007	0.03492007
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000203	1.000028	1.000014	1.000033	1.000454	1.000034	1.000066	1.000052
Attributable fraction (AF):	2.0E-04	2.8E-05	1.4E-05	3.3E-05	4.5E-04	3.4E-05	6.6E-05	5.2E-05
Increased number of cases in population:	0.014	0.0045	0.0010	0.0018	0.013	0.00054	0.00031	0.0010
Risk:	2.1E-06	2.6E-06	5.7E-07	1.6E-07	1.9E-06	4.8E-08	2.7E-08	6.2E-07
Kogarah Bay								
Total Population in study area:	10788	10788	10788	10788	10788	10788	10788	10788
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Population weighted Δx (µg/m^3):	0.00208565	0.00208565	0.00208565	0.00208565	0.00208565	0.00208565	0.00208565	0.00208565
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000012	1.000002	1.000001	1.000002	1.000027	1.000002	1.000004	1.000003
Attributable fraction (AF):	1.2E-05	1.7E-06	8.6E-07	2.0E-06	2.7E-05	2.0E-06	4.0E-06	3.1E-06
Increased number of cases in population:	0.00082	0.00025	0.000056	0.00010	0.00074	0.000031	0.000018	0.000059
Risk:	1.2E-07	1.5E-07	3.4E-08	9.6E-09	1.1E-07	2.8E-09	1.6E-09	3.7E-08
Monterey - Brighton-le-Sands - Kyeemagh								
Total Population in study area:	13915	13915	13915	13915	13915	13915	13915	13915
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	155.7	155.7	155.7	155.7	155.7	155.7	155.7	155.7
Population weighted Δx (µg/m^3):	0.01118936	0.01118936	0.01118936	0.01118936	0.01118936	0.01118936	0.01118936	0.01118936
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	1.000065	1.000009	1.000005	1.000011	1.000145	1.000011	1.000021	1.000017
Attributable fraction (AF):	6.5E-05	9.0E-06	4.6E-06	1.1E-05	1.5E-04	1.1E-05	2.1E-05	1.7E-05
Increased number of cases in population:	0.0057	0.0018	0.00039	0.00071	0.0051	0.00021	0.00012	0.00041
Risk:	6.7E-07	8.3E-07	1.8E-07	5.1E-08	6.0E-07	1.5E-08	8.8E-09	2.0E-07
Rockdale - Banksia								
Total Population in study area:	19957	19957	19957	19957	19957	19957	19957	19957
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-64.3	-64.3	-64.3	-64.3	-64.3	-64.3	-64.3	-64.3
Population weighted Δx (µg/m^3):	-0.00322193	-0.00322193	-0.00322193	-0.00322193	-0.00322193	-0.00322193	-0.00322193	-0.00322193
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999981	0.999997	0.999999	0.999997	0.999958	0.999997	0.999994	0.999995
Attributable fraction (AF):	-1.9E-05	-2.6E-06	-1.3E-06	-3.0E-06	-4.2E-05	-3.1E-06	-6.1E-06	-4.8E-06
Increased number of cases in population:	-0.002	-0.0007	-0.00016	-0.0003	-0.0021	-0.00009	-0.00005	-0.00017
Risk:	-1.9E-07	-2.4E-07	-5.3E-08	-1.5E-08	-1.7E-07	-4.4E-09	-2.5E-09	-5.8E-08
Sans Souci - Ramsgate								
Total Population in study area:	2036	2036	2036	2036	2036	2036	2036	2036
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-19.7	-19.7	-19.7	-19.7	-19.7	-19.7	-19.7	-19.7
Population weighted Δx (µg/m^3):	-0.00967583	-0.00967583	-0.00967583	-0.00967583	-0.00967583	-0.00967583	-0.00967583	-0.00967583
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999944	0.999992	0.999996	0.999991	0.999874	0.999991	0.999982	0.999986
Attributable fraction (AF):	-5.6E-05	-7.7E-06	-4.0E-06	-9.1E-06	-1.3E-04	-9.4E-06	-1.8E-05	-1.4E-05
Increased number of cases in population:	-0.00072	-0.00022	-0.000049	-0.000090	-0.00065	-0.000027	-0.000015	-0.000051
Risk:	-5.8E-07	-7.1E-07	-1.6E-07	-4.4E-08	-5.2E-07	-1.3E-08	-7.6E-09	-1.7E-07
Hurstville								
Total Population in study area:	102	102	102	102	102	102	102	102
% population in assessment age-group:	62%	15%	15%	100%	62%	100%	100%	15%
total change	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6
Population weighted Δx (µg/m^3):	-0.02549020	-0.02549020	-0.02549020	-0.02549020	-0.02549020	-0.02549020	-0.02549020	-0.02549020
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	488.2	412.0	140.6	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00488	0.00412	0.00141	0.00041	0.01209
Relative Risk:	0.999852	0.999980	0.999990	0.999976	0.999669	0.999975	0.999952	0.999962
Attributable fraction (AF):	-1.5E-04	-2.0E-05	-1.0E-05	-2.4E-05	-3.3E-04	-2.5E-05	-4.8E-05	-3.8E-05
Increased number of cases in population:	-0.00010	-0.000029	-0.0000065	-0.000012	-0.000086	-0.0000035	-0.0000020	-0.0000068
Risk:	-1.5E-06	-1.9E-06	-4.2E-07	-1.2E-07	-1.4E-06	-3.5E-08	-2.0E-08	-4.6E-07
Eastern Suburbs								
Total Population in study area:	33621	33621	33621	33621	33621	33621	33621	33621
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-1518.30	-1518.3	-1518.3	-1518.3	-1518.3	-1518.3	-1518.3	-1518.3
Population weighted Δx (µg/m^3):	-0.04515928	-0.04515928	-0.04515928	-0.04515928	-0.04515928	-0.04515928	-0.04515928	-0.04515928
Baseline Incidence (per 100,000) (as per Table 4.5)	1026	9235	3978	492.2	412.0	132.3	41.3	1209.0

	Primary Indicators			Secondary Indicators				
Health Endpoint:	**Mortality - All Causes, Long-term**	**Hospitalisations - Cardiovascular, Short-term**	**Hospitalisations - Respiratory, Short-term**	**Mortality - All Causes, Short-term**	**Mortality - Cardiopulmonary, Long-term**	**Mortality - Cardiovascular, Short-term**	**Mortality - Respiratory, Short-term**	**Morbidity - Asthma ED Admissions - Short-term**
Age Group:	≥ 30 years	≥ 65 years	≥ 65 years	All ages	≥ 30 years	All ages	All ages	1-14 years
β (change in effect per 1 µg/m3 PM) (as per Table 6.17)	0.0058	0.0008	0.00041	0.00094	0.013	0.00097	0.0019	0.00148
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999738	0.999964	0.999981	0.999958	0.999413	0.999956	0.999914	0.999933
Attributable fraction (AF):	-2.6E-04	-3.6E-05	-1.9E-05	-4.2E-05	-5.9E-04	-4.4E-05	-8.6E-05	-6.7E-05
Increased number of cases in population:	-0.053	-0.015	-0.0033	-0.0070	-0.048	-0.0019	-0.0012	-0.0037
Risk:	-2.7E-06	-3.3E-06	-7.4E-07	-2.1E-07	-2.4E-06	-5.8E-08	-3.5E-08	-8.1E-07
Individual subrubs within LGA								
Kensington								
Total Population in study area:	14903	14903	14903	14903	14903	14903	14903	14903
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-704.5	-704.5	-704.5	-704.5	-704.5	-704.5	-704.5	-704.5
Population weighted Δx (µg/m^3):	-0.04727236	-0.04727236	-0.04727236	-0.04727236	-0.04727236	-0.04727236	-0.04727236	-0.04727236
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999726	0.999962	0.999981	0.999956	0.999386	0.999954	0.999910	0.999930
Attributable fraction (AF):	-2.7E-04	-3.8E-05	-1.9E-05	-4.4E-05	-6.1E-04	-4.6E-05	-9.0E-05	-7.0E-05
Increased number of cases in population:	-0.024654	-0.0069746	-0.0015397	-0.0032596	-0.022194	-0.0009041	-0.00055285	-0.0017397
Risk:	-2.8E-06	-3.5E-06	-7.7E-07	-2.2E-07	-2.5E-06	-6.1E-08	-3.7E-08	-8.5E-07
Kingsford								
Total Population in study area:	11769	11769	11769	11769	11769	11769	11769	11769
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-685.7	-685.7	-685.7	-685.7	-685.7	-685.7	-685.7	-685.7
Population weighted Δx (µg/m^3):	-0.05826323	-0.05826323	-0.05826323	-0.05826323	-0.05826323	-0.05826323	-0.05826323	-0.05826323
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999662	0.999953	0.999976	0.999945	0.999243	0.999943	0.999889	0.999914
Attributable fraction (AF):	-3.4E-04	-4.7E-05	-2.4E-05	-5.5E-05	-7.6E-04	-5.7E-05	-1.1E-04	-8.6E-05
Increased number of cases in population:	-0.02400	-0.006789	-0.001499	-0.003173	-0.02160	-0.000880	-0.0005381	-0.001693
Risk:	-3.5E-06	-4.3E-06	-9.5E-07	-2.7E-07	-3.1E-06	-7.5E-08	-4.6E-08	-1.0E-06
Malabar - La Perouse - Chiffley								
Total Population in study area:	3724	3724	3724	3724	3724	3724	3724	3724
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-28	-28	-28	-28	-28	-28	-28	-28
Population weighted Δx (µg/m^3):	-0.00751880	-0.00751880	-0.00751880	-0.00751880	-0.00751880	-0.00751880	-0.00751880	-0.00751880
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999956	0.999994	0.999997	0.999993	0.999902	0.999993	0.999986	0.999989
Attributable fraction (AF):	-4.4E-05	-6.0E-06	-3.1E-06	-7.1E-06	-9.8E-05	-7.3E-06	-1.4E-05	-1.1E-05
Increased number of cases in population:	-0.000980	-0.0002772	-0.0000612	-0.0001295	-0.000882	-0.0000359	-0.00002197	-0.0000691
Risk:	-4.5E-07	-5.6E-07	-1.2E-07	-3.5E-08	-4.0E-07	-9.6E-09	-5.9E-09	-1.3E-07
Maroubra (west)								
Total Population in study area:	2951	2951	2951	2951	2951	2951	2951	2951
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-100	-100	-100	-100	-100	-100	-100	-100
Population weighted Δx (µg/m^3):	-0.03388682	-0.03388682	-0.03388682	-0.03388682	-0.03388682	-0.03388682	-0.03388682	-0.03388682
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999803	0.999973	0.999986	0.999968	0.999560	0.999967	0.999936	0.999950
Attributable fraction (AF):	-2.0E-04	-2.7E-05	-1.4E-05	-3.2E-05	-4.4E-04	-3.3E-05	-6.4E-05	-5.0E-05
Increased number of cases in population:	-0.00350	-0.000990	-0.000219	-0.000463	-0.00315	-0.000128	-0.0000785	-0.000247
Risk:	-2.0E-06	-2.5E-06	-5.5E-07	-1.6E-07	-1.8E-06	-4.3E-08	-2.7E-08	-6.1E-07
Paddington - Moore Park								
Total Population in study area:	189	189	189	189	189	189	189	189
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Population weighted Δx (µg/m^3):	0.02063492	0.02063492	0.02063492	0.02063492	0.02063492	0.02063492	0.02063492	0.02063492
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	1.000120	1.000017	1.000008	1.000019	1.000268	1.000020	1.000039	1.000031
Attributable fraction (AF):	1.2E-04	1.7E-05	8.5E-06	1.9E-05	2.7E-04	2.0E-05	3.9E-05	3.1E-05
Increased number of cases in population:	0.000136	0.0000386	0.0000085	0.0000180	0.000123	0.0000050	0.00000306	0.0000096
Risk:	1.2E-06	1.5E-06	3.4E-07	9.5E-08	1.1E-06	2.6E-08	1.6E-08	3.7E-07
Randwick (North and South)								
Total Population in study area:	85	85	85	85	85	85	85	85
% population in assessment age-group:	59%	13%	13%	100%	59%	100%	100%	14%
total change	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9
Population weighted Δx (µg/m^3):	-0.04588235	-0.04588235	-0.04588235	-0.04588235	-0.04588235	-0.04588235	-0.04588235	-0.04588235
Baseline Incidence (per 100,000) (as per Table 4.5)	1026.0	9235.0	3978.0	492.2	412.0	132.3	41.3	1209.0
Baseline Incidence (per person)	0.01026	0.09235	0.03978	0.00492	0.00412	0.00132	0.00041	0.01209
Relative Risk:	0.999734	0.999963	0.999981	0.999957	0.999404	0.999955	0.999913	0.999932
Attributable fraction (AF):	-2.7E-04	-3.7E-05	-1.9E-05	-4.3E-05	-6.0E-04	-4.5E-05	-8.7E-05	-6.8E-05
Increased number of cases in population:	-0.00014	-0.000039	-0.000009	-0.000018	-0.00012	-0.000005	-0.0000031	-0.000010
Risk:	-2.7E-06	-3.4E-06	-7.5E-07	-2.1E-07	-2.5E-06	-5.9E-08	-3.6E-08	-8.2E-07
Total population incidence - All Suburbs	**-0.40**	**-0.099**	**-0.022**	**-0.055**	**-0.36**	**-0.014**	**-0.0088**	**-0.026**

Annexure H : Uncertainties

H.1 Overview

Any assessment of health risk or health impact incorporates data and information that is associated with some level of uncertainty. In most cases, where there is uncertainty in any of the key data or inputs into an assessment of health risk or health impact, a conservative approach is adopted. This approach is adopted to ensure that the assessment presents an overestimation of potential health impacts, rather than an underestimation. It is therefore important to provide some additional information on the key areas of uncertainty for the health impact assessment to support the conclusions presented.

H.2 Exposure concentrations and noise levels

The concentration of various pollutants in air (i.e. exposure concentrations) and noise levels relevant to different locations in the community have been calculated on the basis of a range of input assumptions and modelling. Details of these are presented within the relevant technical reports.

Traffic modelling

Assessment of impacts of the project on air and noise has relied on the modelling of traffic changes (refer to *Technical Working Paper 1 – Traffic and Transport*). The traffic modelling incorporated inputs provided by the Sydney Strategic Travel Model (STM), developed and operated by Transport for NSW, and a wide range of assumptions, with the aim of providing a realistic assessment of traffic changes in the project area. The model has been calibrated and validated based on existing data from 2014.

Air quality

The air quality impact assessment (refer to *Technical Working Paper 4 - Air Quality*) incorporates information on traffic volumes and composition from the traffic model and other information on the design of the project. The air quality assessment was conducted, as far as possible, with the intention of providing 'accurate' or 'realistic' estimates of pollutant emissions and concentrations. The estimation of air concentrations within the community utilises air dispersion models that are approved by the NSW EPA as suitable for providing estimates of air quality from ventilation facilities and surface road traffic. The modelling incorporates information on the local area such as terrain, meteorology and measured existing air quality.

Evaluation of the air modelling undertaken was detailed in *Technical Working Paper 4 - Air Quality*. This involved use of the model to predict concentrations in 2016 at 11 monitoring stations, with comparison of these results against measured data from these locations. This assessment determined that the modelling of NO_x overestimated concentrations by 35 to 140 per cent. For near road monitoring stations the modelling of NO_x provided a reasonable correlation with measured data, with the exception of weekends where modelled concentrations were overestimated. This is due to the assumption that weekday traffic volumes occur 7 days per week, not only on weekdays.

Further, Section 6.2.2.3 of *Technical Working Paper 4 - Air Quality* provides further discussion on the assumptions adopted in the air quality modelling and implications for conservatism.

Noise assessment

The noise impact assessment (refer to *Technical Working Paper 2 - Noise and Vibration* incorporates information on traffic volumes and composition from the traffic model and other information on the design of the project. The modelling also incorporates measured background noise levels and a range of inputs and assumptions in relation to noise generated from the project.

For the assessment of construction noise, it has been assumed that all plant/equipment for each scenario at all locations is operating continuously at the same time. This is unlikely to occur and would have overestimated construction noise impacts.

The model used in the assessment was validated based on existing information and traffic information for 2018. The modelling undertaken showed that the noise model slightly overpredicts noise levels (by

a median level of 0.9 dB during the daytime and night-time periods). The degree of overprediction the model observed is noted to be generally consistent with experience on previous projects.

The characterisation of health effects associated with changes in noise has been undertaken using the maximum changes in noise during any one day. The noise exposure-response relationships adopted in this assessment relate to annual average changes in noise (at any one location). The use of the daily maximum change in noise is expected to overestimate health impacts derived from noise (in particular localised impacts).

H.3 Approach to the assessment of risk for particulates

The available scientific information provides a sufficient basis for determining that exposure to particulate matter (particularly $PM_{2.5}$ and smaller) is associated with adverse health effects in a population. The data is insufficient to provide a thorough understanding of all of the potential toxic properties of particulates to which humans may be exposed. Over time it is expected that many of the current uncertainties would be refined with the collection of additional data, but some uncertainty would be inherent in any estimate. The influence of the uncertainties may be either positive or negative.

Overall, the epidemiological and toxicological data on which the assessment presented in this report are based on current and robust information for the assessment of risks to human health associated with the potential exposure to particulate matter from combustion sources.

Exposure-response functions

The choice of exposure-response functions for the quantification of potential health impacts is important. For mortality health endpoints, many of the exposure-mortality functions have been replicated throughout the world. While many of these have shown consistent outcomes, the calculated relative risk estimates for these studies do vary. This is illustrated by **Figures 10.1 to 10.3** that show the variability in the relative risk estimates calculated in published studies for the US (and Canadian) population that are relevant to the primary health endpoints considered in this assessment (USEPA 2012). A similar variability is observed where additional studies from Europe, Asia and Australia/New Zealand are considered.

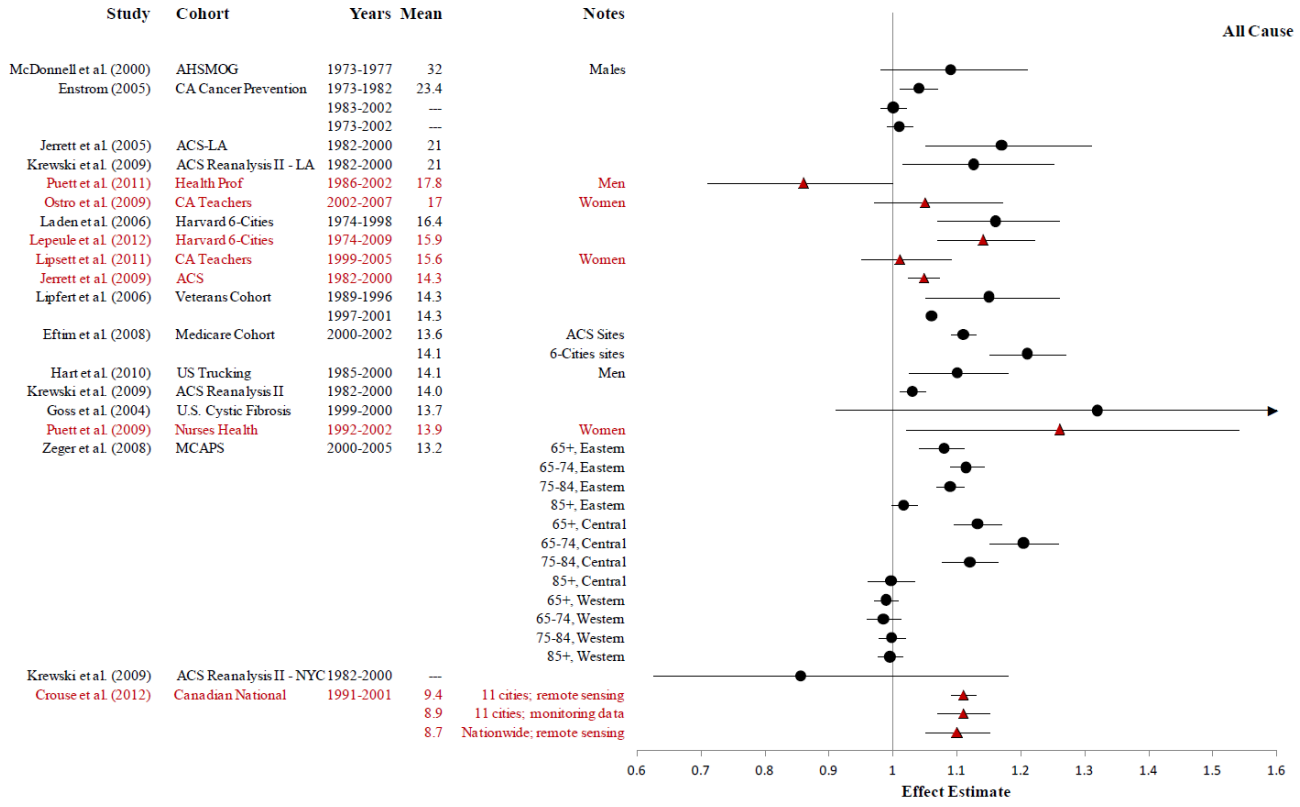

Figure H.1: All-cause mortality relative risk estimates for long-term exposure to $PM_{2.5}$ (USEPA 2012, note studies in red are those completed since 2009)

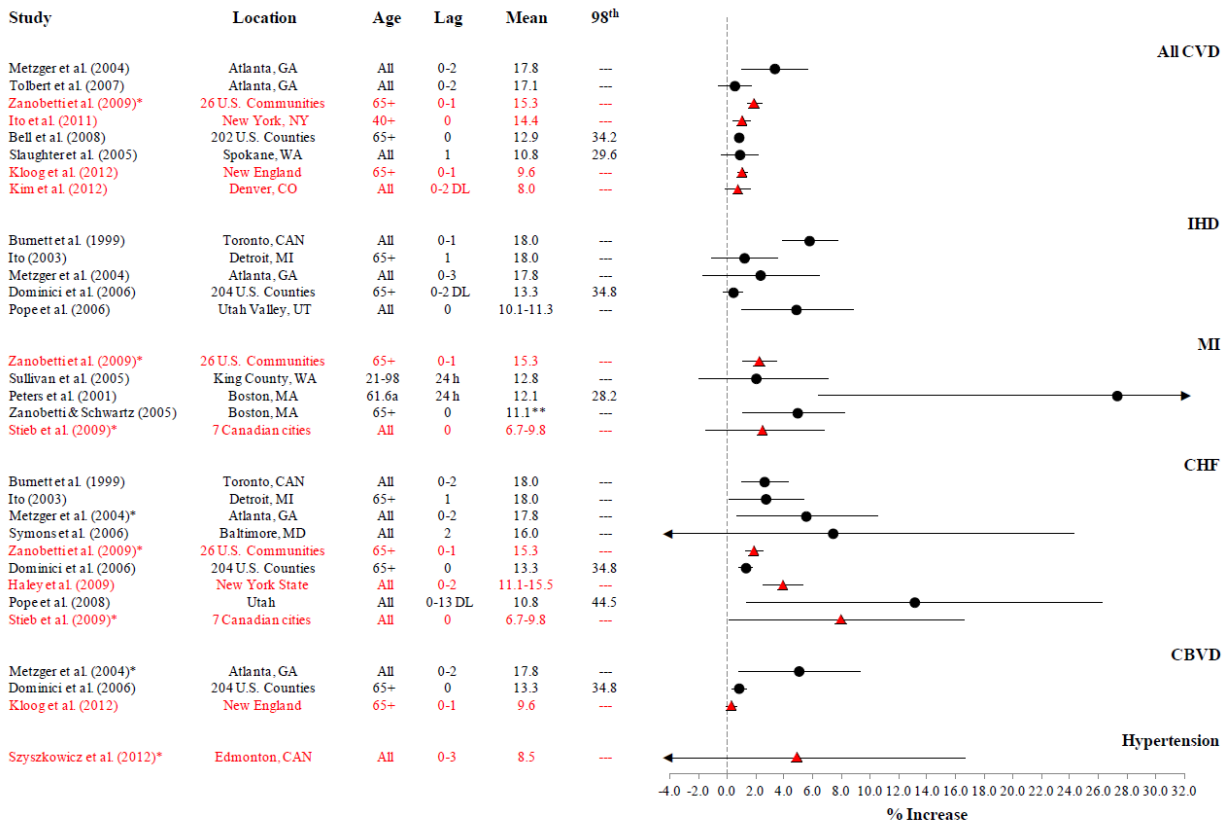

Figure Error! No text of specified style in document.**.2: Per cent increase in cardiovascular-related hospital admissions for a 10 microgram per cubic metre increase in short-term (24-hour average) exposure to $PM_{2.5}$ (USEPA 2012, note studies in red are those completed since 2009)**

(note: CVD = cardiovascular disease; IHD = ischemic heart disease; MI = myocardial infarction; CHF = congestive heart failure; CBVD = cerebrovascular disease)

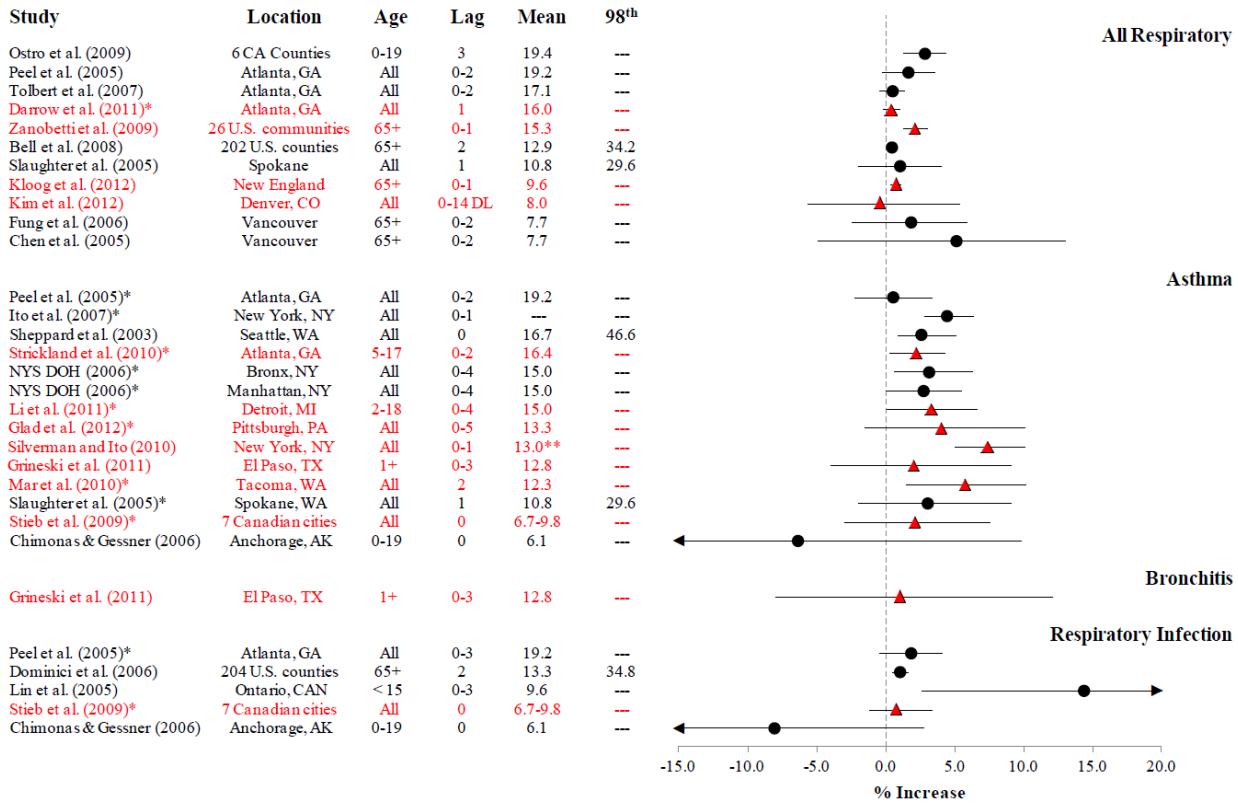

Figure H.3: Per cent increase in respiratory-related hospital admissions for a 10 micrograms per cubic metre increase in short-term (24-hour average) exposure to $PM_{2.5}$ (USEPA 2012, note studies in red are those completed since 2009)

These figures illustrate the variability inherent in the studies used to estimate exposure-response functions. The variability is expected to reflect the local and regional variability in the characteristics of particulate matter to which the population is exposed.

Based on the available data, and the detailed reviews undertaken by organisations such as the USEPA (USEPA 2010, 2012) and WHO (WHO 2003, 2006a, 2006b) and NEPC (NEPC 2016), the adopted exposure-response estimates are considered to be current, robust and relevant to the characterisation of impacts from $PM_{2.5}$.

Shape of exposure-response function

The shape of the exposure-response function and whether there is a threshold for some of the effects endpoints remains an uncertainty. Reviews of the currently available data (that includes studies that show effects at low concentrations) have not shown evidence of a threshold. However, as these conclusions are based on epidemiological studies, discerning the characteristics of the particulates responsible for these effects and the observed shape of the dose-response relationship is complex. For example, it is not possible to determine if the observed no threshold response is relevant to exposure to particulates from all sources, or whether it relates to particulates from combustion sources only.

Most studies have demonstrated a linear relationship between relative risk and ambient concentration however for long-term exposure-related mortality a log-linear relationship is more plausible and should be considered where there is the potential for exposure to very high concentrations of pollution. In this assessment, the impact considered is a localised impact with low level incremental increases in concentration. At low levels the assumption of a linear relationship is considered appropriate.

Diesel particulate matter evaluation

The assessment of exposure to diesel particulate matter has assumed that 100 per cent of the $PM_{2.5}$ associated with the project is derived from diesel sources. This is considered to be a conservative assumption.

The health hazard conclusions associated with exposure to diesel particulate matter are based on studies that are dominated by exhaust emissions from diesel engines built prior to the mid-1990s. With current engine use including some new and many older engines (engines typically stay in service for a long time), the health hazard conclusions, in general, are likely to be applicable to engines currently in use.

However as new and cleaner diesel engines, together with different diesel fuels, replace a substantial number of existing engines; the general applicability of the health hazard conclusions may require further evaluation. The NEPC (NEPC 2009) has established a program to reduce diesel emissions from the Australian heavy vehicle fleet. This is expected to lower the potential for all diesel emissions over time.

An increase in the number of vehicle kilometres travelled (more than estimated in the traffic modelling) may limit the benefits of cleaner diesel vehicles.

H.4 Approach to the assessment of risk for noise

The association between exposure to noise and adverse health effects is well documented and there are a number of robust studies available to characterise these effects. A number of relationships adopted in this assessment come from research where data from a number of studies have been combined. The available studies that are used to determine these relationships often utilise different measures of noise levels (differing between covering average day and evening or day evening and night) and different methods for measuring the disease end-points. This results in the use of some conservative assumptions when combining these data.

Many of the available studies relate to health effects in males, or include populations that are predominantly male. The reported outcomes of these studies have been assumed to equally apply to females.

H.5 Co-pollutants and co-exposures

For the assessment of nitrogen dioxide, particulates and noise, the exposure-response relationships used in this assessment are based on large epidemiology studies where exposures have occurred in urban areas. These exposures do not relate to only one pollutant or exposures (noise) but a mix of these, and others including occupational and smoking. While many of the studies have endeavoured to correct for exposures to other pollutants and exposures, no study can fully correct for these and there would always be some level of influence from other exposures on the relationships adopted.

In relation to air quality, many of the pollutants evaluated come from a common source (e.g. fuel combustion) so the use of only particulate matter (or nitrogen dioxide) as an index for the mix of pollutants that is in urban air at the time of exposure is reasonable but conservative.

In relation to the assessment of cardiovascular effects from road traffic noise, these effects are also associated with (and occur together with) increased exposures to vehicle emissions, specifically particulate exposures.

For this reason, it is important the health risks and incidence evaluations presented for exposure to nitrogen dioxide, particulates and noise should not be added together as these effects are not necessarily additive, due to the relationships already including co-exposures to all these aspects (and others).

H.6 Selected health outcomes

The assessment of risk has utilised exposure-response functions and relative risk values that relate to the more significant health endpoints where the most significant and robust positive associations have been identified. The approach does not include all possible subsets of effects that have been considered in various published studies. However, the assessment undertaken has considered the health endpoints/outcomes that incorporate many of the subsets, and has utilised the most current and robust relationships.

H.7 Exposure time/duration

The assessment of potential exposure and risk to changes in air quality and noise levels associated with the project has assumed that all areas evaluated are residential and people may be at home for 24 hours of the day for 365 days of the year, for a lifetime. This is a conservative assumption to ensure that all members of the public are adequately addressed in the assessment of health impacts, including the elderly and those with disabilities who may not leave the home very often. As a result, the quantification of risk and health incidence is expected to be an overestimation.

H.8 Changing population size and demographics

The assessment presented has utilised information on the size of the population and distribution of the population in relevant ages from the ABS Census data from 2016. As discussed in **Section 4.3** of the report the population in the study area is projected to increase significantly by 2036. In addition, a number of the LGAs are expecting a significant increase in the proportion of the population aged 65+ years.

The increase in population size and distribution does not affect the calculation of an individual risk. The key aspect that does affect this calculation is the baseline incidence of the health effects within the population. Based on statistics from NSW Health the baseline incidence of most of the health effects evaluated in this assessment have been relatively stable or decreasing over time (with improvements in health care). Changes in the population over time are not expected to result in any increase in the calculated individual risk.

For the calculation of the change in incidence in the community, the size and distribution of the population is important. The incidence numbers calculated for the project are low and unmeasurable, and even if the population were doubled the incidence of the key health effects would remain low and unmeasurable within the community.

H.9 Baseline incidence for asthma

Some concern has been raised in the community that the baseline incidence of asthma reported in the statistics for the LGAs may not reflect more localised suburbs, or part suburbs, where the incidence of asthma may be perceived to be higher.

The calculated individual risks relevant to asthma presented in the health impact assessment have been further evaluated assuming that the baseline incidence reported for all the LGAs is double. Where this is assumed the calculated risk increases, but remains well below the unacceptable risk level of 10^{-4}.

This change in baseline incidence for asthma does not change the conclusions presented in this assessment.

H.10 Application of exposure-response functions to small populations

The exposure-response functions have been developed on the basis of epidemiological studies from large urban populations where associations have been determined between health effects (health endpoints) and changes in ambient (regional) pollutant levels (particulates or NO_2). Typically, these exposure response functions are applied to large populations for the purpose of establishing/reviewing air guidelines or reviewing potential impacts of regional air quality issues on large populations.

When applied to small populations (less than larger urban centres such as the whole of Greater Sydney) the uncertainty increases. They do not relate to specific local sources (which occur within a regional

airshed), or daily variability in exposure that may occur because of various different activities that may occur in any one day.

H.11 Overall evaluation of uncertainty

Overall the assessment of health impacts presented in this report has incorporated a range of assumptions and models that would have resulted in an overestimation of impacts. The most significant factors that result in the assessment providing conservative outcomes are as follows:

- Modelling of air quality impacts – this has included a range of conservative assumptions about the type of vehicles and the emissions to air that may come from these vehicles over time. The assessment has also utilised a model to predict ground level concentrations (i.e. concentrations in the community) that are expected to be conservative.
- Assessment of noise impacts – this has been undertaken using a largely qualitative approach, however some quantitative estimates of risk and levels of annoyance and sleep disturbance has been included. These estimates are based on modelled predicted changes in noise levels which are expected to be conservative. In addition, the assessment of health impacts has utilised the maximum daily change in noise in the community, rather than the change in annual average noise levels (which the noise exposure – response (health effects) relationships are based on). This would have overestimated the noise impacts in the community by around 3 dB(A) (potentially more).
- Community exposures – there are a number of assumptions adopted in the characterisation of exposure that would have overestimated exposure:
    - It is assumed that the maximum changes in localised air quality, regardless of where this may occur (e.g. industrial area, in a roadway, open space area or residential area), affects a resident
    - All exposures to changes in air quality and noise that occur, in all areas, assume that all residents are at home all day, every day for a lifetime, and that changes in outdoor air pollution are mirrored indoors.

The above is expected to overestimate exposures and risks in the community.

- Exposure-response – the relationships utilised in this assessment are based on the most current, robust studies that are relate to health effects from exposure to changes in nitrogen dioxide, particulates and noise. The relationships adopted come from large epidemiology studies that include a number of co-pollutants (i.e. exposure occurs to a wide range of factors not just the pollutant being evaluated) and confounding factors that can result in more conservative relationships being developed. In addition, it is assumed the relationships adopted are linear and apply to small changes in air quality or noise, at levels that would not be measurable with air monitoring or noise monitoring equipment.

H.12 References

NEPC 2009, National Environment Protection (Diesel Vehicle Emissions) Measure, NEPC Service Corporation.

NEPC 2016, National Environment Protection (Ambient Air Quality) Measure, Federal Register of Legislative Instruments F2016C00215.

USEPA 2010, Quantitative Health Risk Assessment for Particulate Matter, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency.

USEPA 2012, Provisional Assessment of Recent Studies on Health Effects of Particulate Matter Exposure, National Center for Environmental Assessment RTP Division, Office of Research and Development, U.S. Environmental Protection Agency.

WHO 2003, Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide, Report on a WHO Working Group, World Health Organisation.

WHO 2006a, WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide, Global Update, Summary of risk assessment, World Health Organisation.

WHO 2006b, Health risks or particulate matter from long-range transboundary air pollution, World Health Organisation Regional Office for Europe.

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