Department of Transport and Main Roads

Manual

Road Traffic Air Quality Management

June 2014

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Amendment Register

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Foreword

This manual sets out the obligations, goals and procedures relevant to the prediction and management of the air quality impacts of air pollutant emissions associated with state-controlled road infrastructure in Queensland.

The manual is based on what is generally considered to be best practice environmental management in other parts of Australia and the world, having due regard to existing local conditions and environmental pressures.

The goal of Transport and Main Roads' air quality management is to achieve the best possible air quality outcome for the available resources, to ensure that the community at large benefits from the infrastructure provided and that individuals are not unduly impacted. Cost effectiveness and feasibility of control measures will be important considerations.

Proactive planning will ensure that the design of new road infrastructure does not impose excessive foreseeable impacts on current and future residents or the environment, or unduly constrain future development options.

The manual will be revised as necessary to take account of new information, policies, guidelines, procedures and standards relating to issues such as climate change, energy efficiency, vehicle design, monitoring techniques and health risk assessments.

Officers responsible for the planning, design and management of road infrastructure shall seek to improve environmental outcomes by adhering to the policy, philosophy and standards contained in this manual.

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1 Overview

1.1 Framework behind the manual

1.1.1 Purpose

The Department of Transport and Main Roads has produced this manual to facilitate the understanding and management of planning, assessment, design and operational issues relating to the effects of road traffic on local air quality.

Specific objectives of this manual are as follows:

- Advise on the criteria for road traffic air quality impact assessment and planning.
- Establish consistent methodologies for the assessment of the impact of road traffic air pollutant emissions.
- Provide guidelines on an integrated design process for the inclusion of air quality considerations so that social, economic, visual, safety, community and environmental factors are not compromised.
- Establish good environmental management practices to reduce the impact of road air pollutant emissions.
- Identify technical issues to be considered in managing the effect of road air pollutant emissions.
- Demonstrate performance of Transport and Main Roads' General Environmental Duty by establishing and implementing good environmental management practices as required by the *Environmental Protection Act 1994* and *Environmental Protection (Air) Policy 2008* (EPP Air).

1.1.2 Transport and Main Roads' strategic documents

Transport and Main Roads' endeavours to establish good environmental management practices are reflected in key Transport and Main Roads' policies and strategies, which include the following:

- Transport and Main Roads – Roads Connecting Queenslanders
- Transport and Main Roads Strategic Plan
- Environmental Management Policy and Strategy
- Roads Policy Manual
- Road System Manager, and
- Road Project Environmental Management Processes Manual.

1.1.3 Legislative framework

Where required by legislation, Transport and Main Roads' road projects with potentially significant road air quality effects may be subject to external assessment processes. There are six acts and three pieces of subordinate legislation which have potential to affect the environmental assessment and approval processes for a Transport and Main Roads' road project from an air quality perspective as follows:

- *State Development and Public Works Organisation Act 1971* (*State*)
- *Sustainable Planning Act 2009* (*State*)

- *Environmental Protection Act 1994* (State)
- *Environmental Protection (Air) Policy 2008 (Subordinate Legislation) (State)*
- *Environmental Protection Regulation 2008 (Subordinate Legislation) (State)*
- *National Environment Protection Council (Queensland) Act 1994 (State)*
- *National Environment Protection Council Act 1994 (Commonwealth)*
- *National Environment Protection (Ambient Air Quality) Measure 1998 (Commonwealth)*
- *Australian Land Transport Development Act 1988 (Commonwealth)*

The latest version/updates/amendments of the legislation/subordinate legislation, shall always be applicable.

This manual is based on the above legislative framework to ensure that air quality impacts of activities associated with the construction and operation of state-controlled roads are within appropriate criteria at all nearby sensitive receptors.

1.1.4 Other departmental air quality initiatives

The Department of Transport and Main Roads actively supports requirements for cleaner and more efficient vehicles, reviews the relevance of Australian Design Rules (ADRs) and encourages the review of in-service enforcement of vehicle standards. It is responsible for a smoky vehicle program and its inspectors manage smoky vehicle assessment and the free On-road Vehicle Emissions Random Testing program. The department also promotes integrated land use and transport planning.

1.1.5 Development of the manual

Transport and Main Roads has been active in considering the impact of road infrastructure on the community. Formal procedures were developed for road transport related noise, but a systematic approach to air quality assessments has, until recently, not been considered necessary.

Environmental legislation (such as the *Environmental Protection Act*) and subordinate legislation (such as the *Environmental Protection (Air) Policy*) have in the past been considered in the assessment of new road construction projects, although their main intent is to control industrial emissions.

With the continued growth of traffic volumes, the need to sometimes widen roads in residential areas, the emergence of issues such as tunnel emissions and the Transport and Main Roads goal of continual improvement, a need has arisen for a formal manual that will make the assessment and management of air quality more transparent and consistent.

1.1.6 Role of stakeholders

Transport and Main Roads is only one of many stakeholders responsible for the management of the impact of road traffic air quality. However, it plays a major role in transportation planning and road design, with air quality management being part of the successful delivery of road infrastructure projects.

Traffic and travel demand management of all classes of vehicles is another contribution by Transport and Main Roads, in co-operation with local government and other state departments, to minimise air quality impacts. With new advancements in technology, Transport and Main Roads also encourages research into methods for improvement of air quality emissions from individual vehicles.

There are several other important stakeholders including the following:

Department of Local Government, Community Recovery and Resilience (DLGCRR) and Department of State Development, Infrastructure and Planning (DSDIP)

DLGCRR and DSDIP are responsible for integrating state policy objectives in local and regional land use planning processes. The Sustainable Planning Act 2009 formalises this process.

Transport and Main Roads advises DLGCRR, DSDIP and local governments on road transport issues with respect to land use planning and development. Transport and Main Roads may act as an ‘advice agency’ for developments sited contiguous to state-controlled roads. As an advice agency, Transport and Main Roads may recommend conditions for air quality improvement that can be applied to developers through land-use development applications.

Department of Environmental and Heritage Protection (DEHP)

The Queensland Department of Environmental and Heritage Protection has a role in cleaner fuel standards (for example, removal of lead additives and reducing sulphur in diesel) together with the Commonwealth government. DEHP conducts regional air quality monitoring and is responsible for the administration of the Environmental Protection Act 1994 and the Environmental Protection (Air) Policy 2008.

Local Government

Local governments’ responsibilities include the following:

- advice to developers prior to development applications being determined
- air quality management through local laws and land use planning, and
- ensuring that development proposals consider air quality exposure.

The community

The community is responsible for the following:

- the provision of input to Transport and Main Roads policy development
- compliance with the requirements of the *Transport Operations (Road Use Management – Vehicle Standards and Safety) Regulation 1999*
- ensuring vehicles are kept in good mechanical condition, and
- proposing land uses that consider road traffic air quality.

1.1.7 Transport and Main Roads environmental management document series

This manual is one of a series of manuals published by Transport and Main Roads. These manuals provide guidance on good environmental management practices for a wide range of issues associated with road infrastructure projects. Other manuals include the following.

- Road Project Environmental Processes Manual
- Road Landscape Manual
- Historical Cultural Heritage Manual
- Roads in the Wet Tropics
- Fauna Sensitive Road Design
- Environmental Legislation Register, and

- Road Transport Noise Management Code of Practice

Some of these manuals should be used in conjunction with this manual (particularly the Road Project Environmental Processes Manual and the Environmental Legislation Register).

1.1.8 Limitations in applicability of the manual

Due to legislative, economic and technical constraints, there are a number of areas where Transport and Main Roads will not be able to implement this manual, including financial compensation to affected members of the community, unless compulsory land acquisition (resumption) is involved. Any compensation of this nature would then be in accordance with the *Acquisition of Land Act 1967*.

In exceptional circumstances, the cost of a mechanical ventilation system/air-conditioning system may be considered. Transport and Main Roads will not contribute to the running/maintenance costs of the systems. These will be the responsibility of the persons/institution concerned.

While it would be highly desirable for this manual to be fully implemented, its application will be subject to the individual funding levels of Transport and Main Roads Regions and their works program.

In addition, while Transport and Main Roads is required to embrace the concept of General Environmental Duty from a road traffic air quality perspective, there will be instances where air quality control measures may not be implemented.

Criteria for the implementation of air quality management measures in particular instances are determined by:

- Technical feasibility (an engineering consideration - what can be practically constructed and operated)
- Reasonableness (implies a common sense and good judgement approach to arriving at a decision). The reasonableness criterion includes the following:
  - cost effectiveness of measures
  - absolute air quality level
  - change in air quality level
  - air quality benefits
  - efficacy of air pollution mitigation measures
  - opinions of affected residents (community engagement)
  - input from local and public agencies
  - social, economic, environmental, legal and technical factors
  - date of development beside road, and
  - length of occupancy.

Within a 10 year period following completion of a new air quality sensitive development under the Integrated Development Assessment System (IDAS) framework, Transport and Main Roads will generally not consider the effect of road traffic air quality upon that particular development. This is because air quality issues should have been addressed by the developer. A new air quality sensitive development becomes an existing development 10 years after the development’s completion and final sign off by the assessment manager.

Transport and Main Roads will generally not act on any complaint with respect to the impact of road traffic on air quality from residents or occupants who have lived in/owned a particular air quality sensitive development (contiguous with a state-controlled road) for less than 10 years. Action will be considered if it can be shown that there has been a substantial increase in road traffic air pollutant levels, the magnitude of the increase being equal to or greater than 70% the criteria levels provided in this manual, over a time interval of less than 10 years.

1.2 Guide to use of the manual

1.2.1 Structure of the manual

The management of the effect of road traffic on air quality is outlined in this manual within the following parts.

Chapter 2 Description of Road Traffic Air Quality describes how road traffic affects air quality. It details the factors contributing to the generation and movement of air pollutants. It highlights the most important of these factors in relation to the following parts of this manual and other related policies (for example, *Environmental Protection (Air) Policy 2008*).

Chapter 3 Categories and Criteria provides guidance on the categories and criteria for road traffic air quality management. It focuses on the following situations:

- new road
- upgrading existing roads, and
- existing roads with no roadworks.

(Refer to Glossary for definitions)

Chapter 4 Management and Assessment outlines the type and specific requirements of assessment where the Regional Director deems such assessment necessary. To ensure compliance with the criteria listed in Chapter 3, the assessment process specified in Chapter 4 must be followed.

The chapter specifies the requirements of a Regional Road Traffic Air Quality Management Strategy and a Road Traffic Air Quality Assessment. Chapter 4 also identifies a range of controls for air impact mitigation.

The information provided in Chapter 4 should be relevant to Regional Directors, road planners, road design teams, project managers, air quality consultants and land developers.

Chapter 5 Proposed Air Quality Sensitive Development provides guiding principles to adopt when considering the following issues:

- assessment and report requirements
- air quality management strategies
- land use issues
- implementation of planning controls.

These issues should be considered during the formulation of the Road Traffic Air Quality Assessment. Chapter 5 of the manual is aimed at land use developers to provide guidance in planning, assessment and the implementation of planning controls.

Chapter 6 Construction Air Quality provides advice for those involved in the management and administration of construction activities about how daily activities should be planned, managed and monitored to ensure that air quality is not unnecessarily compromised.

Chapter 7 Managing Air Quality Complaints provides guidelines for the mechanisms and timelines that will be adopted by Transport and Main Roads to ensure that valid complaints are appropriately assessed and the concerns of affected parties are addressed in a timely manner.

Legislation and Bibliography provide references to relevant legislation and sources of information on which the manual is based.

Appendices Appendix A: Modelling Examples, Appendix B: Tunnels, Appendix C: Climate Change Impact Assessment and Appendix D: Assessment of Potential Air Quality Impacts of Busway Projects provide detailed guidance on specific issues.

1.2.2 Departmental management framework

There are three levels of road management in Australia: Federal, State and Local Governments. As part of overall road management, Transport and Main Roads manages the network of state-controlled roads. These state-controlled roads are of national, regional or local importance to the community.

State-controlled roads are generally considered ‘beneficial assets’ for the whole community because of the many services that they supply or enhance.

Despite the concept of ‘beneficial asset’, Transport and Main Roads acknowledges its obligation to consider the amenity of affected property owners.

Community amenity may be improved through appropriate management and planning of new and existing state-controlled roads and land use planning.

There are two alternative approaches to the management of road traffic air quality:

- Regional Road Traffic Air Quality Management Strategy, for existing roads, and
- Project Environmental Assessment for proposed new and upgraded existing roads.

These approaches provide input to the management of the impact of road traffic on air quality.

1.2.2.1 Regional Road Traffic Air Quality Management Strategy

The Regional Road Traffic Air Quality Management Strategy identifies the priorities in the assessment of the impact of road traffic on air quality for existing roads.

The Region may choose for their strategy to cover all state-controlled roads, or only those roads with high traffic volumes or a high proportion of air quality-sensitive sites.

The approach provides Regions with a method to manage and plan for the impact of road traffic on air quality both now and in the future.

Chapter 4 of this manual specifies the requirements of a Regional Road Traffic Air Quality Management Strategy.

1.2.2.2 Project Environmental Assessment (PEA)

The purpose of a PEA is to identify, describe and assess the environmental advantages, disadvantages and constraints associated with new and upgraded road projects.

This process identifies air quality-affected communities and may recommend a Road Traffic Air Quality Assessment be undertaken. The reporting of a PEA would be via a Review of Environmental Factors (REF), an Environmental Impact Statement in an Environmental Approval Report (refer to the Road Project Environmental Processes Manual).

The purpose of a Road Traffic Air Quality Assessment is to:

- determine the existing air quality, local meteorology and landscape environment
- predict the air quality effect of the proposal
- recommend a range or combination of possible air quality mitigation measures
- evaluate total greenhouse impacts of major projects
- recommend strategies to minimise total environmental costs
- provide advice on the integration of air quality mitigation measures, and
- integrate the above issues to produce a design that conforms with good environmental management practice.

Chapter 4 of this manual provides guidance for the undertaking of Road Traffic Air Quality Assessments.

1.2.2.3 Road Implementation Program (RIP)

Out of the above approaches, the Regions will determine a works program for inclusion in the RIP. The PEA (REF) for a road project may generate the need for a detailed Road Traffic Air Quality Assessment.

1.2.3 Proposed new development

Chapter 5 of this manual provides guidance on the appropriate criteria for proposed new development affected by state-controlled roads.

As an advice agency, Transport and Main Roads will review the likely primary impacts of road traffic air emissions on proposed developments.

2 Description of Roadside Air Quality

2.1 Definition of air quality

Air quality is a measure of the purity of the atmosphere, in terms of the quantity of solid, liquid or gaseous air pollutants. The impacts of these pollutants tend to be localised near major sources or groups of sources, since pollutants are continually removed from the atmosphere by processes such as gravitational deposition, rainfall, chemical reaction and solution in water bodies.

2.2 Pollutant impacts

Effects of air pollutants can include human health impacts (short term and long term), irritation, nuisance (for example, soiling of surfaces from deposited dust or increased corrosion rates), aesthetics (light scattering, visual range, haze) and flora and fauna impacts.

The guidelines provided in the *Environmental Protection (Air) Policy 2008* (EPP (Air)) are aimed to protect and enhance:

- the qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems
- the qualities of the air environment that are conducive to human health and wellbeing
- the qualities of the air environment that are conducive to protecting the aesthetics of the environment, including the appearance of buildings, structures and other property, and
- the qualities of the air environment that are conducive to protecting agricultural use of the environment.

2.3 Factors influencing air quality impact

Human direct physical responses to air pollutants, as with most human responses to environmental factors, are highly variable. For a given exposure, it is difficult to predict the response of any individual. At high exposures, there are usually some individuals who show minimal effects. By way of contrast, at low exposures, there may be some individuals who are highly sensitive.

In addition to direct physical impacts, perception or psychological factors also can play an important role. A component of each person's perception of acceptable air quality is subjective, not objective.

2.4 Limitations of criteria

The criterion levels contained within this manual are based on guidelines that are to some extent a compromise, taking account of the range of sensitivities of individuals to air pollutants.

The criteria in the EPP (Air) are based on those from the *National Environment Protection (Ambient Air Quality) Measure 1998* (NEPM), which were designed to protect communities of typically 25,000 persons from excessive exposure to air pollutants. Performance monitoring stations under the National Environment Protection Protocol must be located in a manner such that they contribute to obtaining a representative measure of the air quality likely to be experienced by the general population in the region or subregion.

Performance against the NEPM/EPP criteria is be taken to be characterised by measurements of background levels several hundred metres from roads or major pollutant sources. It could be argued that the NEPM criteria were not devised with consideration of pollution levels near major roads or road construction activities in mind and that the objectives of the NEPM are broadly achieved if general pollutant levels over a region do not exceed the NEPM criteria. The aim of the NEPM in relation to $PM_{2.5}$ was only to gather sufficient data to facilitate a review of the Advisory Reporting Standards, but the criterion for $PM_{2.5}$ has been included in the EPP.

2.5 Application of criteria

The criteria from the EPP (Air) are not point source emission standards. They are taken to be applicable to ambient concentrations at sensitive locations. For the purpose of planning road operations, they are considered by this manual to only apply to residences, educational, community, health or passive recreation facilities at a distance of at least 20 m from the edge of a road.

As well as compliance with environmental criteria, the decision making process should also take into account the total environmental costs, the cost implications for Transport and Main Roads, the technical feasibility of achieving criterion levels and the reasonableness of providing relevant control measures.

For construction activities, the variability of meteorological conditions and operational activities is extremely difficult to anticipate. For this reason, the manual recommends that construction environmental management be based on proven effective control measures applied according to an approved Environmental Management Plan, supported by monitoring in representative locations.

For short-term construction impacts, the criteria should be considered more as a measure of the effectiveness of environmental management strategies rather than a strict licensing requirement. Rapid feedback from monitoring and rapid response to complaints should ensure that pollutant levels are well below the criteria for much of the time and that any exceedence is rapidly investigated and corrected.

2.6 Influences on air pollutant generation, dispersion and movement

The concentration of a particular pollutant at a given location is related to its rate of generation, the motions of the air into which it is emitted and the physical and chemical processes that occur as it travels from source to receptor.

Generation refers to the creation of air pollutants by a source. Traffic air pollutant emissions are the aggregation of the emissions from individual vehicles in the traffic stream.

Traffic emissions are generally modelled as a line source. Point sources are a more appropriate representation of emissions from fixed plant such as construction equipment or tunnel ventilation stacks.

The principal factors upon which the generation of traffic air pollution depends are:

- traffic volume
- average traffic speed (usually represented by the posted speed limit)
- traffic composition (the percentage of heavy vehicles)
- road gradient (the longitudinal slope of the road)
- driving conditions (free-flowing, congested)
- individual vehicle emissions, and
- driver behaviour and vehicle operating conditions.
- Individual vehicle emissions are a combination of emissions produced by:

- the engine
- the fuel system
- the braking system, and
- materials from the road surface disturbed by the wheels and by air movement around the vehicle.
- Driver behaviour and vehicle operating conditions include many components including:
- air conditioner use
- braking and acceleration patterns
- gear operations
- emission reduction technology
- maintenance
- ageing
- fuel quality, and
- ambient temperature.
- The movement and dispersion of air pollutants are influenced by a number of factors including:
- road configuration (whether the road layout is at grade, depressed or elevated)
- distance between the source and reception point
- meteorological conditions (primarily wind speed, wind direction and atmospheric stability)
- type of intervening ground cover between source and reception point (surface roughness affects the wind speed profile and the potential for entrainment of particles), and
- the existence of natural or artificial obstructions.

2.7 Significant air pollutants

2.7.1 Criteria pollutants

The main parameters that have been traditionally used for the assessment of the air quality impact of traffic are as follows:

- concentration of air pollutants in µg/m3 (or ppm or ppb for gases). The substances of greatest relevance are:
  - Carbon monoxide (CO)
  - Nitrogen dioxide (NO_2)
  - Sulfur dioxide (SO_2)
  - Hydrocarbons (often represented by benzene C_6H_6)
  - Ozone (O_3)
  - Respirable particulates (PM_{10}, particulate matter less than 10 microns (µm) in equivalent aerodynamic diameter), and

   – Fine particulates ($PM_{2.5}$)

- particulate deposition rates – the fallout rate of insoluble dust measured in g/m^2/month or mg/m^2/day. This parameter is most useful as an indicator of nuisance during construction.

2.7.2 $PM_{2.5}$

Fine particulates ($PM_{2.5}$), particulate matter less than 2.5 µm (2.5 x 10^{-6}m) in equivalent aerodynamic diameter, are believed to be responsible for most of the health effects of traffic air pollution. Advisory reporting standards only are currently listed in the National Environment Protection (Ambient Air Quality) Measure. The NEPM guideline has been incorporated into the EPP, but is not clear how exceedences of the guideline will be managed. It is not clear how the impacts of transport related pollutants differ from other sources e.g. soil.

2.7.3 Greenhouse gases

Carbon dioxide and water are the major products of fuel combustion. Until recently, neither substance has generally been considered a pollutant because both are non-toxic and produce minimal local impacts.

Both are greenhouse gases, although water is rapidly incorporated into the hydrological cycle and hence anthropogenic emissions of water are expected to cause little impact. The atmospheric lifetime of carbon dioxide is significant and its global warming impacts are now considered in greenhouse assessments (generally also together with other substances emitted in low concentrations, such as nitrous oxide and methane) that are now required as part of major highway impact studies.

Such studies generally compare the total change in global warming potential emissions for traffic carried by the road network incorporating a proposed project in comparison with traffic on the existing road network (usually expressed in tonnes per annum of CO_2 equivalent emissions).

2.7.4 Other pollutants

This section describes air pollutants that:

- have traditionally been considered relevant to motor vehicle impacts but are no longer an issue because of reductions in emissions
- are a regional or global issue and are often not considered explicitly in terms of roadside air quality, or
- are a potential issue for the future, but not considered significant for current traffic levels.

2.7.4.1 Lead

Transport related lead emissions from substances such as tetraethyl lead (formally added to fuel as an octane enhancer) were an issue in the past, but are no longer considered to be significant as a result of fuel quality legislation.

2.7.4.2 Ozone

Ozone is generated by photochemical reactions over a period of minutes to hours. Over this period, the wind will carry pollutants for a distance of several kilometres to tens of kilometres. Hence ozone is a regional issue.

In high concentrations, ozone can cause irritation and accelerate the aging of some materials. Its overall impact is little affected by emissions from individual roads. In fact, nitric oxide emitted from vehicles into the immediate vicinity of roads can react with ozone and depress local ozone levels.

The design and construction of individual roads generally reflects, in the short term, a redistribution of traffic and hence of regional pollutant emissions rather than a step increase. As total regional pollutant emissions represent the cumulative contributions from all roads, ozone is not considered to be a useful indicator of roadside air quality.

2.7.4.3 Air toxics

Air toxics such as polycyclic aromatic hydrocarbons, dioxins, diesel exhaust and soot are emerging issues. The impacts of air toxics associated with vehicle emissions are under review and they may be included in later versions of the manual.

2.7.4.4 Ultrafines

Ultrafine particulates (less than 0.1 micron in diameter) are a health issue that is currently being researched. Diesel fuel combustion produces significant quantities of ultrafines that can readily be breathed into the lungs and can be difficult for the body to eliminate. Petrol combustion produces a lesser amount of ultrafine particles with different properties.

Ultrafines are normally emitted simultaneously with larger particles and in proportion to the emissions of PM_{10}. Studies have yet to establish criteria that quantify the impacts of ultrafines. Criteria may be based on number density, concentration, composition, state, combinations of these parameters or other factors. As an emerging issue, ultrafines may be included in later versions of the manual.

2.7.5 Averaging time and frequency of exposure

The exposure of an individual to air pollutants is influenced by both the concentration of the substances and the duration of the exposure. Some substances have a rapid impact at high concentrations (for example, nitrogen dioxide can cause eye irritation and coughing) and others have a more chronic impact which may occur at quite low concentrations (for example, benzene may cause cancer).

Some substances can cause both short-term and long-term impacts by different mechanisms and hence different threshold levels for the substance are relevant to the various averaging times. Thus guidelines for a particular pollutant are generally specified in terms of concentration and averaging time (sometimes with an allowable frequency of exceedence to account for the variability of atmospheric processes).

Short term impacts are generally covered by guidelines for averaging times of one to 24 hours and long term impacts by guidelines for averaging times of up to one year.

3 Categories and Criteria

3.1 Introduction

The purpose of Chapter 3 is to specify the Transport and Main Roads road air quality performance criteria and where they are to be applied.

Categories describe the road project as:

- a new road
- an upgrade of an existing road, or
- an existing road with no roadworks.

All criteria for the consideration of air pollutant mitigation strategies shall be assessed against predicted or measured levels. Chapter 4 details the process by which actual or predicted levels are assessed against these criteria.

In general, criteria can be advisory, flexible or fixed as shown in Table 3.1.1 which compares the advantages and disadvantages of these three approaches.

Transport and Main Roads chooses to use criteria utilising a fixed pollutant concentrations when considering the implementation of air pollutant mitigation strategies. It may not always be possible to achieve the criteria in all circumstances.

The criteria listed below represent a compromise between the need to improve local amenity and the technical/cost constraints in providing air quality management controls.

Transport and Main Roads will determine the work schedule for installing such controls depending on budget, the total roadwork program and other considerations.

The Regional Road Air Quality Management Strategy will also serve as an important reference document in this process.

Chapter 4 of this manual outlines the methodology behind the Regional Road Air Quality Management Strategy.

Table 3.1.1 Comparison of approaches

Approach	Comment	Disadvantages	Advantages
Advisory	Exceeding the criteria is tolerated on a case-by-case basis whenever compliance is undesirable, impractical, not feasible or not cost effective.	• Relatively ineffective • Low level of control by relevant authorities.	• No need to check compliance, as exceeding the criteria is tolerated • Low impact on infrastructure budgets when policy implemented • Low costs for management, as exceeding the criteria is tolerated

Approach	Comment	Disadvantages	Advantages
Flexible	Criteria are set relatively low, but can be adjusted upwards on a case-by case basis if compliance with base criteria is impractical.	• Relatively complex to implement and manage policy.	• Ensures that air pollution impacts must be considered in all situations involving significant air quality impact • Allows costs to be managed • Allows negative impacts of air quality control measures to be managed
Fixed	Criteria must be complied with.	• Pressure to set high criteria • May lead to high costs • May lead to excessively expensive control methods with associated impacts	• Relatively simple to monitor compliance • Maintains consistency of standards • Establishes criteria up front in order to manage expectations

3.2 Limitation on use of categories and criteria

There are a number of situations where the ability to meet the criteria for the applicable category may be limited, including:

- areas impacted by emissions from non transport-related sources
- areas where sensitive land uses are already inappropriately sited near busy roads, and
- the immediate vicinity of tunnel portals and stacks, particularly at elevated locations.

In cases of compulsory land acquisition, each air pollutant sensitive site will need to be considered on an individual basis. Section 25(3)(c) of the *Transport Planning and Coordination Act 1994* provides the Chief Executive of Transport and Main Roads with the power to acquire land for the purpose of ameliorating negative environmental effects associated with transport infrastructure.

3.3 Guideline levels

Road planning should aim to achieve the levels listed below at existing or proposed sensitive locations at a distance of 20 metres or greater from the edge of the nearest traffic lane. The concentration levels are to be achieved for normal road operations when emissions from the road are added to the 90th percentile background level of the pollutant.

Exceedence of the levels may trigger a review, but not necessarily remedial action. For example, high particulate levels may occur in a region during bushfires or dust storms, or locally when construction or agricultural activities take place near a road and have the potential to impact on sensitive locations or when mud or dirt is spilled on the road.

Assessment of the impact of high levels of air pollutants should take into account the full circumstances of the exposure. Short-term exposure to high air pollutant levels will normally be more acceptable during construction because of the limited duration of such impacts compared to operational impacts.

A summary of air pollutant guideline levels that should not be exceeded at sensitive locations for the criteria pollutants identified in Section 2 is provided below in Table 3.3.1.

Exposure of pedestrians and cyclists is not considered in this manual because the duration of their exposure to air pollutants is generally shorter than the averaging times referenced in health criteria.

Where possible, infrastructure for pedestrians and cyclists should be situated to minimise air pollutant exposure, bearing in mind the sometimes conflicting constraints of economics, travel time, convenience and efficiency. Occasional sections featuring grade separation and increased separation distance can give respite from peak exposure.

Table 3.3.1 Criteria air pollutant guideline levels

Air Quality Indicator	**Air Quality Guideline**			
	micrograms per m^3 (except where noted)	**parts per million (except where noted)**	**Averaging time**	**Source[A]**
Ambient levels				
Nitrogen dioxide	62	0.03	1 yr	EPP
	250	0.12	1 hr	EPP
Sulfur dioxide	570	0.2	1 hr	EPP
	230	0.08	24 hr	EPP
	57	0.02	1 yr	EPP
Particles (as TSP)	90 (construction)	n/a	1 yr	EPP
Particles (as PM_{10})	50[B] (operation)	n/a	24 hr	EPP
Particles (as $PM_{2.5}$)	25 (operation)	n/a	24 hr	EPP
	8 (operation)	n/a	1 yr	EPP
Insoluble dust deposition	4 g/m^2/month (construction)	n/a	1 month	DEHP
Carbon monoxide	11,000	9	8 hr	EPP
Benzene	10	0.0003	1 yr	EPP
Tunnel levels				
Carbon monoxide	112,500	100	15 min	PIARC
Nitrogen dioxide	2,054	1	15 min	PIARC
Visibility – extinction coefficient K[C]	7 x 10^{-3} (m^{-1})	n/a	1 min	PIARC

Note A: EPP Queensland Environmental Protection (Air) Policy (2008)
DEHP Queensland Department of Environment and Heritage Protection informal dust deposition guideline
PIARC World Road Association – Technical Committee on Road Tunnels Operation C5 (2004)

Note B: Level not to be exceeded more than five times per year

Note C: This is equivalent to a smoke concentration which will absorb 50% of a beam of light in 100 meters. The intensity *I* is related to distance *x* and the constant *K* by: $dI/dx = -K\,x$ or $I = I0e^{-Kx}$

3.4 Planning levels

The process of undertaking an Air Quality Assessment is summarised in Chapter 4.3. For planning purposes, concentration or deposition levels that are 60% of the guideline levels specified in Table 3.3.1 (including a 90th percentile background) should generally be used in the assessment of development applications, to allow for potential inaccuracies in the dispersion modelling process (Katestone, 2005).

The background level is taken to be the level exceeded for 90% of the time at a local representative location 200 m or more from major roads (>10,000 vpd) for averaging times up to 24 hours.

For pollutants where criteria averaging times greater than 24 hours are specified, annual average concentrations established over a period of at least one year should be used as background. Where possible, the statistical variability of annual averages should be considered.

Where proponents consider that planning levels other than those described above are appropriate or when requested by the Regional Director or assessment manager, an uncertainty analysis of the modelling process should be undertaken.

3.5 Categories and criteria: existing residences

3.5.1 Category 1: New road

This will apply to cases of new roads:

- in proposed or existing unused corridors adjacent to existing residences, and
- in proposed corridors where formal approval by a local government or other statutory authority for adjacent land development is current at the date of compulsory land acquisition, even if the development is not yet in existence.

The manual considers the predicted level at a sensitive location at a distance of at least 20 m from the edge of the nearest traffic lane of a criteria pollutant emitted by traffic on a new state-controlled road within the 10 year traffic planning horizon following the completion date of construction.

When the predicted level is predicted to be greater than 80% of guideline levels (including a 90th percentile background for averaging times of up to one day), management measures for air pollutants will be considered with the aim of reducing levels to 80% of guideline levels.

Slightly higher criteria are adopted for new roads than for assessment of development applications that could result in the construction of new sensitive receptors because it is expected that studies for new roads will be more detailed and hence more accurate.

If no sensitive receptors are located within 20 m of the proposed new road, it may be permissible to relax the above criterion in some circumstances.

If sensitive receivers that would experience levels greater than the criteria level from vehicle emissions associated with a state-controlled road are present at the time of construction, consideration will be given to the acquisition of the affected land.

Pollution levels at residences less than 20 m from the new road are to be considered on a case-by-case basis.

3.5.2 Category 2: Upgrading existing roads

Slightly higher criteria are adopted for new roads than for existing roads because it is expected that information about existing roads will be more accurate than for new roads and because there is generally less opportunity to install mitigation measures for existing roads.

3.5.2.1 Subcategory 1

When the air pollutant levels associated with criteria air pollutant emissions from a state-controlled road at a sensitive location at a distance of 20 m or more from the nearest traffic lane within the 10 year horizon following upgrading is predicted to be:

- greater than the guideline levels, and
- an increase of more than 20% over existing levels,

then management measures for air emissions will be considered with the aim of ensuring pollutant levels at sensitive locations will be reduced to below 90% of guideline levels.

3.5.2.2 Subcategory 2

When the air pollutant levels associated with criteria air pollutant emissions from a state-controlled road at a sensitive location at a distance of 20 m or more from the nearest traffic lane within the 10 year horizon following upgrading is predicted to be:

- greater than the guideline levels, and
- an increase of 20% or less over existing levels,

then management measures for air emissions will be considered with the aim of ensuring pollutant levels at sensitive locations will be reduced to below guideline levels.

3.5.3 Category 3: Existing roads - no roadworks

3.5.3.1 Subcategory 1

When the air pollutant levels associated with criteria air pollutant emissions from a state-controlled road at a sensitive location at a distance of 20 m or more from the nearest traffic lane within the 10 year horizon from the assessment date is:

- greater than the guideline levels, and
- an increase of more than 20% over existing levels,

then, management measures for air emissions will be considered with the aim of ensuring pollutant levels at sensitive locations will be reduced to below 90% of guideline levels.

3.5.3.2 Subcategory 2

When the air pollutant levels associated with criteria air pollutant emissions from a state-controlled road at a sensitive location at a distance of 20 m or more from the nearest traffic lane are:

- greater than the guideline levels, and
- an increase of 20% or less over existing levels,

then, management measures for air emissions will be considered with the aim of ensuring pollutant levels at sensitive locations will be reduced to below guideline levels.

Preferential consideration will be given to treatment in cases where there is a sudden increase in traffic volumes or a high percentage of heavy vehicles.

The actual priority will be determined as an outcome of a Regional Road Air Quality Management Strategy.

3.6 Rationale and criteria: outdoor educational and passive recreational areas (including parks)

The recommended maximum air pollutant level for criteria pollutants for outdoor educational and passive recreational areas (including parks) are the guideline levels (measured or predicted, including background) over a 10 year horizon.

All cases are to be determined on a case-by-case basis, taking into consideration the full circumstances surrounding the provision and future use of the outdoor educational or passive recreational areas. For example, in large areas of open space, only a small percentage may be affected by high air pollutant levels. Moreover, there is often scope to locate activities away from the influence of air pollution.

However, Transport and Main Roads recognises that, in some situations, it will be desirable to provide some protection for these areas. This is best resolved by consultation with local government and community groups. The location of the assessment site should reflect the above issues.

3.7 Rationale and criteria: exceptional circumstances

When exceptional circumstances prevail, air pollution management measures may be considered outside the road reserve for individual dwellings at the discretion of the Regional Director.

The range of possible management measures will be determined by the predicted air pollutant levels outside the ventilation openings of façade(s) of habitable room(s) within a 10 year horizon and based on sustainable development principles such as equity, energy efficiency and economics as follows:

- Where predicted outdoor air pollutant levels do not exceed the criterion level, no treatment of the dwelling will be offered.
- Where predicted outdoor air pollutant levels exceed the criterion level by less than 20%, provide mechanical ventilation complying with AS 1668.2 (2002) so that windows facing the road can remain closed to reduce the level of air pollutants entering habitable rooms.
- Where predicted outdoor air pollutant levels exceed the criterion level by 20% or greater, provide air-conditioning and mechanical ventilation so that windows can remain closed to reduce the level of air pollutants entering habitable rooms.

Air-conditioners with HEPA filters can significantly reduce the levels of solid particles, but have negligible influence on gaseous pollutants. Ventilation inlets should be situated as far as possible from the air pollutant source.

4 Management and Assessment

4.1 Introduction

Project managers, road design teams, land developers and consultants must comply with the requirements of this chapter to ensure that a consistent and comprehensive approach is applied when addressing roadside air quality.

This development of air quality management measures can be initiated:

- by recommendations for the conduct of a project environmental assessment for a new or upgraded proposal
- by recommendations from a Regional Road Traffic Air Quality Management Strategy, or
- in response to an enquiry or development approval condition.
- The contents and methodology of a Regional Road Traffic Air Quality Management Strategy are outlined in Section 4.2.

Requirements that must be addressed in a Road Traffic Air Quality Assessment are specified in Section 4.3 and should form the basis of the preferred strategy for air quality management measures. Section 4.3 also identifies a range of measures for air pollutant management.

4.2 Regional Road Traffic Air Quality Management Strategy

Queensland is experiencing an increase in population and development. This has caused a significant increase in traffic volumes and a subsequent increase in vehicle air pollutant emissions.

Traffic on state-controlled roads under the jurisdiction of Transport and Main Roads is a significant source of air pollutants in urban as well as some rural areas (mainly through regional transport processes).

A Regional Road Traffic Air Quality Management Strategy (RRTAQMS) will align with the requirements outlined in the policy document Transport and Main Roads - Connecting Queenslanders by helping to realise Transport and Main Roads' vision for a road system that enhances the social, cultural, economic and environmental well being of Queensland communities.

The strategy will provide a means for Transport and Main Roads to implement the recommendations of the South East Queensland Regional Air Quality Strategy and South East Queensland Regional Plan 2005-2026 under which air quality is addressed in *Desired Regional Objective 2 Natural Environment's policy 2.3 Atmosphere.*

A RRTAQMS may be prepared for all state-controlled roads or for a selected number within a Region. The study area for such a RRTAQMS will be at the discretion of the Regional Director and will be dependent on the type of land uses adjoining the state-controlled roads.

The department quantifies the current and future air quality adjacent to state-controlled roads within a Region by applying a suitable predication methodology (as described later in this Chapter).

The predicted roadside air quality levels are to be representative of current and expected future traffic volumes on these roads and are to be expressed in terms of the relevant criteria described in Chapter 3 of this manual for 'Existing roads – no roadworks'.

The principal outcome of the strategy is to identify priorities for air quality management and recommend that Road Traffic Air Quality Assessments be carried out where required. The criteria for these priorities are set out in Chapter 3 of this manual.

The proposed works program of each Region should reflect these priorities. The implementation of these priorities may be subject to social, technical, works priority and cost considerations. Works may be integrated into the Transport and Main Roads' Roads Implementation Program (RIP).

When determining priorities for air quality management measures, the following should be considered:

- traffic composition and volumes
- vehicle speeds
- road gradients
- congestion
- air movement and dispersion conditions
- predicted air quality
- receptors relative to each road link, and
- development approval conditions.

The key factors determining these priorities will be the predicted air quality levels and the number of affected sensitive receptors.

As part of the strategy, data shall be presented on plans for each road link showing land uses, predicted pollutant levels, the location of any air quality management measurements and any other data considered relevant.

It is recommended that a Regional Road Traffic Air Quality Management Strategy be revised every five years.

4.2.1 Purpose of strategy

A Region may have implemented a works program, which has resulted in road traffic air quality assessments being undertaken and air quality management measures being implemented.

In cases where road upgrades are imminent, priorities determined in a RRTAQMS may be subject to change with the provision of air quality management measures being considered as part of the overall planning and design process.

The purpose of a RRTAQMS is to achieve the following objectives:

- To assist a Region in working towards achieving the department's obligations with respect to its 'general environmental duty' under the *Environmental Protection Act 1994* and its associated policies related to road traffic air quality.
- To assist a Region in the planning of future upgrading of existing access-controlled roads.
- To identify likely road traffic air quality impacted areas with respect to the current and projected road traffic conditions (10 year horizon).
- To provide an estimate of the number of residences likely to be affected by levels of road traffic air pollutants above the departmental criteria resulting from traffic travelling on state-controlled roads under the jurisdiction of a Region.

- To provide road traffic air quality levels/air pollutant contours for state-controlled roads under the jurisdiction of a Region to allow presentation in ARMIS GIS format.
- To assist a Region to prioritise air quality management measures for areas identified as air quality affected according to the number of residences affected, the cost of the proposed management measures, duration of exposure and level of exposure to air pollutant levels above the criteria levels in accordance with this manual.
- To propose applicable air quality management measures and estimates of costs for the measures that will achieve the criteria levels stated in this manual.
- To assist in the preparation of an appropriate implementation strategy that meets the department's obligations to provide air quality management measures in accordance with this manual.

4.2.2 Scope of strategy

The study area for a RRTAQMS is limited to areas adjacent to (within 300 m of) state-controlled roads under the jurisdiction of a Region.

The RRTAQMS study does not include areas where current Regional construction projects including air quality management measures are underway or where funds have been committed in the Roads Implementation Program (RIP) for these construction projects. The road traffic air quality exposure in these areas will be addressed on a project-by-project basis.

The most important issue is to identify potential air pollution problems areas as a consequence of current and likely future road traffic, and to prioritise those areas requiring air quality management measures, based on the air quality criteria contained in this manual.

To determine a priority rating for the provision of air quality management measures in air pollution affected areas, the following parameters shall be considered as a minimum:

- the duration and level of exposure to road traffic air quality levels comparable to the departmental criteria levels at air pollution sensitive development
- the provision of existing management measures
- the number of residences affected by road traffic air pollutant levels comparable to the departmental criteria levels, and
- the cost-effective, equitable and practical provision of air quality management measures.

A summary of the relative merits, advantages, disadvantages and costs for the different forms of air quality management measures under consideration shall be included.

Advice regarding land requirements and landscaping issues may be sought from relevant specialists (e.g. in terms of suitable species for buffer zones and their management, vegetation characteristics, landscaping themes, earth mound design etc.).

There is an improved community awareness of environmental issues and therefore a higher expectation that the department will commit funding to providing air quality management measures. Therefore the RRTAQMS report shall include a discussion on the community's awareness, expectations and perceptions of traffic air quality issues in relation to the prioritisation of air quality management measures.

Given that there is a finite budget for the provision of air quality management measures, the assessment process should follow a rational methodology that transparently identifies and prioritises those areas experiencing the greatest impact.

The RRTAQMS report should also make reference to appropriate conditions for development control outlining measures to minimise air pollutant impacts at new residences in accordance with this manual.

The RRTAQMS report should collate the findings of any detailed air quality studies that may have been carried out within the study area.

4.2.3 Methodology of strategy

A detailed methodology for the preparation of a RRTAQMS report shall be provided to meet the objectives identified previously.

The methodology shall address the following key issues:

4.2.3.1 Presentation of data

Air quality predictions shall be made for the criteria pollutants or others as determined to be relevant by the Regional Director. Any descriptors must be specified and should be in accordance with this manual.

Data shall be presented in tabulated or graphical form to allow ready determination of affected receptors.

In situations of complex geometry, e.g. interchanges, information should be presented in a computerised graphical manner (e.g. air pollutant concentration contours).

Land use data shall form an integral part of the presentation.

4.2.3.2 Measurement, calculation and predication of air quality levels

The study may be a combination of measurement, calculation and prediction of road traffic air pollutant levels.

If measurements are required, the measurement methodology, the location of air quality measurements, the number of measurement locations and the duration of those measurements must be specified and approved by a Region prior to any measurement programme being undertaken.

The results of any air quality measurements carried out previously shall be documented in the report and on appropriate plans. Calculation and predication of air pollutant levels shall be undertaken in accordance with this manual.

4.2.3.3 Verification of calculated air quality levels by field measurement

The methods used for calculation of air pollutant levels must be described in the RRTAQMS report. If required by the Regional Director, verification of the predictions shall be carried out using air quality measurements carried out within the study area in accordance with this manual. The measurement locations and the duration of these measurements must be documented.

Road traffic air pollutant criteria are generally expressed as maximum pollutant concentrations. Because of the inherent variability of atmospheric motions, long term monitoring is required to provide a statistically defensible estimate of air quality.

For example, to statistically define whether air quality exceeds the NEPM PM_{10} guideline of 50 µg/m³ for a 24 hour average more often than the recommended maximum of five occurrences per year would require some years of measurements. The gradual change in traffic numbers and vehicle fleet composition further complicates matters.

Because of the limited accuracy and representativity of measurements and the high costs of obtaining long-term data, measurements will generally only be required for major studies of new or existing road corridors. Measurements will generally not be required to support development applications.

Road traffic air pollutant measurements, where necessary, shall be undertaken in accordance with this manual, the Queensland EPA Air Quality Sampling Manual, Australian Standard 3580 *Methods for the Sampling and Analysis of Ambient Air* and by such methods as the Regional Director or the Road Planning and Design Branch may consider acceptable.

Minimum air quality data requirements may vary dependent on the site and current land use.

4.2.3.4 Assessment of calculated air quality

The data used to calculate and predict air quality levels in residential areas are required to be specified in the RRTAQMS report, including all assumptions made in the calculation process.

It is recommended that the assessment to calculate and predict road traffic air quality be based on actual road and traffic data for the road in question, where available.

The planning horizon to be assessed is 10 years from the completion of construction.

Pollutant concentration calculations are to be made for transverse distances of 20, 40, 60, 100, 150, 200 m from the road.

Calculations are to be made for discrete sensitive receptors where the above transverse calculations indicate concentrations greater than 80% of criteria.

In the absence of data, the following assumptions are acceptable:

- The receptor height is 1.8 m.
- The peak hourly traffic may be taken to be 10% of AADT.
- The four hour traffic volume may be taken to be 25% of AADT.
- The eight hour traffic volume may be taken to be 45% of AADT.
- The road longitudinal grade is measured, determined from plans or estimated as 2.5%, 7.5% or 12.5%, based on Table 4.2.3.4.
- The speed is the posted speed limit.

Assessments should consider the impact of road gradient on emissions. The following approach would be acceptable.

The longitudinal grade for each road link shall be categorised as ‘Level’, ‘Rolling’ or ‘Mountainous’ as described in Table 4.2.3.4. Where more than one longitudinal grade category is contained within a road link, the steepest longitudinal grade shall be used.

Table 4.2.3.4 Longitudinal grade categories

Longitudinal Grade Category	Longitudinal Road Grade	Longitudinal Grade to apply for RRTAQMS
Level	<4%	2.5%
Moderate (Rolling)	4% - 6%	5%
Steep (Mountainous)	>6%	10%

The slope categories in the second column of Table 4.2.3.4 are based on the categories used in the Brisbane City Council (BCC)/EPA emission inventories. Emissions for these categories should be based on the data from the inventories. Alternatively, if justification acceptable to the Regional Director is given, emissions for the categories in column two may be modelled by the output from an appropriate emissions model for the corresponding gradient in column three.

The BCC/Transport and Main Roads spreadsheet model described later in this chapter is currently considered an acceptable emissions model.

The Regional Director will decide on the acceptability of other models, based on any supporting documentation submitted by the compiler of the RRTAQMS. It is expected that such models will incorporate local fuel quality and vehicle fleet data.

The initial assessment may need to be undertaken in a number of stages in order to refine the calculation/prediction model with respect to a previous stage.

The predicted air quality levels will be used in conjunction with established criteria to carry out an assessment of priority for air quality management measures on a road link.

Although these assumptions are not likely to be representative in all cases, it provides a consistent approach by which an unbiased priority listing can be determined. It is however important to note that these assumptions may result in significantly higher air quality levels than may be expected in reality.

It is expected that the use of more detailed terrain and road design data will only be needed in areas that are initially identified as having a high priority, based on an initial assessment with predicted road traffic air quality levels based on flat terrain between the road and receptor.

The accuracy of estimates of the extent of air quality impacts would be improved and the cost of air quality management measures potentially reduced as a result of including detailed data.

4.2.3.5 Assessment of exposure duration for air pollutants

Various factors affect the duration of exposure of sensitive persons to air pollutants. If predicted levels approach or exceed the departmental criteria, particularly if significant numbers of persons are potentially affected, the matter of exposure duration should be addressed in the Assessment.

Such factors include:

- the location of the sensitive area in relation to the source and the frequency of relevant prevailing winds
- the timing of peak emissions (peak hour) in relation to adverse dispersion conditions and the presence of persons (e.g. school hours), and
- the sensitive land use (e.g. short-term accommodation vs long-term criteria).

It is not envisaged that there would be any need to analyse exposure in terms of work/home/recreation, as the criteria generally take this into account through conservative assumptions (e.g. continuous exposure for the entire averaging period). Such analysis would only be contemplated in the case that predicted levels exceed the criteria, to support arguments that particular persons will only be exposed to high levels for short durations.

4.2.3.6 Identification of air pollution from sources other than road traffic (e.g. industry, agriculture, rail and aircraft)

Areas that may have other sources dominating contributions from road traffic should be identified. It may be necessary to estimate the relevant contributions from each source.

4.2.3.7 Methodology for prioritisation of air quality management measures

The methodology used to determine the priority rating for the provision of air quality management measures in air quality affected areas shall be determined by consideration of the following issues:

- the duration and level of exposure of sensitive locations to road traffic air pollutant levels above the departmental criteria levels
- the number of residences (population density) in the air quality sensitive area affected by road traffic air pollutant levels above the departmental criteria levels
- the amount of control provided by any proposed air quality management measures
- the cost of providing the necessary air quality management measures, and
- the ability to provide air quality management measures in a suitable location.

The priorities for the implementation of air quality management measures will be useful in the preparation of future Roads Implementation Programs.

These priorities may need to be separated into those roads which are federally (National Highway) or state funded (other state-controlled) to be consistent with the structure of the Roads Implementation Program.

Indicative budgets shall be determined for the necessary management measures to reduce air pollutant levels to the departmental criteria levels up to the relevant planning horizon.

All indicative budgets shall be calculated based on management measures required to comply with the departmental criteria levels determined in accordance with Chapter 3 of this manual.

To determine the actual cost and technical feasibility of each measure, detailed road traffic air quality assessments are recommended. It is important to note that final decisions on issues of cost and technical feasibility of the measures proposed will be determined by the Regional Director.

4.2.3.8 Data required in an assessment

The following information will be required:

- digital topographic maps, aerial photographs, orthoimagery, photogrammetry and a digital representation of the road network for the study area, where available
- AADT traffic flow for the study area in both electronic (where available) and/or hard copy formats (traffic data to include the percentage of commercial vehicles and the signposted traffic speed) based on no change to the network at the time
- projected traffic growth rates for the Region (road specific)

- the location of existing management measures, road gradients and cross section data where available
- the base cost of all air quality management measures to be considered
- the location of current and future road works (including any proposed management measures)
- locations within the study area that are deemed unsuitable for the provision of air quality management measures
- a Region's Roads Implementation Program
- air quality studies (current and previous) carried out within the study area including EPA data
- previous air quality measurement results for the study area
- the records of relevant previous correspondence regarding air quality complaints
- meteorological data from the EPA, Bureau of Meteorology, DNRW and so on
- land use data for the Region. Only residential developments, reserves, educational institutions and public/private hospitals shall be considered in the strategy. All land use information shall be that which is current up to and including the date of release for the strategy, and
- any other information considered to be relevant to this study and not determined by a Region to be of a confidential nature.

4.2.3.9 Statistical accuracy of the measurements and calculations/predictions

The number and location of measurements will affect the usefulness and accuracy of the findings of an assessment. Conclusions based on modelling will also have a degree of uncertainty because all such calculation methods have inherent inaccuracies.

The limitations, due to assumptions, of the air quality calculation methods and how these limitations affect the calculation accuracy shall be stated in any report.

The accuracy of the methodology shall be discussed in relation to the form of output (e.g. the accuracy of locating air pollutant level contour lines).

4.2.4 Other considerations

There may be a number of current projects involving the implementation of air quality management measures within a Region. Some of these projects may have been identified in the Roads Implementation Program.

These projects may involve the construction of new measures or replacement of existing measures as a consequence of other road infrastructure projects. These projects may be at various stages of design and construction.

Roads other than access-controlled roads within a Region may be addressed in a RRTAQMS.

There are many areas throughout a Region where new residential developments are occurring beside state-controlled roads. It is currently recognised by all stakeholders that the administration for all provision of measures for air quality management measures is the responsibility of local government through its development approval process.

A Region can be asked to provide an advice role in reviewing developer's consultant's reports for the assessment of the impact of road traffic air quality.

4.2.5 Presentation of results

The RRTAQMS report shall contain as a minimum:

- methodology (modelling, monitoring if undertaken, criteria, prioritisation of air quality management measures)
- predicted road traffic air quality levels
- identification of air pollutant affected areas and the contributing pollution sources
- prioritisation of air quality management measures
- cost estimate of required air quality management measures (area specific), and
- data including traffic data, collected or calculated, documented on appropriate plans. In general terms, these plans shall be provided according to the appropriate road links identified in the Road Status Report (unless stated otherwise). Each plan shall be identified by the relevant road number (e.g. U18A-2).

4.3 Air quality assessment

A road traffic air quality assessment may be prepared for a given section of road or at an individual site. The need for such an assessment may be identified by a:

- Project Environmental Assessment (Review of Environmental Factors)
- Regional Road Traffic Air Quality Management Strategy
- enquiries from an affected property owner, or
- development approval condition.

The aim of a Road Traffic Air Quality Assessment is to determine the impact of road traffic air pollutant emissions and appropriate management measures, including guidance on the integration of air quality management measures with the landscape and the road corridor.

For new, upgraded or existing roads, the requirements for an air quality assessment are described below:

4.3.1 Measurement

4.3.1.1 Reasons for measuring road traffic air quality

Measurements will not generally be required to support Development Applications due to the cost and time required to obtain statistically valid data.

Measurement of road traffic air quality levels or of pre-construction ambient air quality levels can be undertaken for a variety of reasons, depending on the situation.

Measurements will generally be undertaken for a major new road construction project:

- to obtain background data prior to construction
- to assess construction impacts, or
- if required after commissioning, to assess air pollutant impacts in areas where predictive modelling indicated levels greater than 50% of criteria at distances greater than 20 m from the roadside.

Table 4.3.1.1 presents the situations under which air quality measurements may be undertaken, along with the reasons for conducting the measurements.

Table 4.3.1.1 Reasons for undertaking air quality measurements

Situation	Reasons
Prior to construction	To provide a snapshot of pre-construction air quality levels To provide data for a before/after study of air quality levels To enable criteria to be set when criteria are dependent on pre-construction air quality levels To verify that an air quality model is acceptable by comparing measured and calculated air pollutant levels
During construction	To assess short term air quality impacts of construction activities, primarily nuisance and health issues relating to dust Continual improvement Complaint management
After construction	To confirm compliance with criteria or project goals To provide data for a before/after study of air quality levels Quality control/assurance regarding management measures Continual improvement
Ongoing	Quality control/assurance Complaint management Ongoing review of compliance Ongoing review of community exposure, by building a database with which to track how air quality levels change

4.3.1.2 General principles of road traffic air quality measurement

Typically, air quality is measured outdoors at a location at which pollutant levels are representative of levels experienced at the façade or air inlet of a potentially affected building. The appropriate location should be determined by reference to the appropriate standard (AS3580.1:2007).

It is important when measuring air quality to ensure that the conditions under which the measurements are conducted include those likely to be representative of the maximum impact.

Here the term conditions refers to factors such as the weather (e.g. wind, atmospheric stability, temperature, rain, humidity), the proximity to intersections, roundabouts or other sources of congestion and the operation of other sources of air pollutants that are not related to the road traffic being investigated.

It is critical that all relevant conditions and factors that could potentially affect the measurements are both monitored and recorded.

While this may at first appear to be an intuitively obvious requirement, it is often difficult to achieve. One key reason for this is that it is often not clear just what conditions and factors are relevant and could affect the measurements.

Well-proven and documented techniques for the measurement of air quality are set out in comprehensive detail in various documents such as the DEPP's Air Quality Sampling Manual and relevant Australian Standards. Given what appears there, the overall process of measuring air quality requires attending to the following seven issues:

- Define objectives and data requirements
- Determine representative sites and measurement locations
- Record all site details
- Measure the air pollutant levels
- Monitor and measure the weather conditions
- Monitor the traffic conditions, and
- Fully document all results.

4.3.1.3 Objectives and data requirements

Decide and set out clearly the objectives for undertaking the measurements and how the subsequent collected data is to be applied, e.g. is the data required for the determination of a Regional Road Traffic Air Quality Management Strategy, or will it be tendered and debated during legal proceedings as a consequence of compensation offered due to land acquisition?

The objectives may include the identification of hot spots such as congested intersections, although land use is an important issue (criteria relate to sensitive receptors which are not found on many congested intersections of major roads).

4.3.1.4 Sites and measurement locations

Where and when the measurements are to be undertaken are important issues that can only be addressed once the above matters have been resolved.

Because most criteria are the observed maximum time averaged pollutant concentrations, sites should generally be located downwind from the road for prevailing conditions.

The selection of suitable sites can be a critical element of the entire data collection process. This is because externalities (such as unrelated pollutant sources for example) have the potential to affect the measurements.

4.3.1.5 Record all site details

This is an important procedure that involves measuring and recording all the relevant site data necessary to clearly identify the site and to conduct a road traffic air quality calculation and/or prediction.

Site diagrams shall be prepared and several photographs taken for each site's identification and all data recorded in a systematic manner. All data including air pollutant measurement and weather conditions shall be recorded for each measurement location.

This collection process will also ensure that air quality data can be confidently applied to any before/after studies that may be required.

4.3.1.6 Measure the air quality levels

Air quality measurements are expensive and time-consuming to obtain. For these reasons, air quality studies will generally only be required for:

- planning of major new road projects potentially affecting numerous persons
- as part of a regional study where it is suspected that there are potential exceedences of criteria

- short-term monitoring of operational impacts of new road infrastructure
- management of construction impacts, and
- in relation to complaints reasonably expected to be associated with potential exceedences of criteria.

For determination of an annual air quality descriptor, air quality measurements need to be undertaken over a minimum of one year with due consideration being given to the requirements for monitoring the traffic and weather conditions.

Where approved by the Regional Director or for shorter averaging periods, data may be obtained over a shorter monitoring period. The preference for daily or shorter averaging periods is that data shall be collected for a minimum of 30 days in total. It is preferable that data be collected for each season.

The required air quality data are to be collected using appropriate instrumentation systems according to procedures such as those of Standards Australia. It is important to ensure that all instrumentation systems are suitably calibrated and have current calibration certification.

Measurements obtained during periods of atypical traffic flows and patterns may be excluded if such conditions are considered unlikely to reoccur. Periods affected by extraneous air emissions such as those from nearby construction activity or adverse meteorology (e.g. rain) should also be excluded.

When monitoring daily averages of pollutant levels over durations of up to ten days, if extraneous air pollutant sources or adverse meteorology are identified as interfering with the traffic air quality data for more than two continuous hours or for more than three non-continuous hours during a 24 hour day, then daily data for that day shall be eliminated from the road traffic air quality assessment for which the data were being collected and an extra day's data shall be collected.

Where there are up to two continuous or three non-continuous hours during a 24 hour day affected by extraneous sources or adverse meteorology, the measured air quality data during these hours shall be discarded and replaced with values determined by simple linear interpolation of other data collected during that day.

4.3.1.7 Monitor and measure the weather conditions

Weather conditions shall be monitored and measured locally in conjunction with the traffic air quality measurements. Particular attention shall be given to wind speed and direction, atmospheric stability, solar radiation and rain periods. In addition the location of the weather station shall be documented.

Weather conditions can substantially affect the quality and accuracy of road traffic air quality measurements. The primary weather conditions that affect traffic air quality measurements are wind and rain. For traffic air quality measurements relating to criteria averaging times up to 24 hours that are conducted over one to 10 days, the acceptable values of these two weather factors are as follows:

- average wind speed up to 5 m/s, and
- rainfall up to 0.3 mm/h.

It will not generally be necessary to make allowances for weather for measurement periods representing averaging periods of more than one day.

It will also not be necessary to make allowances for weather for measurements conducted over more than 10 days.

Traffic air quality measurements conducted for a 24 hour averaging period parameter are unlikely to be representative of maximum values when there are more than three non-continuous hours of adverse weather conditions.

For monitoring duration of up to 10 days, when there are up to three hours of adverse weather conditions during a 24 hour day (with at most two of these being consecutive) when monitoring for a daily averaged parameter, the measured traffic air quality data during these hours shall be discarded and replaced with values determined by simple linear interpolation of the other data collected during that day.

Where road traffic air quality measurements are for descriptors with averaging times less than 24 hours, a proportionately lower number of hours than those listed above during which adverse weather conditions of wind and rain is allowable.

When air quality levels are being measured in terms of one hour descriptors, there shall be no rain during the relevant hour.

At some measurement sites it may be difficult for the wind speed specification to be met and consequently in such cases it might be necessary to relax the wind speed specification.

There are some techniques available to improve the usefulness and reliability of air quality measurements, including:

- measure air quality data on days when the wind is blowing from the road to the measurement location or suitably relocate the monitoring equipment, and
- measure air quality data at each site over a range of wind speeds.

Where dust from construction activities is being monitored, data from all wind speeds shall be included in monitoring summaries as with high winds, more energy is available to dislodge and suspend surface dust producing high dust concentrations.

4.3.1.8 Monitor the traffic conditions

The monitoring of traffic data undertaken during the time of the air quality measurement is always preferable to traffic estimates such as the annual average daily traffic (AADT) or average daily traffic (ADT).

However, such estimates can be used provided care is taken to ensure that the daily traffic conditions do not vary significantly from the estimates that have been used.

The preferred monitoring of traffic data involves measuring traffic volumes, speeds and compositions for each hour during the air quality measurement period.

Note that one hour traffic data are required to calculate the one hour traffic air quality descriptors. Traffic data are aligned with the traffic air quality calculation model which is to be adopted in the air quality assessment process.

Without representative traffic data, it would not be possible, for example, to realistically predict changes in air quality for a before/after study.

4.3.1.9 Fully document all results

Summaries of all site, traffic, air quality measurement and weather data, along with photographs and any other relevant information, shall be recorded in the report document.

4.3.1.10 Further comments concerning the general principles of road traffic air quality measurement

While the above issues may appear straightforward and somewhat routine, it is critical that they are attended to with sufficient rigour.

Moreover it is important that none of them is neglected. Unless each and every one of the issues is comprehensively addressed, the measured air quality data cannot be applied for the purpose for which they were collected.

This is, of course, usually a most unsatisfactory outcome that can only be rectified by repeating the entire data collection exercise. The consequent time, resource and financial implications of this situation are obvious.

4.3.1.11 Specific requirements for road traffic air quality measurements

In addition to the above general principles, there are several specific requirements set out below that must be addressed when road traffic air quality measurements are being undertaken by, on behalf of or for review by Transport and Main Roads.

Site selection

When undertaking road traffic air quality measurements along a particular roadway, it is firstly required that the sites of all potential sensitive receptors along the roadway are established. These receptors shall include, but are not limited to, the following:

- all existing dwellings, approved future dwelling locations and proposed dwellings under a development application, particularly those where it is reasonable to expect that the relevant air quality criteria might be exceeded
- all educational, community and health buildings, and
- all appropriate outdoor educational and passive recreational areas (including parks).

In most cases where road traffic air quality measurements are being undertaken along a length of roadway, it is not economically justifiable to conduct air quality measurements at the site of every dwelling.

Effectively, each air quality measurement program represents a sample of the air quality exposures of the population of dwellings. As in any sampling problem, the issue becomes one of how well the sample represents the population. Two approaches can be adopted:

- The first is that a group of dwellings is assessed, by inspection, to have the same air quality exposure. Then the measured level at one site within this group is applied appropriately to all of them.
- The second approach involves the grouping of dwellings by inspection so that all dwellings in the group will have better air quality than one particular dwelling in the group, and a measurement is conducted at the site of that one dwelling. Due consideration shall be given to the location of potential air quality sensitive receptors, the surrounding terrain and geometry of the road.

Overall, the guiding principle of site selection is to ensure that there is full spatial coverage of all potential air quality sensitive receptors along the roadway.

To employ this principle, the spatial air quality sampling should use the clustering-based site selection processes described immediately above. In this way measurements will be obtained at an appropriate number of sites along the roadway of interest.

Measurement locations

At each of the sites identified above, the road traffic air quality measurement shall be made at the appropriate location. For dwellings, schools and other sensitive buildings, the measurement location shall be near to and representative of the façade most exposed to the road traffic air emissions.

The measurement location for proposed developments shall be at the set back distance complying with local government requirements wherever possible.

For open space for example, outdoor educational and passive recreational areas (including parks), the location shall be determined on a case by case basis, taking into consideration the full circumstance surrounding the provision and future use of the open space.

For example, in large areas of open space, only a small percentage may be impacted by road traffic air quality and there is often scope to locate activities away from the influence of road traffic air quality.

The minimum area of open space where the Transport and Main Roads criterion level is to be achieved shall be 2000 square metres.

Measurement error

As with all measurements, road traffic air quality is variable and liable to measurement variability and error. Factors that contribute to this variability include wind and atmospheric stability effects (which result in varying dilution), variations in traffic conditions, instrumentation accuracy, calibration errors and interference from other air pollutant sources not associated with traffic.

A statistical improvement in measurement accuracy can be obtained by increasing the number of measurements, but this improved accuracy must be balanced against cost.

It is not a Transport and Main Roads requirement that its consultants or work units, or developer’s consultants determine the measurement error associated with any measurements they conduct as part of each road traffic air quality assessment. Rather the approach should be to take into account the material presented in this section.

Any assessment should err on the conservative side. The measurements should be compared with calculated air quality descriptors for those conditions to aid in the determination of any measurement error.

Quality control

Road traffic air quality measurements have to be conducted according to recognised standards such as those of Standards Australia. Moreover, the measurements must be conducted and interpreted by competent personnel.

Appropriate quality control procedures are required to ensure that the reported traffic air quality levels are, in fact, associated with the roadway source under consideration, and not with extraneous air pollutant sources.

The formal reports which document air quality measurements must include statements that competent personnel undertook the measurements according to appropriate standards.

Post construction measurements

It may be necessary to undertake post construction road traffic air quality measurements once a road becomes operational. The specific requirements already set out above apply directly to these measurements.

Moreover, in accord with the general principles documented previously, post construction measurements should be accompanied by simultaneous measurements of the traffic volumes, compositions and speeds.

In this way the resulting measured air quality levels may be subsequently adjusted (usually upwards) to account for the changes in traffic conditions that will occur between the time of the measurements and the design year for which the traffic air quality impact is to be assessed.

Note that in some cases, a program of installation of roadside noise barriers that could affect atmospheric dispersion is undertaken after the roadway has become operational.

In these cases, post construction air quality measurements at those locations where the traffic air quality levels may be affected by the installation of barriers shall be delayed until the barriers are in place.

4.3.1.12 Measured air quality descriptors

The air quality descriptors

Road traffic air quality is generally measured, calculated and predicted utilising air quality descriptors such as the one to 24 hr average concentration of air pollutants, as discussed in Chapter 3 of this manual.

Relationship between key road traffic air quality descriptors

There are generally correlations between the measured levels of the various road traffic air quality descriptors. These relationships occur because the dispersion behaviour of most gases and fine particles are very similar, so that concentrations are directly related to emission rates.

Emission rates of the various species of air pollutants tend to be proportionally related for typical vehicle fleets with similar vehicle age characteristics and makeup (proportion of heavy/diesel vehicles).

Variability is introduced by factors such as vehicle speed, road gradient and congestion for which different pollutants exhibit different relationships.

4.3.2 Calculation and prediction

For the purposes of this manual, the terms ‘calculation’ and ‘prediction’ of air quality are defined as follows:

Calculation of road traffic air quality involves the use of a road traffic air quality calculation model to estimate the *existing* air quality levels at or near a road.

Prediction of road traffic air quality involves the use of a road traffic air quality calculation model to estimate the *future* air quality levels at or near a road.

Any given road traffic air quality calculation and prediction model usually involves a series of algorithms that describe and quantify the manner in which air pollutants are generated, transported and dispersed. Generally road traffic air pollutant levels are calculated, predicted and measured utilising the air quality descriptors discussed in Chapter 3.

4.3.2.1 Calculations and predictions using computer software

There are many road traffic air quality calculation and prediction models and associated computer software packages available around the world. Without going into a detailed treatment of the features of these models, it is the case that there are considerable technical similarities between most of the models. Moreover, most of the models perform to a generally similar degree of accuracy for basic dispersion geometries in the near field.

Two road traffic air quality calculation and prediction models commonly used in Australia for road projects are the CALINE 4 and CAL3QHC models.

Models designed for point source releases such as Ausplume, TAPM and Calpuff can be adapted for road use but are not set up for normal roadway configurations. They are, however, the best choice for localised sources such as tunnel portals and ventilation stacks.

The Victorian EPA has released the AUSROADS model, a regulatory model for the impact of open road transport corridor impacts on air quality.

The CSIRO has also recently developed a high-resolution chemically reactive near-field dispersion model for assessing the impact of transport emissions.

Considerable skill and experience is required on the part of persons using computer software to ensure that the output is meaningful and accurately models the situation being considered.

The main concerns are to ensure that emissions data are accurate, that the modelled domain is appropriately determined, that meteorological conditions are representative and that terrain and surface influences are appropriately represented.

4.3.2.1.1 Traffic and emissions

Basic traffic data for state-controlled roads is often held by Transport and Main Roads. Traffic volumes for the calculation of emission trends for existing roads can sometimes be obtained by extrapolating existing historical time series.

For new roads or major upgrades, detailed traffic modelling may be required to obtain traffic volumes for the design year.

The Brisbane City Council (BCC) and the EPA (now DEHP) compiled an emissions inventory of air pollutant sources in southeast Queensland in 2003, including motor vehicle emissions (reference Environmental Protection Agency (2004) *Air emissions inventory*).

This data has been compiled into a spreadsheet by BCC and is likely to be the most relevant information for vehicle emission predictions. A copy of an updated version of the spreadsheet may be obtained from Transport and Main Roads and will generally be considered acceptable for modelling purposes if used appropriately. Corrections to the values predicted by the spreadsheet will be required if significant congestion is expected.

The USEPA's MOBILE6 is an emission factor model for predicting gram per mile emissions of HC, CO, NO_x, CO_2, PM, and toxics from cars, trucks, and motorcycles under various conditions. Its use may be appropriate in some situations, given appropriate local source data calibration (reference USEPA (2006) *MOBILE6 Vehicle Emission Modeling Software)*.

4.3.2.1.2 Construction emissions

The USEPA's *AP-42 Compilation of Air Pollutant Emission Factors* document provides emission factors that may be useful for construction emissions, e.g. stockpiles, wind-blown dust and unpaved roads (reference USEPA (1995) *AP-42 Compilation of Air Pollutant Emission Factors*).

Other sources that can provide input to construction air pollutant emissions are the handbooks for the National Pollutant Inventory compiled by the National Environment Protection Council (NEPC) (reference DSEWPC (2013) *Emission estimation technique manuals*).

4.3.2.1.3 Receptor domain

Computer dispersion models can calculate pollutant levels at point locations that may be spread over a calculation grid.

For programs such as CALINE that model roads as constant line sources, it may be sufficient to calculate pollutant levels for an individual long, straight road at equally spaced locations along a perpendicular transect as there would be negligible longitudinal variation.

However, it may be necessary to undertake calculations for each discrete receptor if the road geometry, traffic, slope, traffic composition or vehicle speed varies or if there are contributions from several roads.

Point source models such as Ausplume or TAPM are generally used to make calculations for both individual receptors and over a receptor grid. Such models tend to be used for sources such as tunnel ventilation shafts, where impacts would be expected to be highly localised and concentrations would be strongly dependent on wind direction and speed.

All models tend to be difficult to set up and verify for complex situations such as significant interchanges with multiple road levels.

4.3.2.1.4 Meteorology

Meteorological data requirements for the various dispersion models vary widely. For CALINE, it is acceptable to nominate typical and worst-case wind speed, direction and stability conditions and model these.

For calculation of worst case hourly concentrations using Ausplume, it is necessary to obtain at least one year of representative hourly data for the site. This may be difficult to source and it is possible that local terrain may alter the windfield.

The TAPM model is sometimes used to generate a year long hourly local meteorological file based on its data base of historical synoptic and upper level wind data, local land use and terrain data.

4.3.2.1.5 Averaging time

Dispersion models generally base their predicted concentrations of pollutants on dispersion parameters for a single period (for example, 15 minutes or one hour).

To produce predictions for other averaging times, they either aggregate predicted concentrations over several calculation periods or use empirical averaging time correction factors such as power law formulae.

The latter approach may introduce inaccuracy, as different correction factors would be applicable to point and line sources, surface and elevated releases and so on. Traffic and meteorological conditions are unlikely to remain constant for extended periods. These factors are accounted for to some extent by empirical (for example, power law) averaging time correction factors.

The recommended approach for averaging times of more than one hour would be to undertake short-term (for example, one hour) calculations over a representative period (for example, one year) and use computer software to analyse results for the required statistical periods (for example, four hour, eight hour or 24 hour).

An acceptable approach would be to use local empirical averaging correction factors, established by monitoring studies at a similar distance from a similar road nearby.

Data obtained from a kerbside location in central Brisbane (with several years of carbon monoxide monitoring) indicate that for averaging periods of eight hours, 24 hours, 90 days and 12 months, the maximum concentrations can be obtained from peak one hour concentrations by using multiplicative concentration ratios (persistence factors) of 0.4, 0.24, 0.14 and 0.06 respectively.

For periods of less than an hour, use of a power law correction is generally acceptable if short-term measurements are not available, as discussed below:

> The modelling of the horizontal dispersion of pollutants is often based on a set of curves, one for each stability class, which represent the growth with downwind distance of the standard deviation parameter (sigma y or σ_y) of a transverse Gaussian function. The frequently used curves developed by Pasquill and Gifford are referred to as the P-G curves and correspond to an averaging time of three minutes.
>
> The relationship between t_1-minute average sigma-y curves and those corresponding to another averaging time t_2 (e.g. the original three minute data) may be determined by the approach recommended by Hanna et al. (1977):
>
> $\sigma_{y\ t1} / \sigma_{y\ t2} = (t_1/t_2)^p$
>
> where p is an exponent between 0.17 and 0.6, often taken to be 0.2.
>
> The above curves, corrected for averaging time, can be used in a dispersion model to predict concentrations for an averaging time ranging from minutes to hours.
>
> Alternatively, a similar power law equation may be used to adjust predicted concentrations for a given averaging time directly:
>
> $C_{t1} / C_{t2} = (t_2/t_1)^p$
>
> where C_t is the concentration for a t-minute average and p is an exponent, typically 0.2.

4.3.2.1.6 Photochemical reactions

The major issue in relation to traffic air pollution is generally the peak concentration of pollutants in the immediate vicinity of the road. The effects of chemical reactions on pollutant levels are generally insignificant over the short travel times to the nearest receptors.

The only exception to the above is oxides of nitrogen (NO_x). Most (90-95%) of NO_x is emitted in the form of the relatively benign nitric oxide (NO) for which there are no guidelines. Almost all of the remainder is in the form of the more potent nitrogen dioxide (NO_2), for which guidelines are set.

During the period of seconds to minutes representing the time of travel from source to more distant receivers, some of the NO that was originally emitted can be oxidised to NO_2, particularly in the presence of ozone. The reaction rate also depends on other factors, such as temperature.

For most assessments, it will currently be acceptable to assume that 10% of NO_x is in the form of NO_2 at distances to 20 m. This would include concentrations from the ventilation outlets of tunnels (Cox et al 2005, PIARC 2000).

For freeways, the NO_2/NO_x ratio can be assumed to increase linearly to 20% and 30% at 60 m for morning and evening peak periods respectively. For other roads, the NO_2/NO_x ratio can be assumed to increase to 30% and 45% at 60 m for morning and evening peak periods respectively.

For distances greater than 60 m, it may be assumed that the ratio increases linearly to 100% at 100 m.

These assumptions will need to be revisited in future versions of the manual, as recent information suggests that oxidative catalysts on Euro 4 diesel cars emit a significantly higher proportion of NO_2 (up to 70%). If the proportion of new light duty vehicles based on this technology in the local fleet becomes significant in the future, the source emission characteristics will need to be revised.

4.3.2.2 The accuracy of calculations and predictions

The accuracy of modelling methods should be discussed. This will vary from situation to situation. For example, results predicted near a major road for a surface release in flat terrain modelled as a line source by CALINE should be significantly more accurate than predictions distant from an elevated ventilation stack modelled by Ausplume (since the pollutants from the stack are much less likely to strike the appropriate receptor).

4.3.2.3 Further requirements for road traffic air quality calculations and predictions

There are three further specific requirements for road traffic air quality calculation and predictions in Queensland:

1. When road traffic air quality calculations and predictions are to be conducted by, on behalf of, or for review by Transport and Main Roads, calculations or predictions must be conducted within the confines of a rigorous brief. In this way, consistency in the air quality calculations or predictions will be achieved over several projects.

   In addition, adhering to such a brief will also ensure that if more than one Transport and Main Roads Work Unit or consultant is involved in conducting road traffic air quality calculations or predictions on separate sections of the one roadway project, there will be consistency between the calculations or predictions from each section.

2. When road traffic air quality calculations and predictions are to be conducted by, on behalf of, or for review by Transport and Main Roads, the ability of the Transport and Main Roads Work Units or consultants to conduct high quality, accurate calculations and predictions may need to be tested depending on the type and complexity of the particular assessment.

   Independent assessments may be made to determine the predictive ability of the Transport and Main Roads Work Units or consultants. This may be achieved by establishing one or more test case scenarios and having each Transport and Main Roads Work Unit or consultant conduct calculations or predictions for each test case review via an independent assessment.

3. Appropriate quality control procedures must be adopted by Transport and Main Roads Work Units or consultants when they conduct road traffic air quality calculations and predictions for Transport and Main Roads or for review by Transport and Main Roads.

4.3.3 Assessment

4.3.3.1 General principles

The process of road traffic air quality impact assessment is a subset of the general process of an environmental assessment undertaken during the development of a road infrastructure proposal.

As road traffic air quality is one of many environmental elements that are considered in the environmental assessment, it is desirable for the road traffic air quality impact assessment process to be comparable to the processes adopted for the other environmental elements.

In this way the impacts of each of the elements may be assessed in a consistent and fair manner and subsequent comparisons between these impacts facilitated.

The issue of road traffic air quality may assume a high profile within communities opposed to a particular road infrastructure development proposal. It is often the case that either during or after the conduct of an environmental assessment of a road infrastructure proposal, resident action or other groups will form in opposition to the proposal.

Such groups are often genuinely concerned about road traffic air quality impacts on their members. However, these groups may have other reasons for their opposition to the road infrastructure proposal, such as:

- desire for the maintenance of an existing urban situation, without the imposition of additional traffic and road infrastructure
- safety concerns, particularly for children and the elderly, and
- reluctance to accept any deterioration of local amenity despite a demonstrated need for beneficial community infrastructure.

While all these type of concerns are perfectly legitimate and reasonable, many of them are not amenable to either scientific analysis or precise quantification of their potential impacts on the community. For instance, how would one go about quantifying the potential nuisance associated with parts of a community becoming physically separated from one another as a consequence of the alignment of a new road?

Consequently, what often happens in such situations is that the action groups seek out some other issue that can be analysed and quantified and use this issue prominently in mounting their case against the road infrastructure proposal.

Experience has shown that the issues of road traffic noise and air quality are ideal for such purposes, since established techniques, such as those documented in this manual, are available for measuring, analysing, calculating, predicting and assessing them.

Furthermore, air quality is a physical phenomenon with which the majority of the community can identify. Consequently it is very important indeed that the assessment of road traffic air quality impacts is well founded on a scientific, technical basis.

Assessment of road traffic air quality impacts does not only occur within the ambit of the environmental assessment process. There may be many other situations where such assessments are conducted – typical examples include:

- the potential road traffic air quality impacts of an existing road on a development proposed on land adjacent to the road, or

- the response to complaints about air quality produced by an existing road.

4.3.3.2 The justification for and aims of a road traffic air quality assessment

The justification to undertake a road traffic air quality assessment may be based on one or more of the following matters:

- the conduct of a project environmental assessment for a new or upgraded road proposal (refer to the Road Project Environmental Processes Manual - Main Roads 2004 for further information concerning the objectives and principles relevant to environmental assessment).
- the relevant Regional Road Traffic Air Quality Management Strategy
- enquiries from an affected property owner
- the existence of a development approval condition.

The aims of a road traffic air quality assessment are twofold:

- to determine the nature and extent of any road traffic air quality impacts, and
- to propose all appropriate road traffic air quality management measures, including guidance on their implementation.

4.3.3.3 Selection of a road traffic air quality impact assessment procedure

There are general procedures available for the assessment of road traffic air quality impacts which have evolved over recent years and which form the basis of both regulatory authorities' requirements and various regulations and standards. An outline of these procedures is presented below.

The usual aims of a road traffic air quality impact assessment are to describe and assess the air quality exposures and impacts on residents in a community or on people conducting other activities either indoors or outdoors.

In this context, exposures are taken to be the values of the measured, calculated, or predicted air quality indicators at locations such as the most exposed façades of a residential building, inside a school classroom or at a passive recreational area.

The air quality impacts are then determined by comparing these exposures to relevant criteria.

While this procedure may appear simple and straightforward, there are several issues that must be addressed in order to effect the procedure.

Firstly, the appropriate road traffic air quality indicator must be selected. Commonly adopted indices are the highest predicted one hour average concentration of various gaseous pollutants or the 24 hour average concentration of particulates.

Road traffic air quality indices and indicators are covered in Chapter 3 of this manual. However, it needs to be stated that there must be appropriate technology available for the measurement, calculation and prediction of the chosen air quality indicator.

The accuracy and precision of the chosen technology should also be known and considered for the determination of the measured, calculated or predicted indicators applied.

In addition, the chosen technology should be well tried and tested and should lend itself to independent verification and, where appropriate, to scientific scrutiny.

The techniques set out in Sections 4.3.1 and 4.3.2 of this manual for the measurement, calculation and prediction of road traffic air quality fall into this category.

The criteria also come in a variety of forms. Specific criteria adopted by Transport and Main Roads are set out in Chapter 3 of this manual. It should be noted here that the nature of, and the values associated with road traffic air quality criteria are continuously evolving issues about which there is often considerable discussion and debate.

4.3.3.4 General procedural framework for the assessment of the air quality impact of road traffic

There are many possible methods by which a road traffic air quality impact assessment may be undertaken. Following is a generalised procedural framework within which the assessment of road traffic air quality impacts from a particular road may be conducted.

Set the objectives
Specify clearly what road traffic air quality is to be assessed and why. Generally this involves identifying the road traffic air pollutant sources and the potentially affected receptors.

Specify the context and aims
Usually the aim is to determine the levels of a specified road traffic air quality indicator at locations within an area potentially affected by the air quality generated by traffic on the road under assessment.

From there, the air quality impacts are assessed by comparing the values of the measured, calculated or predicted air quality indicators with relevant criteria.

Information on the air quality indicators and the criteria to be adopted are set out in Chapter 3.3 of this manual.

Determine the assessment area
The assessment is conducted over an area that surrounds or adjoins the road. This area must be carefully specified, yet doing so can often become quite complicated.

In a new road proposal, for example, the initial approach might be to constrain the assessment area to the road corridor plus, say, two or three rows of houses on either side of that corridor although, as is often the case, a wider area of influence may be required to determine the existing air quality for the consideration of potential future community complaints.

However, if the new road will have the effect of altering traffic patterns on nearby existing roads, then it might be appropriate to extend the assessment area to include residences on or around these existing roads.

Consideration must also be given to other relevant conditions in the area and the existence of other air pollutant sources that might interact with the road traffic air pollutant being assessed. The principles documented in Section 4.3 also apply directly here.

Identify the receptor locations
All potentially affected or benefited receptor locations within the assessment area must be located and specified. It may not be necessary, however, to conduct air quality measurements, calculations or predictions for each and every receptor location. What is required is to ensure that the air quality exposure of all receptors is determined fairly, accurately and representatively. Again the principles of Section 4.3 also apply directly here.

Acquire the road and traffic data

For each receiver location all the relevant road and traffic data must be acquired for the road under investigation and also for any other road nearby that may contribute to the total air quality exposure at the receptor location.

These data may be obtained either by direct measurements and observations or by accessing other Transport and Main Roads records and data files. Usually these data files and records are available at the relevant Transport and Main Roads Regional Office whose jurisdiction covers the proposed road.

The information required here includes information on factors such as traffic volumes (hourly and daily), traffic compositions (usually expressed as the percentage of heavy vehicles in the traffic), traffic speeds, speed limits, traffic growth rates and road type.

Note that the values of predicted (future) levels of road traffic air quality indicators shall be based on a 10 year horizon after a new road or new development is expected to be opened. This 10 year horizon shall also apply after an upgrade of an existing road is completed or after the implementation of air quality management measures to an existing road where no road works are involved.

Acquire the road geometry and terrain data where necessary

In most cases road geometry and terrain data are required to determine values of several of the relevant input variables to the road traffic air quality calculation and prediction model.

This data may be taken from the outputs of terrain and road geometrical design models. The terrain model and both the existing and future road geometrical design models shall be obtained from the appropriate source(s) where necessary.

Determine the road traffic air pollutant exposures at nominated receptor locations

This is done by measurement, calculation or prediction or by various combinations of these. It is important to specify how the exposures were determined and to justify the techniques adopted.

If measurements are conducted, principles such as those described in Section 4.3 of this part of the manual shall be adopted and documented.

In the case of calculations and predictions, the principles such as those described in 4.3.2 of this manual shall be adopted and documented. Exposures can be specified in terms of the air quality indicators, such as those described in Chapter 3 of this manual, at the various receptor locations.

This does not necessarily mean that an air quality level will be established for each receptor location, particularly when individual locations that are representative of a given area or cluster of residences are used in accord with the principles of Section 4.3.1.

All results of measurements, calculations and predictions shall be summarised in a tabular format. Values of the predicted air pollutant levels, without air quality control measures in place, shall be presented for all the scenarios considered and compared with the air quality criteria.

In addition, road traffic air pollutant contours may be produced that cover very wide and extensive areas at or near to the road. Therefore, another possibility is for the exposures to be presented as areas where specified road traffic air pollutant levels are exceeded or within which road traffic air quality levels fall within a certain range.

The format to adopt will depend on a number of factors such as the nature and behaviour of the traffic and the type of assessment criteria adopted.

Assess against criteria

At this stage the road traffic air quality exposures are compared with the relevant criteria to determine if any exceedences would be expected.

If the values of the predicted air quality levels are greater than the relevant criteria, consideration shall be given to an appropriate strategy to achieve the criteria.

Consider management measures

Should the assessment reveal that the road traffic air quality exposures are in excess of the relevant criteria, the next step is to consider the introduction of management measures.

Once measures have been selected, their effectiveness must be estimated and the ensuing air quality exposures determined. From there the assessment is repeated and this process continues until the exposures are deemed to comply with the criteria.

Sometimes this outcome cannot be achieved for technical, cost or other reasons. Such a situation should lead to compromises that are negotiated with the community.

Document the procedure and outcomes

Documentation of the assessment is obviously an important component of the entire process. The documentation shall cover all of the matters addressed in this section of the manual.

Ongoing air quality management

After the assessment of a new road or an upgraded road has been completed and the road becomes operational, it is necessary to conduct what is termed ongoing air quality management.

This may involve post construction air quality measurements as discussed in Section 4.3.1.11 to ensure that the values of road traffic air quality descriptors occurring in practice comply with the values finally determined in the assessment.

If such compliance is not achieved, then further remedial measures may be considered.

4.3.3.5 Transport and Main Roads' specific requirements for road traffic air quality assessments of new, upgraded or existing roads and proposed developments

There are a number of specific requirements for the assessment of road traffic air quality impacts from new, upgraded or existing roads.

The material that has been presented in Sections 4.3.3.1 to 4.3.3.4 has set out the overriding principles by which road traffic air quality assessments are conducted.

In concert with the principles of Sections 4.3.3.1 to 4.3.3.4, Transport and Main Roads has a series of specific requirements for the assessment of road traffic air quality impacts, which are set out below. It is important to note that these specific requirements shall be considered in close consultation with the principles of Sections 4.3.3.1 to 4.3.3.4.

All air quality measurements shall be undertaken in accordance with the principles set out in Section 4.3.1.2.

A clear summary of all hourly results of air quality levels and meteorological conditions (particularly wind speed and direction) shall form an attachment to the Road Traffic Air Quality Impact Assessment Report.

External air quality descriptors shall be measured, calculated or predicted, with the measurement/ calculation/prediction position located as specified in Section 4.3.2 of this manual.

Calculations and predictions of road traffic air quality shall be conducted using one of the models specified in Section 4.3.2.1 in accordance with all that appears in Section 4.3.2. CALINE or CAL3QHC are the preferred calculation and prediction method for general air quality calculations.

All measured, calculated and predicted road traffic air quality descriptors shall be presented in tabular format and, where appropriate, in the form of air quality contours and maps.

Following the implementation of air quality management measures and the completion of any roadworks and construction activities, a post construction road traffic air quality assessment may be required. This form of assessment shall be undertaken using measured air quality data collected in accordance with the principles of Section 4.3.1 of this manual.

Where Transport and Main Roads is to undertake a road traffic air quality impact assessment along a particular section of road and a private development has been constructed beside this section of road within a 10 year period prior to this assessment, Transport and Main Roads will not consider the impact on this development unless the impact had not previously been assessed under the IDAS process. It is assumed that the appropriate air quality management measures strategy would have been put in place as part of this process.

If an air quality sensitive building has an existing mechanical ventilation system / air-conditioning system / architectural treatment of the building envelope installed, the assessment of the impact of road traffic air quality shall consider these facts when the assessment is related to internal air quality level criteria.

4.4 Greenhouse gas assessments

Greenhouse gas assessments will not be expected to be part of a Regional Air Quality Management Strategy, but will form a component of the Impact Assessment process for a new road (see Appendix C).

The assessment will not seek to assess the impacts of the greenhouse gases associated with the road project in isolation, but rather to quantify the difference in total emissions for traffic on the new road and associated links compared to the existing network.

For a major project, the context and significance of changes in emissions should be demonstrated by estimating emissions for the new situation compared to the total state emissions for the transport sector.

At this time, it is not expected that the assessment will include the greenhouse gas emissions associated with the construction, maintenance and decommissioning of the road project. The eventual removal of the road is seldom considered because removal is generally not anticipated within current planning horizons.

Current requirements will be for an assessment of emissions associated with the operation of the road network only. Emissions should be calculated on an annual basis, based on the quantity of fuel expected to be burned by the vehicle fleet using the road. If significant, operational emissions associated with use of electrical power for lighting, tunnel ventilation etc should also be included.

The assessment should predict total greenhouse emissions for the project and non-project case at commissioning and in future years. If not specified in the Terms of Reference for an Impact Study, calculated emissions should also be tabulated for 5, 10, 15 and 20 years from the completion of construction.

The Department of Climate Change and Energy Efficiency has published a recommended methodology for the calculation of greenhouse gas emissions from a variety of sources in the publication *National Greenhouse Accounts (NGA) Factors (2013)*.

These methods can be used with fleet fuel consumption calculations (for example, from a spreadsheet tool available from Transport and Main Roads) and predicted flow information from traffic models to predict total greenhouse gas emissions for each link.

The emission factors are based on the quantities of the various greenhouse gases emitted by a given process and their relative global warming potentials (relative to a reference value of 1 for carbon dioxide).

A gas which has a short lifetime in the atmosphere may initially have a large effect, but for longer time periods it will become less important. Thus nitrous oxide has an estimated potential of 310 over 20 years but 298 over 100 years.

The emission factors published by the Department of Climate Change and Energy Efficiency consider the relative emissions of different gases and combine them to produce a combined carbon dioxide equivalent emission factor value for a 20 year horizon.

The published factors also are categorised into different classes that represent:

- direct point source emissions – within the boundary of the project (Scope 1 emissions), and
- indirect emissions – including indirect emissions such as those extraction, production and transport fuels (Scope 2, Scope 3 and full cycle emissions).

Transport and Main Roads current requirement is for use of Scope 1 emission factors. Total emissions should be reported in terms of tonnes of carbon dioxide equivalent emissions for a 20 year horizon.

4.5 Methods for the management of air pollutant impact

There are several ways in which the impact of road traffic air pollutants can be reduced:

- at the source (i.e. controlling the air pollutants emitted by vehicles)
- at the reception point, by locating buildings and designing them to minimise air pollutants intrusion into the interior of a building, and
- between the source and reception point (i.e. dispersing the air pollutants as they travel by means of vegetated areas or buffer zones).

4.5.1 Control at the source

Technically, road traffic air pollutant emissions may be regarded as the aggregation of the air pollutants produced by individual vehicles in the traffic stream.

In each vehicle, air pollutants may be emitted from the engine, the exhaust system and the fuel system.

In the long term, the most equitable method of reducing road traffic air pollutants is through the control at the source. This is being accomplished by means of Australian Design Rules (ADRs), which stipulate maximum air pollutants emission levels of new vehicles.

Transport and Main Roads has been involved in the formulation and administration of these rules. Transport and Main Roads encourages and supports related research and development for less polluting vehicles. The specification and control of vehicle-based measures is not considered in this manual.

However air pollutant source emission rates are also reduced by:

- optimising vehicle speed – maintaining free flowing traffic, reducing congestion, limiting requirements for idling and for acceleration/deceleration
- reduced road gradient – reducing the engine power required, and
- changed road fleet composition – ensuring that heavy vehicle freight routes are located away from residential areas where possible.

4.5.2 Control at the reception point

Transport and Main Roads will consider measures at the reception point where there are:

- alterations to an existing road which impact on a partially acquired property (forms part of a land acquisition agreement
- a change in land use or proposed development contiguous to an existing state-controlled road (developer's responsibility), or
- exceptional circumstances (unforseen significant increases in pollutant levels resulting in exceedences of criteria).

It is desirable to examine air quality issues at the road concept, planning and preliminary design phase. Planned future land development should also be considered in all road traffic air quality investigations.

Proper planning and design at the land use development approval stage should remove the need to attenuate impacts at a later date.

It is expected that the most frequently encountered situations where guideline criteria will be approached or exceeded will be associated with congestion, for example, at intersections. Traffic management measures that ease congestion, for example, access limitation and introduction of roundabouts, are the prime means of meeting criteria requirements in such situations.

Where dwellings are built after construction of a road, appropriate architectural design can limit the intrusion of road traffic air pollutants.

Effective land use planning and design play an important role in abating air quality nuisance. The siting of less sensitive land uses in areas likely to be adversely affected can minimise air pollutant impacts.

Measures such as ensuring that there are no openings in the side of buildings facing the road, installing air conditioning, filtering inlet air, ensuring a positive pressure gradient at all openings and ensuring that ventilation inlets are located as high as possible can be effective means of reducing internal particulate pollutant levels.

4.5.2.1 Exceptional circumstances arrangements

When exceptional circumstances prevail, the assessment of the impact of road traffic air emissions will include the prediction of air quality levels at the façade of every dwelling where the criterion level is likely to be exceeded for a 10 year horizon. This will provide a short list of dwellings which may be eligible for treatment.

Transport and Main Roads or its representative will engage the entity (Transport and Main Roads consultants or work units) which undertook the assessment to conduct an inspection of each dwelling with due consideration being given to the predicted air quality level, in order to confirm whether or not the dwelling is eligible for treatment.

Transport and Main Roads or its representative will confirm in writing whether or not the dwelling qualifies and, if so, provide indicative details of the proposed treatment.

Once the confirmation has been made that the dwelling qualifies for treatment, and the owner(s) agrees in writing to proceed, the following process shall be put in place:

- Transport and Main Roads or its representative will engage a mechanical ventilation/air-conditioning contractor/consultant to inspect the dwelling and prepare a written proposal including scope of works and a schematic design.
- During the inspection, the contractor/ consultant will be accompanied by the Transport and Main Roads project manager (internal or consultants) who will co-ordinate all aspects of the work.
- If the scope and design are acceptable, the contractor/consultant will then be requested to provide a written quote to Transport and Main Roads or its representative.
- The Transport and Main Roads project manager (internal or consultants) will contact the dwellings owner(s) in writing to provide details of the proposal and seek agreement in writing to proceed with the treatment. A Consent and Agreement Deed will be sent to the dwelling owner(s), which will include the scope of works and a schematic design, for signature by the dwelling owner(s) to indicate that the owner(s) is satisfied with the proposal and wishes to proceed with the treatment.
- When Transport and Main Roads or its representative receives the signed agreement, Transport and Main Roads or its representative will instruct the contractor/consultant to proceed with the works. The works will be supervised by the Transport and Main Roads project manager or project manager’s representative.
- On completion of the works, the Transport and Main Roads project manager (internal or consultants) will request the owner(s) to sign a copy of an Acceptance of Treatment Agreement to confirm that the work has been satisfactorily completed and has been demonstrated to be operational.

The owner(s) will be provided with any manufacturer’s warranty details for any architectural treatment of the building envelope and/or air-conditioning /mechanical ventilation system(s) installed.

Transport and Main Roads will not contribute to the running/maintenance costs of the measures. These will be the responsibility of the dwelling owner(s).

4.5.3 Control between the source and reception point

Transport and Main Roads, local government and land developers have the greatest scope to provide control measures between the source and the reception point.

To achieve the external criterion level, the preferred strategy will involve building setback and/or landscaped management measures. Fences or other management measures placed on private land shall be set back from state-controlled road reserves for a width sufficient to permit dense screen plantings.

Effective reductions in road traffic air pollutant levels can be achieved through distance alone. However, in an urban environment, this method is expensive due to the cost of land acquisition.

The selection and positioning of dense vegetation stands, generally to be located in conjunction with environmental barriers requires early consideration in the planning and preliminary design phases.

For proposed developments, new landscaped areas within the road reserve shall be planted and maintained for a period of 12 months from the final approval of constructed works.

Land used outside of the road reserve (including buffer strips) for the purpose of air quality management shall be owned and maintained by the land owners. All management measures and landscaping shall be to the satisfaction of Transport and Main Roads.

For detailed requirements regarding landscaping, the Transport and Main Roads' Road Landscape Manual (1997) should be consulted.

4.5.4 Control measures - effects on dispersion

Air pollutants' dispersion rates can be affected by several forms of environmental control measures. These include the elevation of the road and the introduction of roughness elements (for example, stands of dense vegetation) that will promote dispersion.
The type of ground surface over which air pollutants travel has a substantial effect on air pollutant concentrations, particularly for low releases traversing large distances. Areas covered with grass or other types of ground cover are more absorptive and less liable to re-entrainment than hard, paved surfaces. Dense plantings of trees with an understorey of shrubs may result in a significant reduction in particulate levels.

Some of the most effective vehicle noise control measures (depression of the road in a cutting, enclosure in a tunnel and construction of mounds or tall barriers) can adversely affect air quality.

The situation with barriers and vegetation is not clear cut. Barriers can channel wind movements and limit dispersion in very calm conditions. They can also increase vertical dispersion when winds are forced over or through a barrier. Their restriction of transverse horizontal wind movement during stable conditions can allow the development of enhanced thermally driven vertical motions (promoted by hot vehicle exhausts and heat stored in road surfaces) during moderate to high traffic flows.

It is not expected that artificial barriers will be constructed purely to assist with the dispersion of air pollutants unless:

- a critical problem has been identified in a particular area
- other potential controls are shown to be ineffective
- appropriate studies have established that the barriers would be effective at the proposed location.

Any barriers used for air pollution mitigation would not need to meet the same density requirements as noise fences, merely needing to be sufficiently solid to impede air movement and structurally sound. If noise fences are to be installed, dual purpose barriers could possibly be designed to also assist with air pollution mitigation. Otherwise, dense vegetation could well be the chosen option.

Hence the integration of control measures should be considered carefully in the light of prevailing and worst-case weather conditions during road or land use design to maximise the effectiveness of synergistic management measures and minimise the impact of antagonistic management measures.

4.5.4.1 Barriers - new roads

Barriers can affect air pollutant dispersion and so their installation should be carefully considered from an air quality perspective. The following constraints are placed on barriers:

- The maximum preferred height of a barrier above the proposed natural ground or earth mound level shall be 4.0 metres, and
- The minimum offset from a barrier to the back of any guard rail posts shall be 2.5 metres.

4.5.4.2 Barriers - existing roads

- The maximum height of a barrier above the existing or proposed ground level shall be 6.0 metres
- The minimum offset from a barrier to the back of any guard rail posts shall be generally 1.5 metres, and
- The maximum height of a barrier combined with a concrete safety barrier shall be 6.0 metres.

4.5.4.3 Bridges

Being raised above ground level, bridges are usually effective promoters of pollutant dispersion.

4.5.5 Preferred ameliorative strategies

Recommendations from a Road Traffic Air Quality Study shall include:

- selection of preferred measures for air quality management
- recommendations for the extent of management measures
- evaluation of the ability of management measures to be incorporated effectively into individual dwelling designs, and
- identification of issues requiring further consideration during the detailed design.

The study shall include consideration of the effects of proposed noise control measures (for example, barriers) on the dispersion of pollutants.

Preference will always be given to passive measures such as separation distance and dense plantings, over active measures such as air conditioning that have high cost implications for residents and greenhouse gas implications because of their energy requirements.

5 Proposed Air Quality Sensitive Development

5.1 Introduction

This section of the manual pertains to Proposed Air Quality Sensitive Development. It describes, for example, the methods and procedures that a developer might adopt in planning and obtaining approval for a new residential development near a state-controlled road.

For the purposes of this manual, developments that are considered to be sensitive to air quality are attached or detached residential dwellings, educational, community and health buildings, parks, outdoor educational and recreational areas.

The preparation of all Road Traffic Air Quality Management Reports shall be conducted in accordance with this section of the manual.

Transport and Main Roads' jurisdiction to assess and condition development is derived from the purpose of the *Transport Infrastructure Act 1994*. The objectives of the Transport Infrastructure Act 1994 are to "…provide a regime that allows for and encourages integrated planning and efficient management of a system of transport infrastructure". This manual is part of the regime.

Under the obligations about government supported infrastructure in Section 9 of the *Transport Infrastructure Act 1994*, Transport and Main Roads is able to set standards like this manual that are designed to achieve "efficiency; and affordable quality; and cost effectiveness". Furthermore, Section 24 of the *Transport Planning and Coordination Act 1994* gives Transport and Main Roads all the abilities of the state that are necessary or desirable for carrying out its functions.

Transport and Main Roads operates under the framework of the Integrated Development Assessment System (IDAS) outlined in Chapter 6 of the *Sustainable Planning Act 2009*.

5.2 Assessment and report requirements

Where a development is creating an air quality sensitive area near an existing state-controlled road the applicant may need to undertake a Road Air Quality Management Report addressing the impact of road traffic air pollutants from nearby state-controlled roads, that shall:

- be conducted in accordance with this manual
- be undertaken by a suitably qualified air quality consultant, and
- demonstrate that the relevant Transport and Main Roads road traffic air quality criteria can be achieved with the identification and adoption of suitable traffic air quality controls and strategies to the satisfaction of Transport and Main Roads.

It is within the jurisdiction of the relevant Transport and Main Roads Regional Director to decide whether a Road Air Quality Management Report will be required.

A report will generally be required if an Air Quality Sensitive Development is to be constructed with habitable rooms within 20 m of the edge of a road expected to carry more than 25,000 vehicles per day (vpd) at the completion of construction of that structure (or the completion of the first stage, if staged). A report will also generally be required if an Air Quality Sensitive Development is to be constructed with habitable rooms within 40 m of a road carrying more than 50,000 vpd.

All applications relating to proposed developments requiring road traffic air quality assessments will need a completed Road Air Quality Management Report Form 1 as a minimum requirement. This Form is designed to enable efficient and consistent processing of assessments submitted to Transport and Main Roads for review. The form contains specific guidance on the information required to be submitted for a Road Air Quality Management Report and the guidelines in this form in conjunction with this manual should be consulted prior to submitting any report.

Air quality assessments shall consider potential air quality impacts for a 10 year planning horizon. For the 10 year horizon prediction, only the state-controlled roads are to be included in the assessment in order to remain with Transport and Main Roads jurisdiction with regard to conditions for a proposed development.

5.3 Road traffic air quality management strategies

There are several different air quality control strategies that can be adopted for a proposed development, depending on site specific characteristics or requirements.

One or more of the strategies may be implemented to derive an acceptable solution. Transport and Main Roads will expect compliance with the most appropriate strategy or combination of strategies.

The strategies presented in this manual are likely to be applicable for most proposed developments. However, on occasion, different strategies may need to be considered. Therefore, as it is not possible to anticipate all future situations and scenarios, Transport and Main Roads may deviate from the strategies outlined in this manual.

In reviewing an air quality assessment, Transport and Main Roads does not specifically review the requirements of the Local Government or their approved strategies to manage road traffic air quality.

Transport and Main Roads will strive to ensure that at least its own suitable strategies are in place. In some circumstances, a conflict between Transport and Main Roads' and Local Government strategies to manage road traffic air quality may arise. In this situation, Transport and Main Roads requirements should not be compromised. Where the Local Government criteria are more stringent than Transport and Main Roads, the implementation of the Local Government requirements is supported.

When designing the required strategy to manage road traffic air quality for a particular development, the air quality consultant should aim to appropriately integrate strategies from Transport and Main Roads and the Local Government.

5.3.1 Land use and architectural design

The most preferred strategy by Transport and Main Roads which is available to developers is appropriate land use and function. This strategy has not been considered in detail due to its complex and variable nature, and that it is mostly outside the jurisdiction of Transport and Main Roads.

The designers of proposed air quality sensitive development are generally responsible for what form and function of development is chosen for land contiguous to state-controlled roads.

Air quality sensitive development near state-controlled roads is discouraged. If unavoidable, the architectural design of the air quality sensitive development should consider road traffic air quality as a key variable in the design.

Air quality consultants are encouraged to be proactive in engaging with architects and building designers and planners regarding the opportunities within a development site to improve the development's ultimate amenity with regard to road traffic air quality.

For residential dwellings, architectural design should consider locations of private open space and communal open space. An architectural design should provide at least one functional private open space for each dwelling. Private open space located in an area with negligible privacy such as an unscreened front yard or courtyard adjacent to a driveway would not be considered functional.

Transport and Main Roads would expect that detailed attention be given to architectural design that provides a functional private open space. A suitable communal open space should be considered if the proposed development is an attached dwelling.

Architectural designs should consider opportunities to use building orientation and position to provide increased separation distances from roads. This may involve implementing a series of attached dwellings adjacent to the road, with:

- mainly non-habitable rooms facing the road
- primary balconies and courtyards facing internally, away from the main road and shielded by the building, and
- garages and vehicle access via internal access roads.

5.3.2 Buffers and separation

A strongly recommended strategy by Transport and Main Roads which is available to developers is the maintenance of an adequate separation distance between traffic air pollution sources and sensitive areas. Provision of adequate separation allows gaseous pollutants room to disperse and allows the heavier particles (for example, construction dust, resuspended spillages, particles from brake linings or tyres, soot) to be removed by gravity.

A suitable means of increasing separation between source and sensitive receptor is to use the intervening area for a less sensitive use, for example, light industrial or commercial activities. This strategy can be highly effective, provided that the impacts from activities on this buffer zone are low.

A particular degree of separation does not always guarantee a given amount of dilution. During calm or low wind conditions, or periods of high stability (for example, when temperature inversions are present in the lower atmosphere) pollutant spread may be very low. Although dispersion conditions can be poor at times, poor dispersion conditions normally occur at night when traffic flows and hence emission rates are low.

5.3.3 Road design and intelligent transportation systems

Congestion is a major cause of increased emissions at some locations. Appropriate design (for example, grade separation, roundabouts, ramp metering) and use of intelligent systems that promote smooth traffic flow have the potential to significantly improve air quality at some locations (for example, near intersections). This strategy will generally only be applicable to large scale developments.

5.3.4 Barriers

Barriers used for noise control can be useful in some situations to channel pollutants away from sensitive locations. They will not channel strong winds. However, dispersion is usually adequate during strong winds.

Barriers generally increase the turbulence levels in the lower layers of air passing over them, thus increasing dispersion. Low wind speeds in the zone behind a barrier will be less likely to entrain loose material from the surface and are associated with an increased particle deposition rate.

A single barrier near a road can be effective in reducing pollutant levels behind the barrier in some situations by encouraging pollutants to disperse in another direction. However, barriers on both sides of the road tend to act as restrictive canyons with little benefit in terms of reducing gaseous pollutants concentrations in the vicinity of the road.

Having barriers on both sides of the road will tend to increase the pollutant levels to which drivers are exposed and may accelerate the formation of smog because of these higher concentrations. However, the presence of barriers on both sides of a road is expected to be more effective in restricting the movement of large solid particles.

It is unfortunately almost impossible to quantify the effectiveness of roadside barriers by computer modelling. Some dispersion models allow a simplistic treatment of building wakes, but their methodology generally cannot represent the complex wind flow and turbulence fields associated with barriers.

Computational fluid dynamics (CFD) models can provide a better simulation of the effects of a barrier for specific wind speed and orientation conditions than standard models. However, because their output tends to pertain to discrete meteorological and operational scenarios, it is difficult to use CFD models to fully evaluate the effect of this control measure for the range of wind speeds, directions, emission rates, atmospheric stability and turbulence conditions likely to be encountered.

Barriers are an effective means of reducing emissions from exposed surfaces when employed as wind breaks around stockpiles, excavated areas and cleared areas exposed to wind during construction activities. In the case of stockpiles where frequent access is necessary, it will often be satisfactory to enclose the stockpile on three sides, with the stockpile oriented to allow access from the side downwind of prevailing winds.

5.3.5 Vegetation

Stands of dense vegetation will increase the turbulence and dispersion rates for strong winds that pass over them and reduce the speed and carrying capacity of winds passing through them. Leaf surfaces will tend to trap particles and vegetation will also remove some gaseous pollutants.

5.3.6 Ventilation and filtering

The least preferred strategy for the maintenance of internal air quality is the use of artificial ventilation and filtration systems at the receptor because of the costs and environmental impacts associated with their operation and maintenance.

They offer the opportunity of increasing the effective distance between source and receptor by ensuring that the ventilation inlet is as far as possible from the source of pollutants.

There is also the opportunity to pass ventilation air through a fine particulate filter that can significantly reduce dust levels.

Unfortunately, effective use of such systems generally requires that other natural ventilation pathways be closed so it is generally necessary to include some form of thermal management system.

5.4 Strategy implementation

The methods of implementing the strategies as conditions of development are presented in this section of the manual. The exact implementation is subject to change according to:

- specific Transport and Main Roads Region’s requirements

- changes in relevant legislation, and
- site constraints or advantages, where conditions of development are required to be comparatively unique depending on site specific circumstances.

The strategies will be implemented through conditions on development through the Integrated Development Assessment Scheme (IDAS) process in the *Sustainable Planning Act 2009*.

Implementation of the strategies should be prior to the *Signing and Sealing of the Plan of Survey of the Land* or prior to the issue of the *Compliance Certificate* from Council, depending on the type of application made.

5.4.1 Conditions of development

Conditions of development will depend on particular development circumstances, and their form will need to be revised to take account of changing industry trends or changes to legislation.

5.4.2 Infrastructure agreements

A non-physical strategy available to Transport and Main Roads is the provision of a Deed of Indemnity regarding road traffic air quality. In general the indemnity includes an agreement that the property owner consents and covenants that the property owner and all successors in title shall fully indemnify Transport and Main Roads from all claims for damages and costs related to the impact of road traffic air pollution; and for the costs of provision, operation and maintenance by Transport and Main Roads of road traffic air pollution management treatments.

To implement an infrastructure agreement, the following wording may be used:

Deed of indemnity

- As this development is creating an air quality sensitive area contiguous to an existing state-controlled road, the applicant is requested to acknowledge this fact in writing, and undertake to indemnify the Department of Transport and Main Roads against future claims to provide road air quality management strategies for the property in relation to this application.
- Execution and return of the ‘Agreement and Indemnity’ form would address this issue. Provision of the correctly completed form may or may not exempt the property owner or developer, depending on the specifics of the site, from the alternative requirement to provide a Road Air Quality Management Report in accordance with Transport and Main Roads’ Manual, Road Traffic Air Quality Management Manual and to provide any necessary road air quality management strategies which may be identified.

5.4.3 General conditions

Quite often developments will require general conditions to require re-assessment or clarification if certain future and un-predictable events occur.

Conditions of development are placed on a development based on the information supplied during the application stage. However, it is acknowledged that sometimes changes to the development do occur after the conditions for the development are finalised. From a road traffic air quality perspective, any changes to the development that may affect compliance with the conditions should be reported to Transport and Main Roads and a revised air quality report issued for review.

Also, alternative air quality criteria are established by certain Local Governments across Queensland. Where these other standards are more stringent than Transport and Main Roads Criteria, design to the alternative standards is supported.

To implement general conditions, the following wording may be used:

General conditions

- If any part of the development changes, a change being a difference to the information presented in the approved air quality report or development plans on which the air quality report has been based, that results in air quality levels significantly different to the levels determined by the air quality report or alters the effect of conditions of development, a revised air quality assessment is required to be submitted to Transport and Main Roads along with a request for Transport and Main Roads to re-consider the conditions of development imposed upon the development.
- The applicant shall note that Transport and Main Roads has not specifically reviewed the requirements of Local Government or other Referral Agencies or their conditions of development to manage road traffic air quality or other forms of air quality. In the event of a conflict between Transport and Main Roads' conditions of development to manage road traffic air quality and Local Government or other Referral Agencies conditions of development to manage road traffic air quality or other forms of air quality, Transport and Main Roads requirements shall not be compromised. Where the Local Government or other Referral Agencies conditions of development are more stringent than Transport and Main Roads' with regard to air quality, the applicant is to note that the implementation of Local Government or other Referral Agencies conditions is supported by Transport and Main Roads.

6 Construction Air Quality

6.1 Construction air quality issues

6.1.1 Sources of air pollutants

The main issues of construction air quality relate to particulate emissions from excavation and transport of spoil, the placement of fill and the stockpiling of materials.

Emissions of dust can also be produced from concrete batching plants, vehicles travelling on temporary unsealed roads and wind-generated erosion from open areas.

Other air pollutants can include odours from asphalt laying and asphalt plant and emissions from internal combustion engines of mobile and stationary equipment such as excavators, trucks, generators and compressors.

6.1.2 Air pollutant impacts

Nuisance impacts generally relate to soiling of houses, washing, vehicles and so on by the gravitational settling of dust introduced into the air by the mechanical action of extraction and transportation equipment or raised by the wind.

Sensitive individuals may also suffer respiratory irritation from construction air pollutant emissions, or blame existing symptoms on road construction activities.

There is a possibility that sensitive vegetation or waterways immediately adjacent to construction activities and haul roads may be affected by dust fallout.

Residents have also expressed concern about the impact on tank water quality of dust from unsealed roads that has been deposited on roofs and gutters.

6.2 Pollutant generation, movement and dispersion

The air pollutant typically causing the greatest nuisance during road construction is particulate matter. Fine particles (measured as PM_{10}) can remain suspended in the air for extended periods and potentially affect human health. Larger particles can form dust layers on neighbouring dwellings and vehicles.

The factors that influence the rate of generation of pollutants include the:

- intensity of activity for example, tonnes/hr of material processed
- process being undertaken
- vehicle or wind speed
- number of wheels of vehicles
- material properties for example, particle size distribution, moisture content
- surface roughness
- drop height
- stockpile height
- area exposed to wind, and
- presence of barriers or other control measures.

6.3 Emission rates

The emission rate of air pollutants can be determined by direct measurement methods, by indirect measurement methods or by application of emission factors.

6.3.1 Direct measurement

Direct measurements can be obtained at a source by suitable measurement techniques. The advantages of such measurements are:

- the high pollutant concentrations at source generally result in low instrumental percentage errors
- the influence of confounding factors such as wind speed, wind direction and stability is minimised, and
- the presence of instrument and observer can affect operations and operator behaviour.

Uncertainties in such measurements and subsequent calculations can be due to:

- spatial variability of emissions – only limited volumes are sampled
- temporal variability – source intensity varies with equipment type, operating conditions, operator behaviour, and
- factors such as deposition - have to be accounted for in downstream calculations.

6.3.2 Indirect measurement

In the context of this manual, the technique refers to the use of downwind measurements obtained at a significant distance from the source to estimate a source emission rate.

The advantages of the technique are:

- largely frees estimates from uncertainties caused by source geometry, and
- if suitably planned, the method largely eliminates the influence of factors such as deposition in downwind calculations.

Disadvantages of the method are:

- source-receptor geometry is critical – must usually be directly downwind to obtain good estimates
- variability of source emission rates and meteorological conditions can introduce uncertainty, and
- lower concentrations usually mean greater measurement error.

If the concentration at a particular sensitive receptor is the issue, measurements obtained as close as possible to that receptor are the best means for determining the actual impact.

6.3.3 Emission factors

To enable estimates of air pollutant emissions to be made without the need for measurements, authorities such as the USEPA have developed emission factors that empirically relate emissions for particular processes to factors such as activity rate and weather conditions.

Such techniques are inherently more uncertain than methods based on actual site measurements because the equations developed average out the influence of site-specific variables such as soil type, equipment characteristics and weather conditions.

Emission factors are summarised in the USEPA's AP-42 documents (USEPA, 1995) and the Australian National Pollutant Inventory workbooks (for example, NEPC, 2000).

These estimation procedures do not relate to road construction explicitly – for example, the most relevant NPI emission factors are found in the workbook for mining and processing of non-metallic minerals. Other relevant factors may be found in the workbooks for combustion engines, explosives detonation, hot mix asphalt manufacturing, concrete batching and concrete product manufacturing.

When emission factors are used as the basis of emission estimates, it must be emphasised that the factors are representative of a range of measured values at different locations and are most useful for long-term estimates.

Site-specific measurements of emission rates would be preferable to estimates based on emission factors, but such studies are costly and often impractical, time consuming and open to misinterpretation because of the further complication of dispersion and transport behaviour. Thus greater accuracy will be obtained from direct measurement that are part of an impact monitoring program rather than indirect measurements undertaken to refine emission factor estimates.

6.4 Air pollutant transport

Most air pollutants emitted into the atmosphere tend to settle very slowly if at all. Coarse dust particles settle within a few metres to tens of metres from their source, but particles within the size range most affecting human health (less than 10 microns in aerodynamic diameter) tend to settle very slowly and are readily re-suspended by wind and mechanical turbulence.

Thus air pollutants tend to move with the prevailing winds and the zones most affected can be predicted by examining a site-specific wind rose.

A wind rose is a graphical representation of the frequency of wind speed and direction over a given period. Typically, the rose is presented as a set of radial bars arranged like the spokes of a wagon wheel. The length of each bar represents the frequency of winds from that direction.

Each radial bar of the wind rose may be divided into segments of different lengths. The length of each segment then represents the frequency of a corresponding wind speed group.

6.5 Air pollutant dispersion

At the same time that air pollutants are transported (advected) by the wind, they are simultaneously dispersed by atmospheric processes.

Turbulence is generated by mechanical interaction of the wind with the ground, vegetation or structures or by convective processes associated with surface heating. This turbulence imparts random fluctuations small scale superimposed on the large scale motions of the wind, spreading and diluting the pollutants as they mix with cleaner air.

This dispersion rate is characterised in terms of atmospheric stability, which is usually graded in terms of atmospheric stability classes. The Pasquill stability classes that are often used to classify stability range from A to F (some studies include a Class G).

Class A corresponds to strong convective dispersion that is experienced in the middle of a summer's day. Class D relates to the moderate dispersion rates generated mechanically by moderate to high winds. Class F corresponds to the very low dispersion that occurs on clear nights when atmospheric temperature gradients suppress atmospheric motions.

Meteorological data is important for predictions of pollutant levels that may be undertaken prior to construction, or for the interpretation of measured levels.

The most important meteorological parameters are wind speed and direction. Rainfall is extremely important in terms of its impact on dust emission on those days where it occurs.

Atmospheric stability is more difficult to determine. Stability can be estimated from temperature differences between levels on a high (~50 m) tower, from measurements of wind speed, standard deviation of wind speed and standard deviation of wind direction and from solar radiation measurements.

Most of these parameters are monitored by the Bureau of Meteorology and the Queensland EPA at their monitoring sites, but these sites are only representative of their immediate vicinity. At distances of five to 20 km from these sites, it is quite likely that meteorological conditions will be different for a large proportion of the time.

In regions of complex terrain (hilly areas, areas near water bodies and so on), wind fields can be highly variable on a much shorter distance scale. Thus it becomes necessary to undertake local meteorological monitoring if monitored dust levels are to be put into perspective. Such measurements are extremely valuable in the event of complaints, as they can establish how long and how fast the wind was blowing from a given direction and whether measured values are compatible with particular construction activities being the source of the pollutants.

6.6 Dispersion modelling

Dispersion modelling to predict the impact of roadworks on nearby sensitive locations will be undertaken as part of the impact assessment process for major projects. Modelling will not generally be required for upgrades not involving bulk earthworks.

The same dispersion models used for vehicle emissions modelling may be applicable to construction emissions. However, point and area source models such as Ausplume and ISC3 are likely to be more applicable to construction compounds, construction areas and stockpiles than line source models such as CALINE. If necessary, line sources such as construction haul roads can be approximated by multiple volume sources. An example is provided in Appendix A as Example 2.

6.7 Pollutant monitoring

6.7.1 Particulate matter

6.7.1.1 Nuisance dust

Nuisance dust has often been the only air pollution parameter monitored during road construction. It represents the total dust falling under the influence of gravity over a given area and thus the degree of soiling that might be expected on horizontal surfaces and an indication of additional cleaning that might be required at affected locations.

Dust fallout is measured by dust gauges according to AS3580.10.1 (2003). These simple devices each comprise a glass funnel mounted through a rubber bung above a collection bottle. At the end of a one month monitoring period, any falling dust that has been intercepted by the funnel is washed from the funnel into the bottle, sent to a laboratory and weighed.

The gauges are normally located in open areas away from obstacles that would affect wind movement and from the immediate vicinity of dust sources that would unduly influence results – typically on the boundary of the construction corridor or adjacent to a sensitive location (for example, a nearby residence).

Care must be taken to exclude non-dust materials in the analysis for example, insects, bird droppings, leaves and vegetative matter.

When allowance is made for the effects of such confounding influences, the results of dust gauge monitoring gives a reasonable indication of the likelihood of justified complaints from construction activities.

If there are multiple dust sources in the vicinity, the use of directional dust gauges described in AS2724.5 (1987) may be considered. The results obtained from such gauges are not directly comparable with the results of the normal filter funnel gauges.

The advantage of dust gauges is their cheapness and simplicity of deployment and analysis. Their disadvantages are:

- confounding influences such as insects or vandals can contaminate results
- results cover an extended period, so cannot discriminate individual nuisance events
- by the time monitoring results show that unacceptable dust levels have been present, residents may already be justifiably upset or construction may have moved, and
- the moving nature of construction activities may mean that monitoring periods do not correspond to the period of maximum impact. For example, if a one month period of intense construction starts half way through a monitoring period, reported dust levels may be approximately half of the peak levels experienced.

6.7.1.2 Dust concentration

Dust concentrations are usually only monitored during construction when complaints of health impact have been received or when potential health issues have been identified in the impact assessment process.

Dust concentrations may be reported for the full range of particle sizes present in the air, i.e., Total Suspended Particulates (TSP) or for a selected particle size range subset.

Health impacts are usually related to the concentration of respirable particulate matter (those with an equivalent aerodynamic diameter of less than 10 microns that can be inhaled deep into the lungs, referred to as PM_{10}). Equivalent aerodynamic diameter refers to particles with the same aerodynamic behaviour as a spherical particle with a density of 1 g/cm^3.

6.7.1.2.1 High volume sampler

The standard method of measurement of such PM_{10} particles is by means of a high volume sampler with a size-selective inlet according to AS3580.9.6 (2003).

The high volume sampler is similar in principle to a vacuum cleaner. A filter paper is weighed and then a large known volume of polluted air is sucked through the filter. The filter paper is then reweighed to allow the total dust load in the sampled air volume to be calculated.

A standard high volume sampler measures the mass concentration of particles of all sizes. A size selective head can be fitted to the sampler so that only particles less than, for example. 10 microns are admitted.

The method is highly repeatable and gives a good indication of the average concentration of dust over the monitoring period.

Disadvantages of the method are:

- analysis and reporting of the samples may take up to a week, resulting in delays before remedial action is taken
- additional costs in terms of staff and laboratory analysis (compared to dust gauges) are incurred with daily filter replacement, and
- 240 volt mains power is generally required at monitoring locations.

6.7.1.2.2 Tapered Element Oscillating Microbalance

The Tapered Element Oscillating Microbalance (TEOM) is a standard method with good temporal resolution. TEOMs are generally expensive to purchase and install, requiring installation in an air conditioned hut with 240 volt mains electricity supply.

6.7.1.2.3 Low volume sampler - gravimetric

Partisols and Microvols are low volume samples for PM_{10} and $PM_{2.5}$ that operate on the same principle as the high volume sampler, but with a reduced flow rate of around 3 litres per minute.

They are now covered by Australian Standards AS/NZS 3580.9.9:2006 (PM_{10}) and AS/NZS 3580.9.10:2006 ($PM_{2.5}$).

They are portable and accurate, but have similar temporal resolution issues to high volume samplers.

6.7.1.2.4 Low volume sampler-continuous

Many operators are favouring the use of low volume samplers on the form of portable battery powered units or fixed solar powered units. These units provide continuous output with a temporal resolution of the order of seconds.

Such low volume samplers are not currently covered by an Australian Standard. They typically work on a light scattering principle, based on an assumed particle size distribution.

Because local construction dust may have a different size distribution to that used to calibrate the low-volume sampler, it is recommended that simultaneous measurements over a 24 hour period be undertaken alongside a high volume sampler at the construction site on a monthly basis for calibration purposes.

The local Regional Director should be approached about the requirements of Transport and Main Roads in relation to the acceptability of the use of low volume sampler monitoring systems in any monitoring program.

The advantages of a low volume sampler are:

- a single unit can cover multiple locations at a construction site because of its portability
- instant feedback can be provided to operators when high dust levels are recorded
- the unit is highly portable and has minimal requirements in terms of power

- staff responsible for monitoring can rapidly develop a feel for the level of impact construction and can respond instantly to complaints, and
- feedback on the efficacy of control measures is instantaneous.

Disadvantages of the method:

- not a standard method, and
- requires calibration for local conditions.

6.7.1.2.5 Beta gauge

PM_{10} beta attenuation monitors are another form of low volume sampler now covered by Australian Standard AS/NZS 3580.9.11:2008. They provide a typical time resolution of one to 24 hours, with their measurement principle being based on the attenuation of beta radiation from a radioactive source by particles collected on a filter strip that is automatically advanced from a spool to intercept dust in air that is passed through it at a known flow rate.

6.7.2 Odour

Odour from road construction activities can arise from a number of causes. Sources include the exposure of acid sulphate soils during the excavation of some low lying areas and odours from asphalt laying plant or asphalt batching plant associated with road surfacing operations.

The Queensland EPA has guidelines for odour emissions from industrial or agricultural premises, with no specific mention being made of construction activities.

Acid sulphate soil areas should be identified during the planning process and a management plan put in place to ensure that odour emissions are not significant.

Emission from road surfacing activities tends to only take place for a few hours at a time in a given location and is not generally considered to be a nuisance. However, if asphalt preparation plant is to be installed near a sensitive location on a semi-permanent basis for the duration of a significant project, odour impacts will require careful consideration.

In the event of justifiable odour complaints relative to a source that will be in operation for an extended period (e.g. asphalt batching plant), odour monitoring should be undertaken. As the human nose is currently the most sensitive and flexible instrument from which odour data can reliably be gathered, odour measurements are almost invariably based on human observations.

Instruments have been devised that provide a direct measurement of the concentration of a single compound or small group of compounds, but such measurements then have to be corrected in terms of measured olfactory thresholds of the substance and the nonlinear response of the nose before nuisance can be assessed. In addition, the measurements may not include all odorous compounds and generally do not allow for the assessment of synergistic effects of combinations of different compounds.

In the first instance, odour monitoring could take the form of regular inspections or patrols at various times of day by the site environmental officer. Ideally, such measurements would be taken at the time of arrival at site, as olfactory fatigue sets in and odour sensitivity drops when exposed to an odour for a significant time. The officer should be a non-smoker and should not be exposed to other odour sources such as perfume or deodorant before or during measurements.

The results of such inspections should be diarised, noting the:

- time of observation
- location of observation
- reason for inspection (if not a regular inspection)
- perceived odour level
- perceived odour intensity/ character
- meteorological conditions, and
- observations relating to potential source and activities.

6.7.2.1 Olfactometry

In the event of persistent complaints or confirmed issues, more quantitative measurements may be required.

Such measurements involve the taking of samples by an artificial lung, odour hood or wind tunnel and subsequent laboratory rating by an odour panel (dynamic olfactometry).

Unless the odour is particularly strong, ambient sampling is unlikely to detect it. For most situations, it is preferable to sample at the source and undertake computer dispersion modelling to determine the likely level at a sensitive location.

Advantages of the method:

- provides a quantitative measure of potential odour impact.

Disadvantages of the method:

- sampling is costly and reporting may take several days
- sampling is undertaken at discrete locations and times – may not correspond to maximum emissions or impacts, and
- some individuals are more sensitive than others.

6.7.3 Other pollutants

Other pollutants emitted by construction activities are mainly products of combustion including carbon monoxide, nitrogen oxides, sulphur dioxide and carbon dioxide.

Emissions of these pollutants are generally far lower than when the road is operational and so will not usually need to be monitored. Pre-construction modelling should have established the levels of these pollutants likely to occur at sensitive locations during construction.

A range of monitoring methods is available, as presented in the EPA's Air Quality Sampling Manual, which is available on the internet (EPA, (1997) *Air Quality Sampling Manual*).

Some of the standard methods of monitoring require closely controlled environments for the instruments (for example, air-conditioned monitoring huts) and mains power. Such facilities can be impractical to install and operate. Hand held instruments may not have the sensitivity to accurately determine potential health impacts.

If monitoring of these substances is required during construction because of the proximity of construction equipment to a sensitive location, approval for the proposed monitoring program should be sought from the Transport and Main Roads Regional Director on a case-by-case basis.

6.8 Impact assessment

To assess the impact of road construction on air quality, concentrations and deposition rates of air pollutants at sensitive locations are to be compared with criteria levels specified in Section 3 of this manual for the relevant averaging times.

Monitoring will generally not be required for all air pollutants.

Monitoring for nuisance dust deposition will generally be required. This will often be conducted using dust gauges. It is generally recommended that monitoring be conducted for at least two months prior to construction to obtain an indication of background levels. Such measurements are only indicative, as rainfall, wind and seasonal variations can all give rise to highly variable dust levels. However, they may give an early indication of the need for proactive management measures at some locations and they may support arguments about construction impacts if high background levels are identified prior to construction. Dust gauge measurements should be continued throughout the period that construction activities can be expected to influence dust levels at a site and for the duration of any revegetation activities post construction.

Monitoring of PM_{10} may be required if health impacts are identified as a potentially significant issue during the impact assessment or planning processes, or in relation to complaints of health impact. This may be undertaken by high volume sampler or gravimetric low-volume samplers such as Partisol, TEOM or Microvol.

A PM_{10} measurement program involving low volume samplers calibrated by intermittent high volume sampler comparisons is recommended as a management tool for all major projects involving significant earthworks. Such instruments would currently not generally be acceptable to investigate health-related complaints, however, as their use is not covered by a relevant Australian Standard. Site-specific calibration is generally necessary, as the principle of operation of most low volume samplers is based on light scattering by particles with an assumed size distribution. Without an absolute gravimetric reference (filter weighed before and after sample, with a known volume flow), measurement errors can be significant.

For calibration of a low volume sampler not equipped with gravimetric reference, at least two measurements should be made over 24 hour periods by a high volume and low volume sampler at the same location. A correction factor equal to the average of the high volume sampler readings divided by the average of the low volume sampler readings should then be applied to subsequent low volume sampler readings.

If different models of low volume sampler (i.e. with different internal analysers) are to be used, calibrations should be undertaken separately for each model.

The low volume sampler calibration should be repeated at least three monthly during the construction program. The calibration process should also be repeated if construction moves to an area of differing soil type.

Low volume sampler measurements should be carried out on a daily basis for each day of construction in the vicinity of all sensitive locations potentially affected by those activities (and potentially on days when there is no construction if there are significant disturbed areas or unpaved roads are exposed to traffic at these times and there are sensitive locations nearby).

7 Managing Air Quality Complaints

7.1 Introduction

This chapter describes procedures that are adopted to investigate and manage complaints in relation to the construction and operation of state-controlled roads.

The responsibilities of Transport and Main Roads include planning for the management of air pollutants from general road traffic and investigations into their overall impact on sensitive receptors.

They do not include measures such as the setting of design rules, regulation of emissions from individual vehicles, management of occasional accidental spillage of materials or control of individual smoky vehicles.

7.2 Complaint reporting

Complaints will normally only be investigated if they are provided to Transport and Main Roads in writing, are not frivolous and provide sufficient information to allow an investigation to be undertaken.

7.2.1 Information required

Information that is required for the lodgement of an air-quality complaint is as follows:

- complainant's name
- complainant's address
- complainant's phone number (W/H) and postal address or email contact details
- location affected by air emissions
- relevant state-controlled road or activity
- date of event
- time of event
- alleged source of emissions, and
- circumstances and impact of emissions.

Transport and Main Roads may investigate complaints at its discretion if the above is not supplied in writing.

7.3 Complaint response

7.3.1 Departmental actions

When a complaint concerning air quality is received, it will be directed to a nominated complaints officer within the relevant Transport and Main Roads Region.

A record will be entered into the Region's air quality complaints register set up to store the information described in Section 7.2.

The complaints officer will consider the likely validity of the complaint. If the complaint is assessed to not be frivolous, it will be assigned a priority and passed to a nominated environmental officer for investigation. An acknowledgement providing contact details for the assessment officer and the expected time required for a response will normally be sent to the complainant within one working day.

If the complaint relates to pollution from road construction, a preliminary investigation will normally be made within one working day.

If the complaint relates to issues such as congestion relating to short-term activities of Transport and Main Roads or a contractor, a preliminary investigation will normally be made within two working days.

If the complaint relates to a long-term construction project or normal emissions from the existing road network, it will normally be investigated within seven working days.

When the complaint has been investigated, a letter summarising the findings of the investigation, any proposed action and proposed timelines will be sent to the complainant. A copy of the response will be filed.

If the complaint cannot be assessed or corrective actions relating to the complaint cannot be taken until further information is gathered, the complainant will be notified and a follow-up action record will be inserted into the record system.

If the complaint is resolved at the time of follow-up, a letter will be sent to the complainant describing the findings of the investigation and the results of the corrective actions.

If the issue cannot be resolved according to the nominated timetable, a letter/s will be sent to the complainant giving reasons for the delay/s and a final letter when the complaint is resolved.

An entry to the complaints register will note the finalisation of the process.

7.3.2 Site inspection

A site inspection will normally be undertaken by the nominated environmental officer to investigate complaints. The complainant may also be interviewed, if available.

If the complaint involves construction activities by Transport and Main Roads, the inspection may be delegated to site staff.

If the complaint involves construction by a contractor, the inspection may be delegated to Transport and Main Roads staff responsible for the supervision of that contractor.

If the complaint involves construction by other parties, the inspection may be undertaken by the Transport and Main Roads staff member responsible for supervision of that project.

Details of the inspection will be recorded in the complaints register:

- Transport and Main Roads inspector's name
- date and time of inspection
- location of inspection
- details of complaint
- observations and findings in relation to complaint
- further information required prior to completion of assessment
- proposed corrective action/s
- timeline for further information or corrective action
- contact responsible for provision of information or corrective action, and
- date for follow-up.

Measurements will not generally be taken during the initial site inspection.

If the complaint relates to a project not directly under the control of Transport and Main Roads, information may be sought from the group responsible for management of the project. If collection of the information has been required as part of the approvals for the project, a response will be expected within three working days. If monitoring has not previously been required for the project, additional time will be allowed for the project management group to obtain the data.

7.3.3 Criteria assessment

7.3.3.1 Assessment criteria

Predicted or monitored air pollutant levels will be compared against the criteria of Chapter 3. If levels are exceeded, the priority for action to ameliorate the pollution impacts will be assessed based on the methodology described in Chapter 3.

7.3.3.2 Construction activities

Data obtained from construction monitoring will be assessed if available. Nuisance dust levels may be assessed based on visual appearance.

7.3.3.3 Temporary network changes

A determination of likely pollutant levels will be made based on Transport and Main Roads traffic data and emissions modelling software.

7.3.3.4 Existing road network

A determination of likely pollutant levels will be made based on any existing Road Air Quality Management Strategy for the road in question and/or Transport and Main Roads traffic data and emissions modelling software.

7.4 Corrective actions

7.4.1 Construction activities

Corrective action for construction activities will normally be implemented immediately by management measures as specified in the Environmental Management Plan for the project. Such actions may include increasing the frequency of watering, application of chemical suppressants, tarping of loads, installation of wind breaks, sweeping of roads, installation of wheel washers and installation of grids.

In the event that standard control measures cannot reduce pollutant levels to acceptable values, work may have to be temporarily suspended or reduced in intensity until appropriate control strategies are devised.

7.4.2 Temporary network changes

Corrective action to reduce air quality impacts resulting from temporary changes to the road network may involve traffic rerouting, installation of signs promoting alternate routes, closure of roads to some classes of vehicles during nominated hours and fine tuning of traffic control measures.

7.4.3 Existing road network

Corrective actions for existing roads may involve reconsideration of upgrade priorities, placing of access restrictions on some classes of vehicles, retuning of traffic controls to reduce delays and promotion of alternate routes.

7.5 Follow-up

If a complaint is considered sufficiently serious, follow-up actions may be required. Details of the timing and nature of such proposed actions will be entered into the complaints register. When such actions are taken, additional records will be entered into the complaints register.

7.6 Finalisation of complaint

When the assessment officer is satisfied that a complaint is resolved and the complainant has been so notified, an entry finalising the complaint will be entered into the complaints register.

Legislation

Acquisition of Land Act 1967 (Qld)

Environmental Protection (Air) Policy 2008 (Qld)

Environmental Protection Act 1994 (Qld)

Land Act 1994 (Qld)

Land Title Act 1994 (Qld)

National Environment Protection Council (Queensland) Act 1994 (Qld)

National Environment Protection (Ambient Air Quality) Measure 1998 (Cwth)

Transport Infrastructure Act 1994 (Qld)

Transport Operations (Road Use Management – Vehicle Standards and Safety) Regulation 1999

Sustainable Planning Act 2009 (Qld)

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Glossary

For the purpose of this document, the following definitions apply:

AADT (Annual Average Daily Traffic) - the total yearly traffic volume in both directions divided by the number of days in the year.

Access Controlled Roads - roads where direct access is not permitted e.g. access can only be achieved at an intersection or interchange.

Air Quality Descriptor - specific, commonly used measures of air quality which are used to express pollutant levels such as 1, 4, 8, 24 hour or annual average concentration of a given pollutant (typically in units of ppm, $\mu g/m^3$ or Odour Units), monthly average deposition rate (typically in g/m^2/month), light scattering coefficient (Mm^{-1}) or visual range (km).

Air Quality Sensitive - can be applied to:

- a dwelling (detached and attached), reformatory institution, caravan park or retirement village
- a library, child care centre, kindergarten, school, school playgrounds, college, university, museum, art gallery or other educational institution
- a community building including a place of public worship
- a hospital, respite care facility, nursing home, aged care facility, surgery or other medical centre
- a hotel, motel or other premises which provides accommodation for the public
- a protected area, or an area identified under a conservation plan as a critical habitat or an area of major interest under the Nature Conservation Act 1992
- a public park or gardens that is open to the public (whether or not on payment of a fee) for use other than for sport or organised entertainment (passive recreation only).

Assessment Manager - for an application, the Assessment Manager is:

> ‘the entity prescribed under a regulation as the assessment manager for the application.
>
> (1) Without limiting subsection (1), the regulation may state that the assessment manager for an application is the entity decided by the Minister’.
>
> (Sustainable Planning Act 2009 s246)

Australian Design Rules (ADR’s) - rules issued by the Australian Transport Advisory Council (Ministers of all State Governments and the Australian Government) to exercise control on new vehicles in Australia. The Minister for Infrastructure and Transport is now responsible for determining new or amended standards.

Building Envelope - external façade of a building including external windows, doors, walls, roof, floor etc. through which air pollutants may enter a building.

Community Building - can be applied to:

- a church
- a church hall
- a memorial hall

- a school of arts
- a scout hall
- any other building used by the community for gatherings or meetings (generally non-commercial)
- any emergency services building used for sleeping and/or training.

Development is any of the following:

- carrying out building work
- carrying out plumbing or drainage work
- carrying out operational work
- reconfiguring a lot
- making a material change of use of premises (Section 3.2.7, Sustainable Planning Act, 2009).

Ecologically Sustainable Development, ESD - the protection of the environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends" (Section 3, Environmental Protection Act 1994).

Educational Building - a school, child care centre, public library, public lecture hall, art gallery (other than for business purposes), museum, sheltered workshop and any other place used or intended for use for the training or teaching of persons.

Environment - includes:

- ecosystems and their constituent parts, including people and communities
- all natural and physical resources
- the qualities and characteristics of locations, places and areas, however large or small, that contribute to their biological diversity and integrity, intrinsic or attributed scientific value or interest, amenity, harmony and sense of community, and
- the social, economic, aesthetic and cultural conditions that affect, or that are affected by things mentioned above (Section 8, Environmental Protection Act 1994).

Environmental Nuisance - any unreasonable interference to an environmental value by noise or air/water contaminants (Section 15, Environmental Protection Act 1994).

Environmentally Sustainable Transport - transport infrastructure and related services and systems are provided and managed in a way that accords with the principles of Ecologically Sustainable Development, ESD.

Existing Roads - No Roadworks - includes no roadworks or works limited to an overlay (bitumen seal or asphalt) or any normal or routine maintenance works.

General Environmental Duty - a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm (Section 319, Environmental Protection Act 1994).

In determining the criteria that define reasonable measures, the Act then specifies the following parameters to be considered:

- the nature of the harm or potential harm
- the sensitivity of the receiving environment
- the current state of technical knowledge for the activity
- the likelihood of successful application of the different measures that might be taken, and
- the financial implications of different measures as they relate to the type of activity.

Good Environmental Management Practices - the management of the road network to achieve ongoing minimisation of the impact of road traffic air emissions through cost-effective measures assessed against the measures currently used nationally and internationally.

Habitable Room - as defined in the Building Code of Australia: any room used for normal domestic activities, including but not limited to, a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room and sunroom; but excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, photographic darkroom, clothes-drying room, and other spaces of a specialised nature occupied neither frequently nor for extended periods.

Health Building - premises used or intended mainly for use for the long term or overnight medical or surgical care or treatment of persons and includes institutional residences, mental institutions and doctors surgeries or the like (which provide medical care on an outpatient basis).

Heavy Vehicle - all vehicles with an unladen weight exceeding 1525 kg.

Non - Access Controlled Roads - roads where development has direct access.

Predicted Air Quality - the future air pollutant situation for the planning horizon as determined by analysis of results from air dispersion modelling.

Receptor - a location where persons are regularly present, typically a residential property.

State-controlled Road - a road or a part of road defined in Section 24 and Schedule 6 of the *Transport Infrastructure Act 1994* and a future state-controlled road future state-controlled road means a road or land that the chief executive has notified the local government in writing is intended to become a state-controlled road as defined in Section 43 (11) of the *Transport Infrastructure Act 1994*.

Upgrading Existing Road - a substantial upgrading such as duplication or additional through lanes within some portion of the existing road corridor. Some additional lanes may fall outside the existing road corridor.

Temporary Fixed Facilities - Temporary fixed facilities include sites such as depots, plant maintenance and layover areas, batch plants, asphalt plants, crushing and screening equipment, stockpile sites and other materials processing and handling sites established on a short-term or semi-permanent basis, to service the specific requirements of a particular road construction or maintenance project.

For the purposes of determining applicable air quality criteria and controls, temporary fixed facilities are considered part of the road construction or maintenance activity (whether or not the facilities are located in the road corridor).

Other such facilities, whether semi-permanent or permanent, established for the purposes of production or distribution of products to a number of different clients, sites or projects (which may include road projects) are considered to be similar to other activities of an extractive industrial or an industrial nature and are therefore not included in the provisions of this manual.