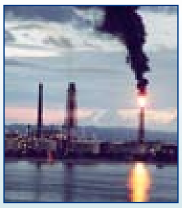
Ministry for the Environment
Manatū Mō Te Taiao






# Good Practice Guide for Assessing Discharges to Air from Industry

June 2008

# Good Practice Guide for Assessing Discharges to Air from Industry

# Acknowledgements

This guidance document is based on a report prepared for the Ministry for the Environment by Jayne Metcalfe and Gavin Fisher, Endpoint. The Ministry would also like to thank Auckland Regional Council for providing permission to use significant source material in this document.

Cover photos: Main photo courtesy of Tasman District Council; third photo from left courtesy of Northland Regional Council.

Published in May 2008 by the
Ministry for the Environment
Manatū Mō Te Taiao
PO Box 10362, Wellington, New Zealand

ISBN: 978-0-478-30234-9 (print)
978-0-478-30235-6 (electronic)

Publication number: ME 880

This document is available on the Ministry for the Environment's website:
www.mfe.govt.nz

Ministry for the
Environment
Manatū Mō Te Taiao

# Foreword by the Ministry

The national environmental standards for air quality were introduced in 2004 because of a strong need for action on ambient levels of particles in most parts of the country. The standards also laid the foundation for an effective management framework for other pollutants associated with industry, such as oxides of nitrogen.

Practitioners preparing assessments of environmental effects and interpreting modelling results must now consider the national environmental standards for air quality. This can, however, be a highly technical and complex process.

In response to the need for guidance, in June 2006 the Ministry for the Environment published a *Draft Good Practice Guide for Assessing Discharges to Air from Industry* for consultation. A number of submissions on the draft document were gratefully received, and the guide was updated to reflect the comments and information provided.

This updated *Good Practice Guide for Assessing Discharges to Air from Industry* provides clear, comprehensive guidance on exactly how to consider the impacts that industry has on air quality. The guide promotes a three-tiered approach in order to separate the simple from the complex. It covers all elements of environmental assessment – not just those pollutants included in the Standards. In doing so, it provides comprehensive guidance on the methods available for assessing how air quality can affect both human health and the environment.

This document is aimed at practitioners (consultants, council officers, scientists and reviewers) making assessments of the effects of discharges to air from industry. I am pleased to present this Good Practice Guide and encourage practitioners to adopt the recommended protocols in the interests of national consistency and technical best practice.

Howard Fancy
**Acting Secretary for the Environment**

# Contents

# Tables



# Figures

# 1 Introduction

## 1.1 Purpose of the Good Practice Guide

This guide is one of a series of good practice guides for air quality developed by the Ministry for the Environment. The series includes the:

- *Good Practice Guide for Assessing Discharges to Air from Industry* (the subject of this guidance document)
- *Good Practice Guide for Assessing Discharges to Air from Land Transport* (Ministry for the Environment, 2008)
- *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004a).

There is a strong relationship between the guides. For example, if an assessment requires a quantitative estimation of pollutant concentrations from industry, this guide will refer you to the *Good Practice Guide for Atmospheric Dispersion Modelling.*

*The Good Practice Guide for Assessing Discharges to Air from Industry* applies the framework provided in the Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins, and Other Toxics) Regulations 2004 (including amendments 2005) and the *Updated Users Guide* (Ministry for the Environment, 2005), which covers the regulations themselves. The aim is that the good practice guide series, taken together, will help provide for comprehensive and consistent management of air quality in New Zealand. The framework for these documents is shown in Figure 1.1.

This Good Practice Guide for industry makes recommendations for which assessment approach to adopt, while recognising the wide variety of potential users. Although the focus is on providing consistent guidance to consenting authorities, consent applicants and their advisers, there is some flexibility if documented and well-justified alternative approaches are proposed.

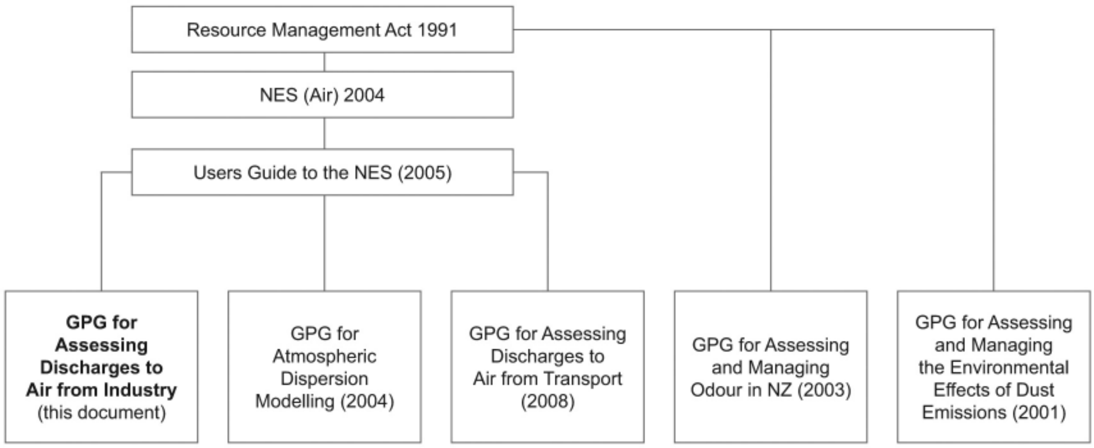
More specifically, this guide:

- outlines the regulatory framework for the assessment process, in particular the national environmental standards for air quality and regional plans
- provides guidance on appropriate levels of assessment, given the variety of development for which assessment will be required
- provides guidance on characterising both the development and the receiving environment
- identifies the air quality criteria by which impacts should be assessed
- provides guidance on key considerations under the national environmental standards for air quality
- provides guidance on the methods available for assessing the impacts of air quality on both human health and the wider environment.

Although the aim of the guide is to promote national consistency in approach, both for consenting authorities and for applicants for resource consent and their advisers, it should be noted that the guidelines have no legal standing.

The assessment of potential dust and odour impacts arising from industrial emissions is not covered in any detail in this document because these are the subject of existing Ministry for the Environment guidance (Ministry for the Environment, 2001a and 2003).

**Figure 1.1: Legal and guidance framework for assessing discharges to air**




Notes: NES = national environmental standard; GPG = Good Practice Guide.

Figures 1.2 and 1.3 show the wide range of relevant Ministry for the Environment air quality publications, and their areas of applicability.

**Figure 1.2: New Zealand air quality guidance documents**

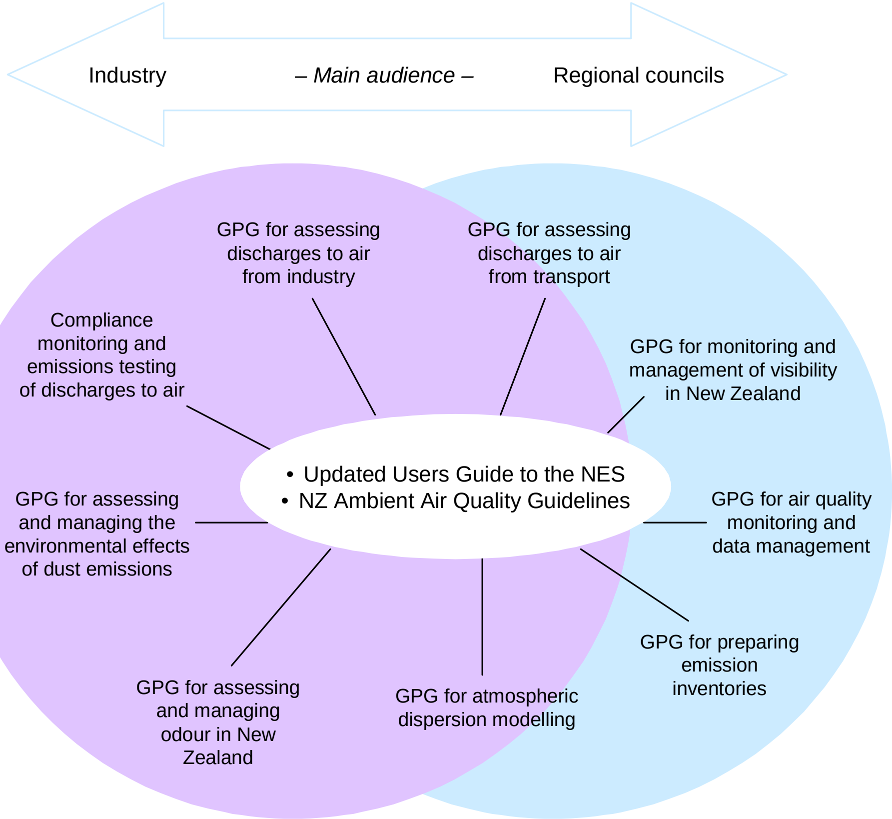
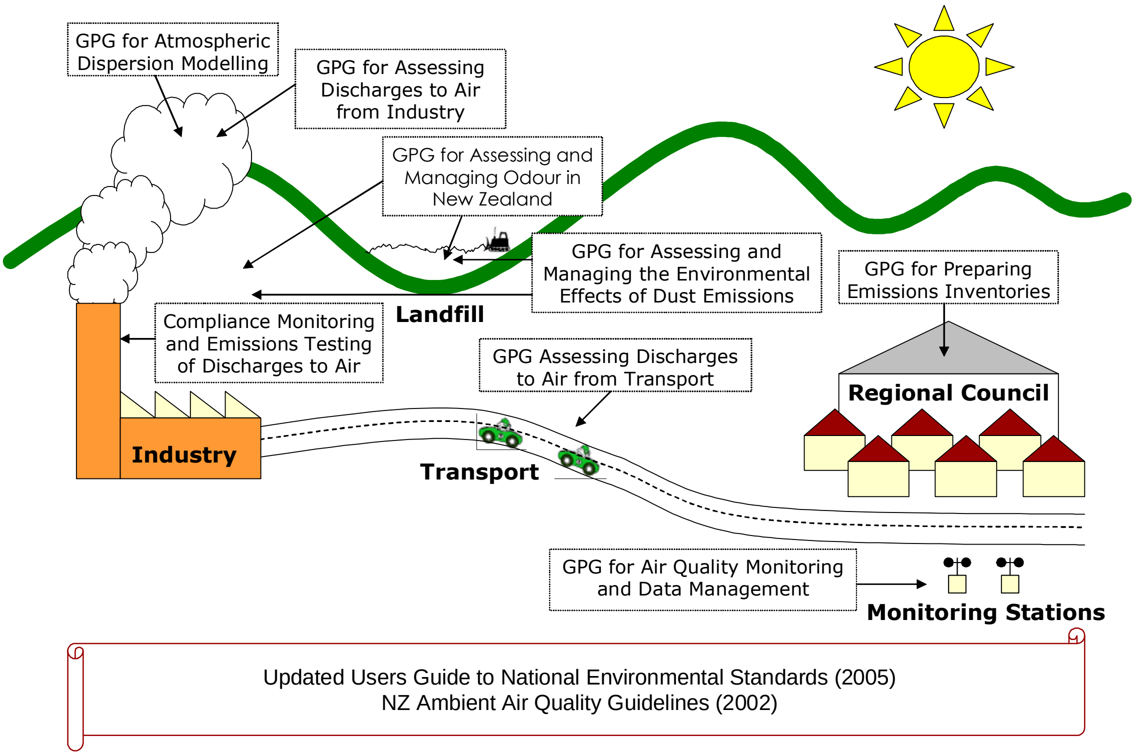



**Figure 1.3: Application of air quality guidance documents**



## 1.2 Target audience

This document is aimed at practitioners making assessments of the effects of discharges to air from industrial sources, including consultants, council officers, scientists and reviewers. It is a detailed technical document, and as such is not aimed at non-specialists, such as the general public, lawyers, planners, hearing commissioners, or specialists in areas other than air. Although some sections may be useful to this latter group, the document has not been prepared with this audience in mind.

As noted above, it is designed to provide assistance, advice and sources of information with the aim of making the assessment process more streamlined and more consistent around the country. It is not binding, and in some cases the level of detail required will go beyond what has been covered here.

# 2 Legislative Context

The following section outlines the legislative context for an assessment of environmental effects relating to air quality, as provided by the Resource Management Act.

## 2.1 Resource Management Act 1991

The purpose of the Resource Management Act 1991 (RMA) is to promote the sustainable management of natural and physical resources, including air. Under section 30 of the RMA, consenting authorities have a statutory responsibility to control discharges of contaminants into air. Section 15 restricts the discharge of contaminants into air, as follows:

> *Discharge of contaminants into environment –*
>
> *(1) No person may discharge any –*
>
> ...
>
> *(c) Contaminant from any industrial or trade premises into air; ...*
>
> *unless the discharge is expressly allowed by a rule in a regional plan and in any relevant proposed regional plan, a resource consent, or regulations.*
>
> *(2) No person may discharge any contaminant into the air, or into or onto land, from –*
>
> *(a) Any place; or*
>
> *(b) Any other source, whether movable or not, –*
>
> *in a manner that contravenes a rule in a regional plan or proposed regional plan unless the discharge is expressly allowed by a resource consent, or regulations, or allowed by section 20 (certain existing lawful activities allowed).*

All regional councils have regional plans that regulate air discharges. Some councils have specific regional air plans that may be proposed, operative, or operative with proposed changes. Other councils have rules for air quality contained within broader regional plans. It is important to consult the regional council to determine plan status and determine which rules (and proposed changes, if appropriate) affect your proposal. Regional plans are discussed in more detail in section 2.3.

Section 88 of the RMA requires an assessment of environmental effects to accompany an application for discharge consent. The Fourth Schedule states what material should be included. Section 88, "Making an Application", requires that:

> *(1) A person may apply to the relevant local authority for a resource consent.*
>
> *(2) An application must:*
>
> *(a) be made in the prescribed form and manner; and*
>
> *(b) include, in accordance with Schedule 4, an assessment of environmental effects in such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.*

The Fourth Schedule states:

*(1)* ***Matters that should be included in an assessment of effects on the environment***
*Subject to the provisions of any policy statement or plan, an assessment of effects on the environment for the purposes of section 88 should include:*

*(a)* *A description of the proposal;*

*(b)* *Where it is likely that an activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods for undertaking the activity;*

*(c)* *Repealed;*

*(d)* *An assessment of the actual or potential effect on the environment of the proposed activity;*

*(e)* *Where the activity includes the use of hazardous substances and installations, an assessment of any risks to the environment which are likely to arise from such use;*

*(f)* *Where the activity includes the discharge of any contaminant, a description of:*

*(i)* *The nature of the discharge and the sensitivity of the proposed receiving environment to adverse effects; and*

*(ii)* *Any possible alternative methods of discharge, including discharge into any other receiving environment;*

*(g)* *A description of the mitigation measures (safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce the actual or potential effect;*

*(h)* *An identification of the persons affected by the proposal, the consultation undertaken, if any, and any response to the views of any person consulted;*

*(i)* *Where the scale or significance of the activity's effects are such that monitoring is required, a description of how, once the proposal is approved, effects will be monitored and by whom.*

*(1A)* ***Matters that must be included in an assessment of effects on the environment***

*As assessment of effects on the environment for the purposes of section 88 must include, in a case where a customary activity is, or is likely to be, adversely affected, a description of possible alternative locations or methods for the proposed activity (unless written approval for that activity is given by the holder of the customary rights order).*

*(1AA)* *To avoid doubt, clause 1(h) obliges an applicant to report as to the persons identified as being affected by the proposal, but does not –*

*(a)* *oblige the applicant to consult with any person; or*

*(b)* *create any ground for expecting that the applicant will consult with any person.*

*(2)* ***Matters that should be considered when preparing an assessment of effects on the environment***

*Subject to the provisions of any policy statement or plan, any person preparing an assessment of effects on the environment should consider the following matters:*

*(a)* *Any effect on those in the neighbourhood and, where relevant, the wider community including any socioeconomic and cultural effects;*

*(b)* *Any physical effects on the locality, including any landscape and visual effects;*

*(c)* *Any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity;*

(d) *Any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural, or other special value for present or future generations;*

(e) *Any discharge of contaminants into the environment, including any unreasonable emission of noise and options for the treatment and disposal of contaminants;*

(f) *Any risk to the neighbourhood, the wider community, or the environment through natural hazards or the use of hazardous substances or installations.*

Readers should note that the above requirements are subject to the provisions of any policy statement or plan (which may require more, or less, information).

This Good Practice Guide expands on the requirements of Schedule 4 and is designed to help applicants meet their requirements by using current best practice techniques for assessing the impacts of discharges to air from industry. For basic information about what should be within an assessment of environmental effects, readers are referred to *A Guide to Preparing a Basic Assessment of Environmental Effects* (Ministry for the Environment, 1999a) and *An Everyday Guide to the Resource Management Act Series* (Ministry for the Environment, 2006a).[1]

Note that sections 104E and 104F of the RMA place discharges of greenhouse gases outside the remit of consenting authorities in their consideration of discharge consents.

## 2.2 National environmental standards

Readers should familiarise themselves with the *Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004* as amended in 2005 (hereafter referred to as the Standards). The Standards are technical environmental regulations prepared in accordance with sections 43 and 44 of the RMA. They are designed to protect public health and the environment in New Zealand by setting concentration limits for clean air and regulating or prohibiting certain activities that pollute the air.

The detailed application and interpretation of the Standards is provided in the *Updated Users Guide* (Ministry for the Environment, 2005). The ambient air quality concentration limits provided by Schedule 1 of the Standards are discussed in section 5.

There is no national policy statement relating to air quality.

[1] http://www.mfe.govt.nz/publications/rma/everyday/

## 2.3 Regional plans and policy statements

The RMA is the applicable overarching legislation and the Standards provide an absolute baseline for acceptable effects. Regional councils provide the next level of regulation in their regional plans and associated policy statements.

As noted above, all regional councils have regional plans that regulate air discharges. Some councils have regional plans specifically for air quality. These air plans may be proposed, operative, or operative with proposed changes. Air plans detail regional, and sometimes local or airshed-specific, management of air quality. Other councils have rules for air quality contained within broader regional plans. All plans, however, contain specific rules about the types of industrial discharges that are and are not allowed.

**It is essential that the relevant regional plan is consulted before preparing an assessment of environmental effects,.**

To do so, consult with the regional council. This will allow you to determine plan status and determine which rules (and proposed changes, if appropriate) affect your proposal. Also, and as noted above, an assessment of environmental effects must meet the provisions in the local plan. The assessment may, therefore, be required to provide more information than that contained in the Fourth Schedule of the RMA.

Regional plans and air plans are different for each region to reflect different local circumstances. Many plans contain more stringent criteria than exist in the Standards (or the national ambient air quality guidelines). One of the justifications for this is to allow adequate time for regional councils to respond if air quality is approaching unacceptable levels. The regional council process to develop and implement policy for emissions reduction takes several years. One of the ways that councils address this is by adopting 'target' values that are typically 66% of the relevant standard or guideline value. This allows them a time buffer that helps ensure the Standards are not breached. For more information on air quality criteria, please refer to section 5.

Following the introduction of the Standards in 2004, many councils are in the process of implementing new policies requiring reductions in $PM_{10}$ emissions from all sources, including industrial sources where practicable. The details of these vary, but may be of the nature of 'the council requires a 15% reduction in annual $PM_{10}$ emissions for any consent renewal', or 'for any new discharge of $PM_{10}$, apart from meeting the regional objectives, the council requires that best practice be employed for mitigation'. It is not possible to detail these polices any further, since they are only very recent and are at different stages of development for different councils.

## 2.4 Types of activities

Regional plans generally classify activities into six primary categories:

- permitted
- controlled
- restricted discretionary
- discretionary
- non-complying
- prohibited.

These different categories determine aspects such as whether a resource consent application:

- is required before carrying out the activity
- can be lodged (eg, you cannot lodge a consent for a prohibited activity)
- will be publicly notified
- must, may or may not be granted
- what will be considered when making a decision on a resource consent application.

Rules in regional and district plans specify which category an activity falls within. The consenting authority can also confirm the plan status and any additional proposed changes that may apply. For further information refer to *An Everyday Guide to the Resource Management Act Series* (Ministry for the Environment, 2006a).[2]

It is important to consult with the consenting authority to confirm which category an activity falls within and which rules apply. This may range from a simple confirmation to more detailed discussions, but a pre-application meeting is strongly recommended.

### Prohibited activities and the national environmental standards for air quality

In addition to any activities prohibited within regional plans, the Standards prohibit the following activities:

- landfill fires
- burning of tyres*
- bitumen burning for road maintenance
- burning of coated wire*
- burning of oil in the open
- new high-temperature hazardous waste incinerators
- school and health-care incinerators, unless resource consent was obtained before October 2006.

* Burning of tyres and coated wire in the open is prohibited, but provision is made for industrial and trade premises that have resource consent and emission control equipment.

---

2 http://www.mfe.govt.nz/publications/rma/everyday/

Further detail is provided in the *Updated Users Guide* (Ministry for the Environment, 2005).

**Legislative context − recommendations**

The Resource Management Act is the applicable overarching legislation and the national environmental standards for air quality provide an absolute baseline for acceptable effects. Regional councils, however, have specific requirements for discharge consents and air quality management in their regional plans and associated policy statements.

It is essential that the relevant regional plan is consulted before preparing an assessment of environmental effects.

Readers are further recommended to liaise with the regional council before undertaking an assessment of environmental effects.

# 3 Assessing Discharges to Air: General Considerations

This section includes background information on assessing discharges to air from industry, including:

- liaison with consenting authorities
- consultation.

## 3.1 Liaison with consenting authorities

Air discharge consent applications are, by their nature, site- or case-specific. They can also be extremely complex. Establishing what information is required to be provided with an application *before* formally lodging it with a consenting authority can significantly reduce the amount of time and cost of an application for all parties.

Industries that have not consulted sufficiently with their consenting authority, or that have poorly engineered proposals, have a far greater likelihood of having to revisit either the assessment process or the engineering design in order to progress the resource consent application. For these reasons, early liaison with the consenting authority is essential.

### 3.1.1 Pre-application meeting

Establishing the type and level of information required can be achieved through one or more pre-application meetings and/or site visits. A pre-application meeting between staff from the consenting authority and the applicant (including any relevant consultants) should be held well before the application is to be lodged – at the earliest feasible stage, but at least several weeks and preferably more than three months before lodgement. Where the application is for a consent to replace an existing consent, the meeting should ideally be held at least nine months before the existing consent expires. These timeframes should enable any outcomes of the meetings to be actioned and included within the application.

The aim of pre-application meetings is to determine the extent of the information required to be included in the assessment of environmental effects, which forms part of the consent application. The matters that may be covered include:

- the consent process and timeframes
- written approval and consultation requirements
- reverse sensitivity issues
- complaints relating to the site
- the site location, particularly with respect to the relevant district plan, any relevant regional air plan, and designated airsheds under the Standards
- emission and/or ambient monitoring requirements
- appropriate air quality assessment criteria

- process description requirements, including any proposed changes to existing process(es) or plant
- air dispersion modelling requirements
- for sources of $PM_{10}$, any straight-line paths that may apply under the Standards and any options for the use of offsets, if applicable.

These matters are all discussed in detail later.

To assist in the above process, a checklist is provided in Appendix 1. The checklist sets out the basic information requirements for the factors to be considered in defining the level of assessment. Ideally, an applicant should gather the information identified in the checklist before attending a pre-application meeting. While not mandatory, completing the checklist will facilitate the discussion and any decision on the information that may need to be provided with an assessment, as well as the appropriate level of assessment.

The consenting authority may wish other matters beyond those identified in the checklist to be considered, and the pre-application meeting provides an opportunity for these matters to be identified. Once again, a pre-application meeting between council staff and the applicant is not mandatory but is strongly recommended.

Current practice is that the costs associated with the officer's time for the pre-application meeting and any additional work required may either be charged at the time or added to the processing costs once the consent application is lodged.

### 3.1.2 Site visits

Site visits (sometimes more than one will be required) are essential for assessing an air discharge consent application and for establishing the level of assessment likely to be required. A site visit can provide context and significant information that cannot be gained from reviewing the application alone, even when this is done in conjunction with maps or photographs. It is particularly important for establishing the surrounding land use, proximity to or presence of sensitive receptors (eg, homes, hospitals, aged-care facilities), the presence and proximity of complex terrain, etc. It is critical that consenting authorities, consent applicants and their advisers undertake site visits.

## 3.2 Consultation, affected persons and notification

Consultation can significantly improve a proposal and the resource consent application process by:

- **gaining local knowledge** – consultation may reveal information on a range of issues that are important to the proposal but which the applicant might not otherwise be aware of
- **incorporating tangata whenua values and interests** – there may be matters of significance to Maori that can be accommodated into the proposal, and this information will be held by local tangata whenua (iwi, hapu, whanau)
- **enhanced proposals and improved environmental outcomes** – consultation may provide input that will improve the project and reduce its impact on the natural, physical, cultural and social environment
- **making the consent process easier** – consultation may lessen any concern, doubt or confusion people may have about the proposal (in the absence of accurate information), which can reduce potential opposition and improve the chances of consent being non-notified and granted.

Detailed guidance on consultation and affected persons is provided in *An Everyday Guide to the Resource Management Act Series 2.2 Consultation for Resource Consent Applications* (Ministry for the Environment, 2006a).

Before submitting an application for air discharge consent, it is *strongly recommended* that a prospective applicant undertake consultation with relevant parties, and, in particular, with any parties with the potential to be adversely affected.

### 3.2.1 Consultation with affected parties and written approval

Consultation, as a minimum for a discretionary activity, would normally include all immediate neighbours. The Fourth Schedule of the RMA requires that details of any consultation and any response to that consultation be provided in an assessment of environmental effects.

#### Affected parties

'Affected persons or parties' are people who may experience an effect generated by the proposal which is significantly greater than or different from the effect on the general public. The regional council determines who is an adversely affected party. This determination is generally made after the application is received and after the regional council has assessed all relevant information.

The location of the activity and the sensitivity of the receiving environment will influence the decision as to who is potentially adversely affected. An industry in a heavy industrial zone may not be required to consult or obtain written approvals to the same extent as an activity in a more sensitive location (eg, a residential area).

### Written approval

If the council considers that the environmental effects of a resource consent application will be no more than minor, and that the written approval of all those they consider likely to be affected has been obtained, they will usually not publicly notify the application. However, if the effects are no more than minor and written approval of all affected parties has not been obtained, the application will be served on all affected parties, who may then choose to make submissions and be heard at a hearing.

When obtaining written approval, the applicant must provide the potentially affected party with sufficient information about the application to enable the person to understand the proposal and what the potential adverse effects may be on that person.

Once a written approval form is signed, the consenting authority does not consider any adverse effects to that person or organisation in its decision-making. Copies of any written approvals should be provided with the application.

Effective consultation by an applicant, including obtaining written approval from potentially adversely affected persons, may reduce or do away with the need for formal notification. Conversely, if an application is submitted without consultation, it is more likely the application will be notified.

## 3.2.2 Notification

Section 93 of the RMA contains the presumption that all consent applications will be notified unless the application relates to a controlled activity, or the council is satisfied that the adverse effects of the activity on the environment will be minor. Air discharge consent applications (excluding minor changes to consent conditions) will generally be notified unless:

- the application is for a controlled or restricted discretionary activity and meets the requirements of the regional council's air plan, or
- the applicant has obtained all the necessary written approvals of affected parties as discussed above, and
- the environmental effects are no more than minor.

In making a decision on whether an application needs to be notified, or limited notified, the consenting authorities typically consider:

- the level of adverse effects of the activity on the environment
- who might be adversely affected by granting the consent
- whether written approvals from affected parties are required, and if so, whether they have been received.

Consenting authorities do not make a decision on whether to notify an application until all information necessary to assess the level of adverse effects has been provided. The decision on whether to notify is made solely by the consenting authority after consideration of all the relevant matters.

Notification is carried out by the consenting authority through the local newspaper and individual notification of all potentially adversely affected parties and other prescribed persons. The consenting authority may also place signs on the property.

Because air discharge consents are often complex applications containing a considerable level of information, notification will not generally include sending a copy of the full application to all notified parties. However, to ensure that any person is provided with adequate information to assess whether they wish to know more about the application or to make a submission, it is recommended that applicants provide a one- or two-page summary of the application. This should detail what the application is for and the potential adverse effects of the proposal.

#### Limited notification

If the council considers that the environmental effects of the resource consent application will be no more than minor, but the applicant has not obtained the written approval of all those they consider are likely to be affected, they may serve notice of the application on only those people they consider may be affected rather than publicly notify the application. In this case, the council will serve notice on all the identified affected parties, even if some have provided written approval to the application, but details of the application will not be advertised in the local newspaper. Limited notification allows an adversely affected party to make a submission in support of, or in opposition to, the application, and to appear at a hearing if they make a submission.

### 3.2.3 Pre-hearing meetings and mediation

If a consent application is notified and submissions are received in opposition to the application indicating that submitters wish to be heard, then consenting authorities will generally encourage the applicant and submitters to hold a pre-hearing meeting. The consenting authority can also require mandatory attendance at a pre-hearing, if the applicant agrees. In this case, if a submitter does not attend without good reason, the council may disregard their submission.

The purpose of a pre-hearing meeting is to allow submitters the opportunity to discuss any concerns they may have with the applicant, and for the applicant to discuss the proposal and how submitters' concerns will be addressed. The council must make it clear that the meeting is for the purpose of providing information only and does not indicate in any way the decision that may be reached. A decision on the application will still be made after the application is lodged.

The pre-hearing meeting can provide an opportunity to clarify the issues and/or mediate or facilitate a resolution to any issues arising from the submissions. The outcomes – if any – of the pre-hearing meeting are put in a pre-hearing report and form part of the information the council will have regard to in its consideration of the process for the application up to and including the hearing (for instance, by noting in the officer's report any agreements made).

The council may also refer parties to mediation, the outcomes of which are reported to the council. In general, applicants are encouraged to consult and mediate an application by involving neighbours as much as possible. This helps to forge a better relationship and a better degree of understanding between all parties.

### 3.2.4 Tangata whenua

The RMA includes a number of matters that relate to the relationship tangata whenua have with the sustainable management of natural and physical resources, including air. These matters include sections 5, 6(e), 7(a) and 8 of the RMA. Key areas in which tangata whenua may be included in the consent application process include pre-application consultation, notification processes and affected party approvals.

Where a marae or an area of customary practice is within the potential area of effect of an activity, the consenting authority may suggest consultation with, and generally written approval (for consent applications not requiring notification) from, the potentially adversely affected marae or iwi.

In the event of large-scale applications, which may affect large portions of the airshed or potentially cause widespread nuisance, the consenting authority will be increasingly likely to request that consultation take place with relevant iwi, irrespective of the local presence of directly affected marae or areas of customary practice. Consultation requirements with iwi may be discussed at the pre-application meeting.

Many air discharge consent applications are notified. If an application is notified then all relevant iwi will be directly notified of the application.

Potential issues of significance for Maori, with respect to air discharge proposals, include the:

- deposition of air pollutants onto mahinga kai (places where food and resources are traditionally gathered), mare and waahi tapu (sacred places)
- reduction of visibility (eg, Putauaki maunga / Mt Edgecombe in the Bay of Plenty is sometimes shrouded in brownish clouds as a result of air discharges that reduce visibility)
- increase in airborne smell (eg, some meat-processing plants have a particular smell associated with their activities and discharges into air)
- impact of contaminants on important or valued sites (eg, discharge material from the flue of a crematorium can be blown by predominant winds over mahinga kai).

**Assessing discharges − recommendations**

Consultation can significantly improve a proposal and the resource consent application process.

Before submitting an application for air discharge consent, it is strongly recommended that a prospective applicant undertake consultation with relevant parties, and, in particular, with any parties with the potential to be adversely affected.

Consultation should occur with the relevant council, with neighbours, with the local community and with iwi. A number of potential issues of significance for Maori (such as deposition of air pollutants into waterways) are highlighted.

# 4 The Assessment Process

## 4.1 Key steps in the assessment process

An assessment of discharges to air from industry will typically involve the following steps.

1. Gather information and make a qualitative preliminary assessment of air quality impacts.
2. Liaise with the consenting authority.
3. Predict the industry contribution to ground-level concentrations.
4. Characterise the existing environment.
5. Assess the cumulative air quality impacts.

In practice the process may be simpler – or more complex. For example, an assessment of effects for a permitted activity would generally only require a preliminary assessment.

Each of these steps should be undertaken to a level of detail that is appropriate to the nature and scale of the proposal. This guide suggests a three-tiered approach to assessment, as discussed below. A brief description of each component of the process is provided in this section, with more detail given in the following sections of the guide.

### Make a preliminary assessment

The first step in any assessment of air quality impacts is to compile information and make a qualitative assessment of the likely impacts. For some proposals this preliminary assessment may be all that is needed. However, in most cases the purpose of this stage is to identify key issues early in the process. The preliminary assessment is referred to as a Tier 1 assessment in this guide.

### Liaise with the consenting authority

Early liaison between the consent applicant and the consenting authority is essential to confirm the consenting requirements. (The importance of liaison for air quality assessments is discussed in section 3.) Liaison is not a one-off process. The applicant and the consenting authority should keep talking until they confirm an agreed approach for each stage of the assessment process.

### Predict industry contribution to the ground-level concentration of pollutants

Atmospheric dispersion modelling is often used to predict the likely contribution of the proposal to ground-level pollutant concentrations. Detailed guidance is provided in the *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004a).

### Characterise the existing environment

The potential impacts of the proposal on air quality must be considered in light of the existing air quality, the sensitivity of the receiving environment, and the local topography and meteorology.

### Assess the cumulative impacts of the proposed discharges

Industrial emissions can cause a range of environmental effects, including human health effects and effects on ecosystems. These effects can generally be assessed by comparing the predicted ground-level concentration of pollutants (including existing background concentrations) with appropriate assessment criteria. Air quality assessment criteria are discussed in section 5.

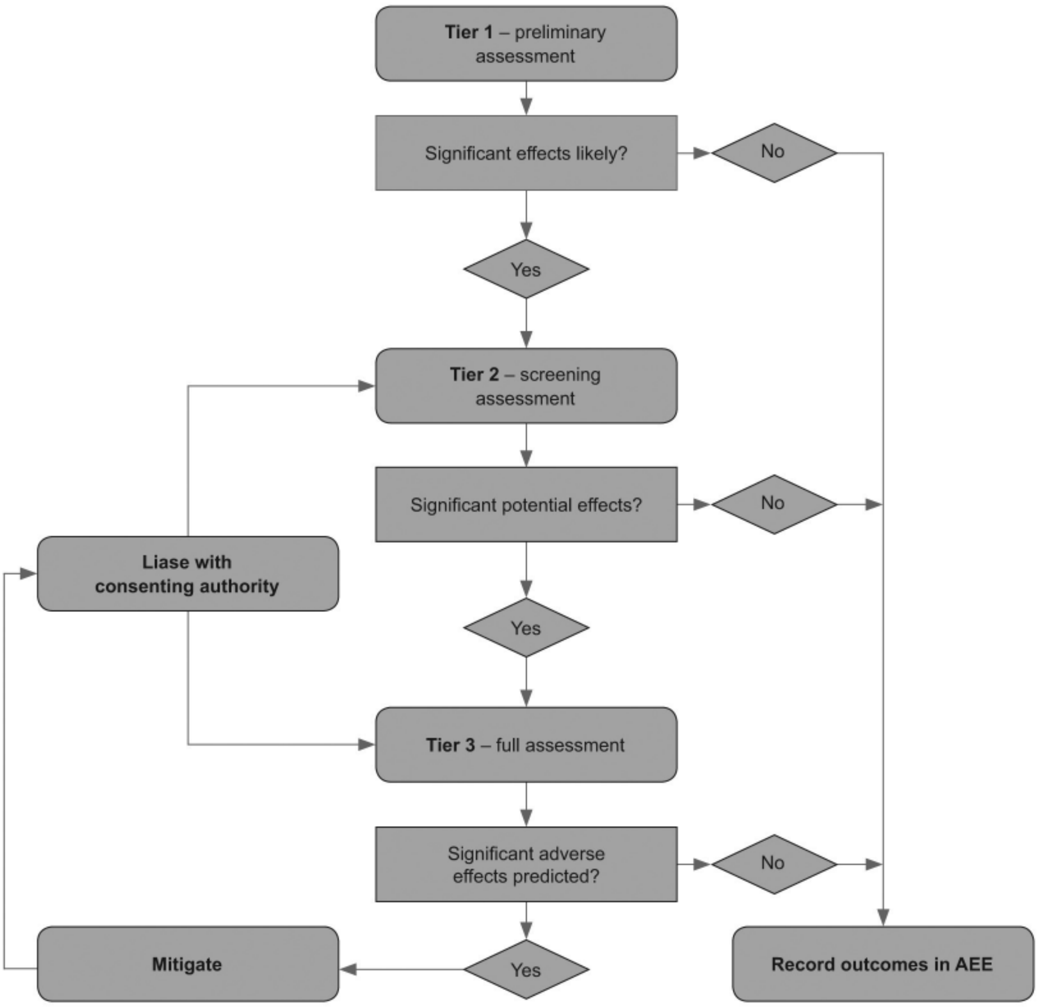
## 4.2 The level of assessment required

Section 88 of the RMA requires an assessment of environmental effects to be provided "in such detail as corresponds with the scale and significance of the effects that the activity may have on the environment". This section provides guidance on the level of assessment that is appropriate for industrial assessments. Figure 4.1 illustrates the overall assessment process recommended in this guide. The three-tiered approach is intended to ensure the level of assessment undertaken reflects the likely level of effect from a proposal.

The three tiers are:

- **Tier 1** – a preliminary assessment to identify whether there are likely to be significant air quality effects
- **Tier 2** – a largely qualitative assessment with screening-level modelling only
- **Tier 3** – a largely quantitative assessment with increased complexity in modelling and reliance on site-specific data.

**Figure 4.1: The air quality assessment process**




Note: AEE = assessment of environmental effects.

## 4.2.1 Tier 1 assessment

The Tier 1 preliminary assessment is a qualitative assessment to determine whether there are likely to be adverse effects. In some cases a preliminary Tier 1 assessment may be all that is needed. For larger projects the preliminary assessment provides an opportunity to identify key issues early in the process.

It is likely that a Tier 1 assessment will be all that is required for a controlled activity in an appropriately zoned area with no highly sensitive receptors located nearby. The appropriate level of assessment for this type of project is essentially a notification to the consenting authority of the key features of the operation, such as its location, scale, design, environmental controls and contact details. Discharges to air from these activities are likely to be minimal and easily controlled by process design and standard operating practices. Adequate dispersion of air emissions should be achievable via appropriately designed discharge points. The potential for offsite human health, environmental or amenity effects would be low.

### 4.2.2 Tier 2 assessment

This level of assessment focuses on – but is not exclusively – a qualitative approach to assessing the potential effects of the development on air quality. It considers the design and operation of the development and the nature of the local environment, and relies on a screening modelling assessment of the potential effects of any air discharges. This level of assessment may require some compliance testing for existing facilities.

A Tier 2 screening dispersion modelling study provides conservative estimates of likely air quality impacts. This means the assessment can provide confidence that a project will not result in a significant air quality impact, despite the relative inaccuracy of the predictions.

If this screening assessment indicates there is a potential for adverse impacts or non-compliance with air quality criteria, then the modelling and assessment approach may need to move up to the Tier 3 assessment level, with the modelling further refined to increase the accuracy of the estimates, enabling some of the conservativeness of the assessment to be removed.

### 4.2.3 Tier 3 assessment

This level of assessment involves a more comprehensive quantitative assessment of the potential effects on air quality of the operation. It will often include the use of emission testing, atmospheric dispersion modelling with local meteorological data (actual or derived), and/or ambient monitoring techniques.

Monitoring or estimating air emissions from process parameters will probably be required to provide data for a quantitative assessment of potential off-site human health, environmental or amenity effects.

More detailed atmospheric dispersion modelling studies are likely to be required to provide estimates of downwind pollutant concentrations, provided the emissions can be reliably characterised and simulated in such a study. For existing sites, or those where there is poor data availability, data from an ambient monitoring programme may be required to verify the results of the modelling.

### 4.2.4 Deciding which tier

The concept of splitting the assessment methodology into three tiers is somewhat arbitrary, and may not be entirely consistent with the preferences and processes used by all councils. The aim is to provide some guidance – particularly to people new to the field – on the different levels of work and detail needed. For instance, looking crudely at the resources required:

- Tier 1 probably requires just *several hours* of work, using existing documentation and information (these might be smaller businesses and will almost certainly all be controlled activities).
- Tier 2 probably requires *several days* of work, including the generation of some new results, and probably a report (these might be medium to larger business, and will probably be either controlled or discretionary activities).

- Tier 3 probably requires *several weeks* (or months) of work, needing advanced modelling, possibly new monitoring, the use of a number of experts, and probably several reports, with peer review. These types of activities are those most likely to be appealed to the Environment Court. They typically have significant potential discharges and are almost always discretionary activities.

Thus the delineation between Tiers 1 and 2 is fairly straightforward (controlled vs discretionary or other), while that between Tiers 2 and 3 is more subjective. Different councils may have different requirements. **The primary advice is to contact the consents manager at the relevant council at an early stage to discuss the application process.**

## 4.3 Factors affecting the level of assessment

The factors affecting the level of assessment include the:

- scale of the development
- adoption of pollution prevention measures
- complaints/compliance record
- nature of the pollutants released to air
- airshed designation under the Standards
- existing air quality (particularly if background levels are elevated)
- physical geography of the receiving environment
- land use of the receiving environment
- type of consent required.

The Tier 1 preliminary assessment process includes a qualitative assessment of these factors. In some cases it will be obvious from the preliminary assessment and discussions with the consenting authority that a Tier 3 assessment will be required. However, a Tier 2 screening assessment may still be undertaken to identify the pollutants or sources of most concern before undertaking a Tier 3 assessment.

In reality, it is likely that the methodologies described in the Tier 2 and Tier 3 procedures would be combined for any significant assessment. For example, a scarcity of information on existing air quality may result in the need for air quality monitoring, whereas the required dispersion modelling technique may be very straightforward due to simple topography.

It is important to remember that every assessment is different and that the level of assessment required should be confirmed with the relevant consenting authority. To help this liaison process with the consenting authority, a simple checklist is provided in Appendix 1. It is recommended that this checklist be completed before a pre-application meeting, as mentioned in section 3.

One of the advantages of early consultation with the council is the opportunity to get advice on the level of quantitative assessment that is likely to be required, based on their experience with similar proposals. In this way, the assessment process can be targeted at the appropriate level rather than wasting time by following an iterative approach of increasing detail and complexity.

Figure 4.2 provides an example of the application of the tiers of assessment to three developments.

**Figure 4.2: Examples of applying appropriate levels of assessment**

| Factors affecting level of assessment | Tier 1 | Tier 2 | Tier 3 |
|---|---|---|---|
| Scale of development | Small scale (eg, workshop paint spray booth) | Medium scale (eg, 5- 10 MW gas-fired boiler) | Large scale boiler (eg, > 20 MW) |
| Pollution prevention measures | Simple (eg, VOCs abated) | Moderate (eg, gas-fired with low $NO_x$ burners) | None (eg, high-sulphur, fuel-oil-fired boilers, no $SO_2$ abatement) |
| Complaints and compliance | No previous complaints | Minor historical dust complaints from former industry | Residents sensitised to odour, noise and dust |
| Key pollutants released | Minimal VOCs | Moderate $NO_x$, CO | $SO_2$, $NO_x$, $PM_{10}$, dust and odours |
| Airshed designation | No gazetted airshed | Gazetted airshed | Gazetted airshed |
| Existing air quality | Very good | Good | Some NES breaches |
| Physical geography | No complexities | Inland site, gently undulating topography | Coastal site, complex topography |
| Land use | Commercial | Industrial | Borders residential and tourist areas |

| Assessment required | | |
|---|---|---|
| Simple notification of the key features of the proposal | Largely qualitative assessment with screening-level modelling only | Largely quantitative assessment with increased complexity in modelling and reliance on site-specific data |

Notes: VOC = volatile organic compound; $NO_x$ = oxides of nitrogen; $SO_2$ = sulphur dioxide; NES = national environmental standard; CO = carbon monoxide; $PM_{10}$ = particulate matter less than 10 microns.

### 4.3.1 National environmental standards for air quality

At the time of publication, 69 areas throughout New Zealand have been gazetted as 'airsheds' under the provisions of the Standards. Of these, around 30 are likely to exceed the national ambient air quality standard for $PM_{10}$ and are therefore subject to controls on the granting of resource consents. It is likely that any industrial development within these airsheds that shows any significant increase in $PM_{10}$ emissions will require a Tier 3 assessment.

The additional requirements imposed by the Standards (as well as those already in council plans) cover many other pollutants as well as $PM_{10}$. For instance, some regions have an issue with $NO_2$ (mainly in Auckland due to its high level of traffic emissions), and some with $SO_2$ (mainly due to industries using coal). Regions with these issues will invariably have additional specific requirements on industrial dischargers if they have an impact on high ambient concentrations of these pollutants.

### 4.3.2 Assessments for an existing activity

Where an application is for the continued discharge from an existing consented activity, and no changes to the emissions have occurred (or are likely to occur) since the previous application was processed, it may be appropriate to provide significantly less information with the application.

Similarly, a minor change to a large-scale industry may only require a low level of assessment. This is because for changes to existing industry, far more relevant performance data are typically available than would be the case for a greenfield development, such as:

- emissions and ambient monitoring data
- complaints records
- the use of management systems and their effectiveness in process operation and control.

An assessment of changes to an existing facility will typically be required to consider both the existing and new emissions. The existing performance data will be valuable in any assessment of the level to which evidence of improvements to existing processes might be sought. For a new development process, information is based on similar developments, and greater attention will be required to generate and demonstrate reliable process data.

## 4.4 Reporting

It is a good idea to develop a standard reporting methodology and format. Although specific projects will have specific requirements, any report should contain the following features.

1. **Executive summary:** a one-page statement of the key features and results. This may be the only part of the report that some users read, so it should be succinct and clear.
2. **Scope:** who has commissioned the project, and why, including the intended outcomes.
3. **Introduction:** the background to the issues and the relevance of any previous work.
4. **Methodology:** a description of the process used, any models employed, assumptions made, and any statistics or analysis used.
5. **Site description:** the area being assessed, including maps with all relevant features (and photos if available). Show any facilities where there are likely to be sensitive members of the public (eg, young, old, sick), such as hospitals and schools, in relation to the proposal.
6. **Description of proposal:** a description of the project and any changes to existing activities. This section should include adequate information to characterise the discharges and the receiving environment, as detailed in later sections of this guide.
7. **Description of receiving environment:** a description of the receiving environment as detailed in later sections of this guide.

8. **Existing consenting requirements:** include details of any existing consent requirement and the level of compliance with these requirements.
9. **Data used:** the sources and validity of all input data, including emissions and process data, meteorology, existing concentrations and all assumptions made.
10. **Assessment of effects:** the outcomes of the study, and all options assessed, as much as possible in summary tabular and graphic form. The emphasis should be on key results that can inform decision-making. Detailed results should be given in an appendix.
11. **Discussion:** any implications, uncertainties and reliance on assumptions. Include discussion of possible mitigation options and associated emissions reduction.
12. **Conclusion:** a summary of the scope, method, results and implications.
13. **References:** all material used should be referenced explicitly, and should include web-based links where appropriate.
14. **Appendices:** any detailed calculations or results that are used. This should include model control files.

The size and nature of each of these sections will depend on the project, but it is anticipated that for any Tier 3 assessment each section will be included and the report will run to 30 to 60 pages. Specific requirements for Tier 1, 2 and 3 assessments are discussed in sections 6, 7 and 8, of this guide.

Any assessment of effects for a resource consent application should address all matters outlined in the Fourth Schedule of the RMA, as well as any requirements of the council.

### The assessment process − recommendations

An assessment should be undertaken in such detail as corresponds with the scale and likely significance of the effects. A three-tiered approach is outlined as a first-order guide to the different types of information required and the different levels of resources required to complete the application. If you have any doubts about the application, consult the local council air quality consent officer before carrying out any significant work on the application – particularly for new projects.

Use a reporting format for any assessment of environmental effects reports, to ensure consistency and avoid omissions of important relevant material.

# 5 Air Quality Criteria

The extent to which the impacts on air quality caused by an industrial development are considered acceptable is judged by the use of air quality criteria. The New Zealand regulatory framework contains the following air quality criteria:

- national environmental standards for air quality
- national ambient air quality guidelines
- objectives and policies in regional plans.

It is important to note that regional plans are statutory instruments under the RMA. **If the air quality objectives in a regional plan are more stringent than the national environmental standards for air quality, then the regional plan takes precedence.** For this reason it is very important to check the requirements of the relevant regional plan before undertaking any assessment of the discharges to air from industry.

New Zealand and other international air quality criteria are discussed in more detail below.

A thorough air quality assessment (some Tier 2 and all Tier 3) should address both short-term and long-term impacts. This means you will need to use air quality criteria with both short- and long-term time averages. Air quality criteria published by different agencies may overlap, complement or sometimes outright contradict each other for some pollutants and some time averages. It is very important, therefore, when selecting air quality criteria for an air quality assessment that the fundamental purpose of the standard or guideline is understood. Similarly, the application of the criteria should be considered. What may be appropriate for an existing facility operating for a five-year consent may not be appropriate for a brand new plant applying for a full 35-year term.

It should also be noted that air quality criteria may become outdated. The Ministry for the Environment website (www.mfe.govt.nz) should be checked for any updates to the national ambient air quality standards or guidelines discussed in this section.

**In all cases, the assessment should explain which criteria have been selected and why.** For those pollutants not covered by the criteria discussed below, or in cases where the criteria are exceeded, health risk assessment techniques should be applied.

## 5.1 National environmental standards for air quality

Schedule 1 of the Standards provides ambient concentration limits for the following pollutants:

- carbon monoxide (CO)
- nitrogen dioxide ($NO_2$)
- ozone ($O_3$)
- fine particulate matter that is less than 10 micrometres in diameter ($PM_{10}$)
- sulphur dioxide ($SO_2$).

**The primary purpose of the national ambient standards is to provide a guaranteed level of protection for the health of all New Zealanders.**

The national ambient air quality standards, therefore, comprise acceptable concentrations for a particular time average, with a specified number of permissible exceedances each year, as summarised in Table 5.1.

Guidance on applying the national ambient air quality standards is provided in the *Updated Users Guide* (Ministry for the Environment, 2005). A number of key issues relevant to the assessment of discharges from industry are discussed here.

The national ambient air quality standards apply in the open air *everywhere people may be exposed*. This includes roadside verges, residential areas, central business districts, parks and beaches. Areas that are *not* in the open air and where the Standards do *not* apply include:

- inside a house
- inside tunnels
- inside vehicles.

However, the national ambient air quality standards are not applicable on sites to which resource consents apply. For example, Acme Fertiliser may operate a large factory with emission limits specified in their resource consent for discharges of $SO_2$. The national ambient air quality standard for $SO_2$ does not apply within the area to which Acme's resource consent applies (ie, the site boundary), because the workers on the Acme site are protected under health and safety legislation. Off-site next door at the Green Fingers Garden Centre, however, the national ambient air quality standard for $SO_2$ does apply, in order to protect the health of any members of the public that may be exposed to emissions of $SO_2$.

**Table 5.1: National ambient air quality standards 2004**

| Pollutant | Standard | Time average | Allowable exceedances per year |
|---|---|---|---|
| Carbon monoxide (CO) | 10 mg/m$^3$ | 8-hour | 1 |
| Nitrogen dioxide ($NO_2$) | 200 µg/m$^3$ | 1-hour | 9 |
| Ozone ($O_3$) | 150 µg/m$^3$ | 1-hour | 0 |
| Fine particles ($PM_{10}$) | 50 µg/m$^3$ | 24-hour | 1 |
| Sulphur dioxide ($SO_2$) | 350 µg/m$^3$<br>570 µg/m$^3$ | 1-hour<br>1-hour | 9<br>0 |

In addition to this, when assessing the potential impacts of discharges to air from industry, careful judgement is required to determine whether people may be exposed and over what time period. General guidance is provided in Table 5.2.

**Table 5.2: Location and applicability of the Standards for assessment purposes**

| Averaging period | Locations where assessment against the Standards *should* apply | Locations where assessment against the Standards *should not* apply |
|---|---|---|
| 1 hour | This includes any outdoor areas where the public might reasonably be expected to spend one hour or longer, including pavements in shopping streets, as well as the facades of any building where the public might reasonably be expected to spend one hour or longer. | Any industrial premises that have resource consents (for that pollutant). |
| 8 hours | This includes all outdoor locations where members of the public might be exposed (eg, residential gardens) as well as the facades of residential properties, schools, hospitals, libraries, etc. | Any industrial premises that have resource consents (for that pollutant). |
| 24 hours | This includes all outdoor locations where members of the public might be exposed. | Any industrial premises that have resource consents (for that pollutant). |
| All | | In any enclosed space (ie, not in the open air), including:<br>• indoors<br>• inside tunnels<br>• inside vehicles. |

## 5.1.1 Airsheds that breach the $PM_{10}$ standard

The regulations place constraints on resource consents depending on the pollutant, the existing air quality of an airshed relative to the national ambient air quality standards, and the date of the application. This section applies to applications for 'significant' discharges of $PM_{10}$ only. The term 'significant' is discussed below.

In airsheds that breach the national ambient standard for $PM_{10}$ before 1 September 2013, regulations 17A to 17C apply if the discharge to be permitted by the resource consent is likely to significantly increase the concentration of $PM_{10}$ in the airshed. After 1 September 2013, in airsheds where $PM_{10}$ levels exceed the standard, councils cannot give consent to any discharges of fine particles (as $PM_{10}$) to air.

Readers are referred to the *Updated Users Guide* (Ministry for the Environment, 2005), which provides a practical interpretation of regulations 17A to 17C. Summarised, Regulation 17 means that in areas where levels of $PM_{10}$ exceed the standard, councils must not give consent for discharges of $PM_{10}$ to air if the discharges are likely to cause the airshed to be significantly above the 'straight-line path' (or 'curved-line path') to meeting the Standards. We now need to look at these paths in more detail.

## Straight- and curved-line paths

The 'straight-line path' and 'curved-line path' refer to lines on a graph that plots $PM_{10}$ over time. The form of the path is determined by the state of the air quality when the national ambient air quality standards came into force on 1 September 2005 and the rate at which things must improve to achieve compliance by 1 September 2013. According to the Regulations, a straight-line path or curved-line path applies to any airshed in a region in which the concentration of $PM_{10}$ breaches the national ambient air quality standard. The formal definitions are:

> ***Curved-line path*** *means a curved line that:*
>
> *(a) starts on the y axis of a graph at a point representing, as at 1 September 2005 or the date that the plan is publicly notified (whichever is the later), the concentration of* $PM_{10}$ *in the airshed; and*
>
> *(b) ends on the x axis of the graph at a point representing as at 1 September 2013, the ambient air quality standard for* $PM_{10}$ *in the airshed*
>
> ***Regional plan*** *includes a proposed regional plan*
>
> ***Relevant date*** *means:*
>
> *(a) in the case of an airshed that is the region of a regional council, 1 September 2005;*
>
> *(b) in the case of an airshed that is part of the region of a regional council, the date of the notice in the Gazette that specifies the part to be a separate airshed*
>
> ***Straight-line path*** *means a straight line that:*
>
> *(a) starts on the y axis of a graph at a point representing, as at the relevant date, the extent to which the concentration of* $PM_{10}$ *in the airshed breaches its ambient air quality standard; and*
>
> *(b) ends on the x axis of the graph at a point representing, as at 1 September 2013, the ambient air quality standard for* $PM_{10}$ *in the airshed.*

For the purposes of deciding resource consents, the straight-line path and curved-line path are *projections* of how the regional council will achieve compliance with the $PM_{10}$ standard by 1 September 2013. They are determined by:

- the state of the air quality at the relevant date (ie, when the national ambient air quality standards came into force on 1 September 2005 or the gazettal date of their airshed)
- the rate at which air quality must improve in order to achieve compliance by 1 September 2013.

Although straight-line paths are not required to be gazetted, they are likely to be published by regional councils to indicate the effectiveness of various air quality management strategies to meet the $PM_{10}$ standard. In addition to these projected paths to compliance, as time passes councils will be able to plot their *observed* path to compliance (ie, a plot of concentration versus time).

## Interpretation of Regulations 17A to 17C

Taking into account the airshed status, the significance of the discharge, the approach to compliance (projected) and the status of compliance (observed), the application for resource consent may then be decided, as shown in Table 5.3.

**Table 5.3: Resource consents for significant discharges of $PM_{10}$ under regulation 17**

| Concentration of $PM_{10}$ in the airshed at the time the application is decided | Application for renewed discharges causing a significant increase in concentration | Application for new discharges causing a significant increase in concentration |
|---|---|---|
| Tracking below the straight-line path or curved-line path | Can be granted if still below the path, or if the increase in $PM_{10}$ is offset by an amount equivalent to the increase above the path. | Can be granted if still below the path, or if the increase in $PM_{10}$ is offset by an amount equivalent to the increase above the path. |
| Tracking on the straight-line path or curved-line path | Can be granted if the increase in $PM_{10}$ is offset by an amount equivalent to the increase above the path. | Can be granted if the increase in $PM_{10}$ is offset by an amount equivalent to the increase above the path. |
| Tracking above the straight-line path or curved-line path | Can be granted only if discharges are fully offset*. | Must be declined – there is no ability to offset. |

* Offsets are explained below.

It is worth noting that the curved-line path has additional conditions to the straight-line path. In particular, regulation 17B specifies that a curved-line path must be contained within a regional plan, and further that the regional plan have rules restricting the granting of resource consents. For more information, refer to the *Updated Users Guide* (Ministry for the Environment, 2005).

## Significance

No specific guidance can be offered for what constitutes a significant discharge because it depends on a multitude of factors. However, some issues to consider when determining whether a discharge is significant include:

- the predicted impact of the proposal
- the conservatism in predicting impacts:
  - is it likely that breaches will actually occur?
  - if so, under what conditions will breaches occur, and how often?
- the sensitivity of the receiving environment
- the accuracy/reliability of the assessment process
- the extent to which the national ambient air quality standard is already breached
- for major projects, the valuation/cost of health impacts.

Because of these various factors, what constitutes 'significant' will need to be determined by the normal RMA process on a case-by-case basis.

## Offsets

Offsets occur when mitigation measures are included in a proposal to offset predicted impacts, so that emissions from the new activity are offset by emission reductions elsewhere in the airshed. A straightforward example would be an industrial development helping to reduce emissions from a hospital boiler located nearby: the reduced fine particle emissions from the hospital boiler offset the proposed industrial discharges of $PM_{10}$.

Regulation 17C was amended in July 2005 to explicitly provide for the use of offsets when considering applications for resource consents for significant discharges of $PM_{10}$ into airsheds where the $PM_{10}$ standard is already exceeded. The key provisions for offsets in regulation 17C are that they must:

- be from another source in the same airshed
- take effect within one year after the grant of the resource consent
- be effective for the duration of the consent.

The amount of the offset is dictated by the *observed* path to compliance, as follows:

- if the airshed is on or below the path to compliance, then the offset must be at least equal to the change in concentrations caused by the resource consent, or
- if the airshed is above the path to compliance, then the reduction must be at least equal to the amount of discharge permitted by the resource consent.

Regulation 17C does *not* make explicit provision for consideration of the following.

- **Contaminant** – the nature of the contaminants being 'put-in' needs to be similar to the nature of those 'taken-out'.
- **Location** – the emissions 'taken-out' should be in the same area as the emissions 'put-in' and not just happening in the same airshed. For example, it would not be sufficient to take out emissions from a facility in Manukau to offset emissions to be put in by a facility on the North Shore of Auckland, even though both areas are within the same airshed.
- **Timing** – the emissions 'taken-out' should occur at the same time as the emissions 'put-in'. For example it would not be sufficient to take out emissions from a facility that discharges all year round to offset emissions that discharge only once a year, even though both discharges are the same mass amount.

It is, however, sensible to take such factors into consideration when considering applications involving offsets. An emissions offset may be carried out by any party.

### 5.1.2 Airsheds that do not breach the $PM_{10}$ standard

In airsheds where $PM_{10}$ levels do not exceed the national ambient air quality standard for $PM_{10}$, either before or after 1 September 2013, councils must not give consent for discharges of $PM_{10}$ to air if the discharges are likely to cause the airshed to exceed the $PM_{10}$ standard.

### 5.1.3 Carbon monoxide, nitrogen dioxide and ozone

For carbon monoxide (CO), oxides of nitrogen ($NO_x$) and volatile organic compounds (VOCs), resource consents must be declined where the discharge is likely to cause a breach of the national ambient air quality standards for CO, $NO_2$ or ozone, and the discharge is a principal source (of CO, $NO_x$ or VOCs).

### Principal source

As with the concept of 'significance' in the regulations, there is no specific guidance on what constitutes a 'principal source'. The wording is designed to offer practical advice in implementing the Standards. Without such a qualifier, very minor and even trivial discharges of CO, $NO_x$ and/or VOCs could be subject to mitigation in circumstances that did little to improve air quality. The interpretation needs to be made in the context of the specific issues within the airshed, particularly the extent of any exceedances, and the contribution of the source to those exceedances.

### 5.1.4 Sulphur dioxide

For $SO_2$, a council must decline an application for a resource consent to discharge $SO_2$ into air if the discharge to be allowed is likely to cause the concentration of $SO_2$ in the airshed to breach the national ambient air quality standard for $SO_2$.

## 5.2 New Zealand air quality guidelines

The New Zealand *Ambient Air Quality Guidelines* were developed following a comprehensive review of international and national research, and are widely accepted among New Zealand practitioners (Ministry for the Environment, 2002). They were published by the Ministry for the Environment as guidance under the RMA, and provide the minimum requirements that outdoor air quality should meet in order to protect human health and the environment.

**The primary purpose of the national *Ambient Air Quality Guidelines* is to promote sustainable management of the air resource in New Zealand.**

Guideline levels for pollutants (and averaging periods) not covered by the Standards still apply. The Standards replace any previous guideline levels for that particular pollutant and averaging period. In addition to the human health-based guidelines presented in Table 5.4, guidelines for ecosystem protection are provided for sulphur dioxide, sulphate particulate, nitrogen dioxide, ammonia, ozone and fluoride, as shown in Table 5.5.

**Table 5.4: National Ambient Air Quality Guidelines, 2002**

| Indicator | Level | Averaging time |
|---|---|---|
| Carbon monoxide | 30 $mg/m^3$ | 1 hour |
| Fine particulates ($PM_{10}$) | 20 $\mu g/m^3$ | Annual |
| Nitrogen dioxide | 100 $\mu g/m^3$ | 24 hours |
| Sulphur dioxide | 120 $\mu g/m^3$ | 24 hours |
| Ozone | 100 $\mu g/m^3$ | 8 hours |
| Hydrogen sulphide | 7 $\mu g/m^3$ | 1 hour |
| Lead | 0.2 $\mu g/m^3$ | 3-month moving average, calculated monthly |
| Benzene (2002)<br>Benzene (2010) | 10 $\mu g/m^3$<br>3.6 $\mu g/m^3$ | Annual<br>Annual |
| 1,3 butadiene | 2.4 $\mu g/m^3$ | Annual |
| Formaldehyde | 100 $\mu g/m^3$ | 30 minutes |
| Acetaldehyde | 30 $\mu g/m^3$ | Annual |
| Benzo(a)pyrene | 0.0003 $\mu g/m^3$ | Annual |
| Mercury (inorganic)<br>Mercury (organic) | 0.33 $\mu g/m^3$<br>0.13 $\mu g/m^3$ | Annual<br>Annual |
| Chromium VI<br>Chromium metal and chromium III | 0.0011 $\mu g/m^3$<br>0.11 $\mu g/m^3$ | Annual<br>Annual |
| Arsenic (inorganic)<br>Arsine | 0.0055 $\mu g/m^3$<br>0.055 $\mu g/m^3$ | Annual<br>Annual |

**Table 5.5: Critical levels for protecting ecosystems**

| Contaminant and land use | Critical level | Averaging period | Additional requirements |
|---|---|---|---|
| Sulphur dioxide ($SO_2$): | | | |
| • agricultural crops | 30 µg/m$^3$ | Annual and winter average | |
| • forest and natural vegetation | 20 µg/m$^3$ | Annual and winter average | |
| • lichen | 10 µg/m$^3$ | Annual | |
| Sulphate particulate: | | | |
| • forests | 1.0 µg/m$^3$ | Annual | Where ground-level cloud present > 10% of time |
| Nitrogen dioxide ($NO_2$) | 30 µg/m$^3$ | Annual | |
| Ammonia | 8 µg/m$^3$ | Annual | |
| Ozone ($O_3$): | | | |
| • forests | 21,400 µg/m$^3$/h | 6 months | |
| • semi-natural vegetation | 6,420 µg/m$^3$/h | 3 months | |
| • crops (yield) | 6,420 µg/m$^3$/h | 3 months | |
| • crops (visible injury) | 428 µg/m$^3$/h | 5 days | Daytime vpd below 1.5 kPa |
| | 1,070 µghm$^3$/h | 5 days | Daytime vpd above 1.5 kPa |
| Fluoride: | | | |
| • special land use | 1.8 µg/m$^3$ | 12 hours | |
| | 1.5 µg/m$^3$ | 24 hours | |
| | 0.8 µg/m$^3$ | 7 days | |
| | 0.4 µg/m$^3$ | 30 days | |
| | 0.25 µg/m$^3$ | 90 days | |
| • general land use | 3.7 µg/m$^3$ | 12 hours | |
| | 2.9 µg/m$^3$ | 24 hours | |
| | 1.7 µg/m$^3$ | 7 days | |
| | 0.84 µg/m$^3$ | 30 days | |
| | 0.5 µg/m$^3$ | 90 days | |
| Conservation areas | 0.1 µg/m$^3$ | 90 days | |

Notes: Critical levels for $NO_2$ assume that either $O_3$ or $SO_2$ are also present at near guideline levels. Critical levels for $O_3$ are expressed as a cumulative exposure over a concentration threshold referred to as AOT40 values (accumulative exposure over a threshold of 85.6 µg/m$^3$, at 0°C), calculated as the sum of the difference between hourly ambient $O_3$ concentrations and 85.6 µg/m$^3$, when $O_3$ concentrations exceed 85.6 µg/m$^3$). $O_3$ is only measured during daylight hours with a clear global radiation of 50 Wm$^{-2}$ or greater.

vpd = vapour pressure deficit.

# 5.3 Regional plans

By 2007 all regional councils had regional air quality plans either operational or in the final stages of becoming operational. The plans reflect particular regional circumstances and may range from the very straightforward, dealing primarily with issues of open burning, to the more complex, with specific rules and plans for meeting the Standards.

**It is important to understand the purpose of each regional plan when considering the application of air quality objectives (sometimes referred to as targets or goals).**

From a regulatory viewpoint, regional air quality plans are statutory instruments under the RMA and have equal status with the Standards. Where concentration thresholds double up, the more stringent level applies. Thus a regional air quality objective that is more stringent than a national ambient air quality standard supersedes the national standard. The regional air quality objectives cannot, however, be more lenient than the national ambient air quality standards.

## 5.4 WHO air quality guidelines

In response to the increasing evidence of the health impact of air pollution, the World Health Organisation (WHO) revised its existing air quality guidelines for Europe in October 2006 and expanded them to produce the first global air quality guidelines. These guidelines are based on the latest scientific evidence and set targets for air quality to protect the large majority of individuals from the effects of air pollution on health.

**The primary aim of the WHO guidelines is to provide a uniform basis for protecting public health from the effects of air pollution. They are intended for worldwide use.**

Table 5.6 summarises the updated WHO air quality guideline levels. These include annual guidelines for $PM_{2.5}$ and for $NO_2$, which are not currently covered by New Zealand standards or guidelines. The WHO 24-hour average $PM_{2.5}$ guideline is consistent with the New Zealand monitoring $PM_{2.5}$ guideline (Ministry for the Environment, 2002). The WHO 24-hour guideline for $SO_2$ is considerably more stringent than the New Zealand ambient air quality guideline.

**Table 5.6: Updated WHO air quality guideline values**

| Pollutant | AQG value | Averaging time |
|---|---|---|
| Particulate matter<br>$PM_{2.5}$<br><br>$PM_{10}$ | <br>**10 μg/m$^3$**<br>25 μg/m$^3$<br>20 μg/m$^3$<br>50 μg/m$^3$ | <br>**1 year**<br>24 hours (99th percentile)<br>1 year<br>24 hours (99th percentile) |
| Ozone ($O_3$) | 100 μg/m$^3$ | 8 hours, daily maximum |
| Nitrogen dioxide ($NO_2$) | **40 μg/m$^3$**<br>200 μg/m$^3$ | **1 year**<br>1 hour |
| Sulphur dioxide ($SO_2$) | **20 μg/m$^3$**<br>**500 μg/m$^3$** | **24 hours**<br>**10 minutes** |

Notes: Items in bold are not covered by New Zealand standards or guidelines; AQG value = air quality guideline.

## 5.5 International air quality criteria

If there are no New Zealand ambient air quality standards or guidelines, or WHO guidelines, relevant to the chemical under assessment, a number of other international air quality criteria may be used.

As noted above, air quality criteria published by different agencies may overlap, complement or sometimes outright contradict each other for some pollutants and some time averages. It is very important, therefore, when selecting air quality criteria for an air quality assessment, for the fundamental purpose of the standard or guideline to be understood. Similarly, the application of the criteria should be considered. What may be appropriate for an existing facility operating for a five-year consent may not be appropriate for a brand new plant applying for a full 35-year term.

**When using international air quality criteria, the assessment should explain which criteria have been selected and why.**

The criteria discussed below are recommended because of their traceable derivation from toxicological data.[3] They should be applied primarily as screening criteria. If the modelling/ monitoring results are well within the assessment criteria, then the effects on public health and the environment should be minor. However, if the results exceed the criteria, then a full health risk assessment is required (see section 8.5) and/or action will be needed to mitigate the emissions before consent is granted.

### 5.5.1 Acute exposure

For assessing short-term impacts, the California Office of Environmental Hazard Assessment *acute* reference exposure limits (RELs) are recommended:

www.oehha.ca.gov/air.html

The acute reference exposure limits are concentrations that are not likely to cause adverse effects in a human population, including sensitive subgroups, exposed on an intermittent basis to that concentration for one hour.

**Acute reference exposure limits are intended to protect the individuals who live or work in the vicinity of emissions of these substances.**

The focus of the acute reference exposure limits is generally a one-hour exposure for non-cancer health impacts.

[3] Although the traceable derivation from toxicological data has been selected as the basis of recommendation in this Good Practice Guide, it is recognised that this may hinder updates to air quality criteria. More recent and more stringent guidelines may be appropriate for some pollutants in some cases. The use of any alternative air quality criteria should be clearly justified.

### 5.5.2 Chronic exposure

For assessing long-term impacts, the US EPA inhalation reference concentrations (RfCs) and air unit risk factors are recommended:

http://www.epa.gov/iris/limits.htm

The inhalation reference concentration is an estimate of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime. It should be noted that these concentrations are based on an assumption of lifetime exposure and may not be appropriately applied to less-than-lifetime exposure situations.

**The inhalation reference concentrations can be used to estimate a level of environmental exposure at or below which no adverse effect is expected to occur.**

The inhalation reference concentrations are 24-hour averages and focus on non-carcinogenic health impacts.

The US EPA air unit risk factors are quantitative estimates of the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ in air. The interpretation of unit risk would be as follows:

> *If unit risk = $2 \times 10^{-6}$ per $\mu g/m^3$ then two excess cancer cases (upper-bound estimate) are expected to develop per 1,000,000 people if exposed daily for a lifetime to 1 µg of the chemical in 1 cubic metre of air.*

Quantitative estimates of risk factors for carcinogens are provided in the US EPA Integrated Risk Information System (IRIS) database, referred to in the above web address. As with the inhalation concentrations, the unit risk factors are based on an assumption of lifetime exposure and may not be appropriately applied to less-than-lifetime exposure situations.

In New Zealand, an acceptable environmental risk for exposure to environmental pollution of 1 in 100,000 has been adopted by the Ministry for the Environment in a range of guidelines for the management of contaminated land, most recently in the *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand* (Ministry for the Environment, 1999b). It is recommended that a similar level of risk be used when assessing discharges to air from industry.

Alternatively, the California Office of Environmental Hazard Assessment *chronic* reference exposure limits (RELs) may be used. A chronic reference exposure level is an airborne level that would pose no significant health risk to individuals indefinitely exposed to that level. RELs are based solely on health considerations, and are developed from the best available data in the scientific literature.

www.oehha.ca.gov/air.html

Chronic reference exposure limits are annual averages and focus on non-carcinogenic health impacts.

## 5.6 Workplace exposure standards

For some contaminants, and *in the absence of any other guidance*, the Department of Labour Occupational Health and Safety, Workplace Exposure Standards, Time Weighted Average (OSH WES TWA) can be amended for use as assessment criteria. The workplace exposure standards cover many of the chemicals that might be discharged, but they are set for protecting healthy people in a workplace setting (ie, 40-hour working week). In order to be used to protect more sensitive members of the community (the very young, the elderly, those whose health is already compromised) these standards should be divided by a safety factor for assessment over an eight-hour exposure period.

Historically a range of factors has been used. The Auckland Regional Council approach is recommended here (Auckland Regional Council, 2002):

- WES TWA divided by 50 for low and moderately toxic hazardous air pollutants, or
- WES TWA divided by 100 for highly toxic bioaccumulative or carcinogenic hazardous air pollutants.

This is based on division by 42 (rounded to 50). The factor of 42 is used to convert the eight-hour WES TWA into a 24-hour average over a whole week of discharges and then adding a further safety factor of 10 to account for protecting more sensitive portions of the population than healthy workers. The 100 factor has been derived by the same method, except that a safety factor of 20 has been used to account for more toxic hazardous air pollutants or more long-term chronic effects.

These WES TWA criteria should be compared with either a three-minute (Ausplume) or a one-hour average (all other models) depending on the air dispersion model used.

**Air quality criteria − recommendations**

A number of criteria are available for assessing the effects of air quality. Some take precedence in terms of stringency (eg, regional objectives over the national environmental standards for air quality). Others take precedence in terms of time average and application (eg, WHO guideline for sulphur dioxide should be applied to new plant).

In general terms the following criteria should be selected, in the following order of priority:

- national environmental standards for air quality
- national ambient air quality guidelines
- regional objectives *(unless more stringent than above criteria)*
- WHO air quality guidelines
- California reference exposure levels (acute and chronic)
- US EPA inhalation reference concentrations and unit risk factors (chronic).

*Adapted workplace exposure standards should only be used as a last resort.* Most common pollutants are covered by New Zealand ambient air quality standards and guidelines.

# 6 Tier 1 Preliminary Assessment

The Tier 1 assessment is a qualitative assessment. The objectives are to compile background information, identify key issues and determine the appropriate level of assessment. It is recommended that a Tier 1 preliminary assessment be undertaken before the first pre-application meeting with the council. The checklist in Appendix 1 may help with this.

The Tier 1 assessment should consider the receiving environment and the nature and scale of the proposal, focusing on the:

- scale of the development
- nature of the pollutants released to air
- adoption of pollution prevention measures
- alternatives
- complaints/compliance record
- existing air quality, including any airshed designation under the Standards
- physical geography of the receiving environment
- sensitivity of the receiving environment
- type of consent required
- any relevant objectives, policies or rules in the regional or district plan.

These factors are discussed further below. The level of detail required will vary depending on the proposal.

## 6.1 Proposals that do not require further assessment

It is likely that a Tier 1 assessment will be all that is required for a controlled activity in an appropriately zoned area with no highly sensitive receptors located nearby. Discharges to air from these activities are likely to be minimal, and easily controlled by process design and standard operating practices. Adequate dispersion of air emissions should be achievable via appropriately designed discharge points. The potential for off-site human health, environmental or amenity effects would be low.

An assessment for this type of activity should include:

- any information that may be required by the relevant regional plan, including evidence that the activity is permitted or controlled
- the site location and contact details
- a process and site description, including quantities of raw materials and fuels to be used
- a description of emissions to air
- a description of emission controls and mitigation measures
- a description of the receiving environment, including air quality, topography and meteorology

- a qualitative description of the potential effects, taking into account the emissions and the receiving environment
- a summary of any complaints relating to discharges to air from the site.

## 6.2 Information required for a Tier 1 assessment

### The scale of the development

The scale of a development may be thought of in terms of throughput of raw materials or output of product compared to similar developments. The assessment should therefore include a description of the activity, including process throughputs and quantities of raw materials to be stored and handled. Typically, the scale of the development determines whether or not consent is needed. Clearly it is more likely that larger-scale complex industry will require a higher level of assessment than smaller-scale activities.

### The pollutants released to air

The assessment should include a description of the type and likely quantities of air discharges. This will influence the level of assessment required.

### The type of consent required

The type of consent sought (ie, controlled, permitted, etc) will influence the level of assessment required. The preliminary assessment should include adequate information to demonstrate that the activity meets any requirements of the relevant regional plan for the type of consent required. The preliminary assessment should also consider whether the proposal may require other resource consents.

### Pollution prevention measures

The assessment should review the existence and effectiveness of any pollution prevention measures, and whether the measures in place (or proposed) are consistent with best practice for the type of industry being considered. Pollution prevention measures may include:

- cleaner production technologies – where waste reduction is a focus of industrial process design and operation so that more benign and fewer raw materials are used, less energy is consumed, and fewer waste materials are released to air, land or water, etc
- pollution control equipment (eg, the use of flue gas desulphurisation equipment with a conventional coal- or oil-fired power plant)
- the use of appropriately sized stacks to ensure adequate dispersion of emissions to air before a pollutant plume reaches potentially affected receptors
- the use of management or operational controls, such as process or emissions monitoring or management plans

- the use of buffer zones to separate receptors from industrial emission sources
- the provision of offsets.

The best local guidance on what constitutes best practice in terms of emission levels is set out in the NSW Department of Environment and Conservation (2002) *Protection of Environmental Operations (Clean Air) Regulations*. This regulation was amended in 2005 to incorporate emission concentration limits for new plant (ie, Group 6) that reflect contemporary best practice control technology.

Secondary guidance on clean technologies and abatement equipment available to a wide range of industrial sectors is available from the website of the European Integrated Pollution Prevention and Control Bureau (http://eippcb.jrc.es/). This provides reference documents on the best available techniques under the EU Integrated Pollution Prevention and Control Directive.

Offsets are another potential form of mitigation, whereby emissions from an activity are 'offset' by emission reductions elsewhere in an airshed (see section 5.1.1 for further explanation of offsets). The *Updated Users Guide* (Ministry for the Environment, 2005) expands on this form of mitigation.

Pollution prevention measures act to prevent and minimise the potential impacts of industrial emissions to air. A well-controlled industrial development, from the perspective of emissions to air, would be expected to require a lower level of assessment and have a greater chance of proceeding than one that is poorly controlled.

### Alternatives

The Tier 1 assessment should consider alternatives, including:

- alternative locations that may be less sensitive
- alternative methods of undertaking the activity (eg, cleaner production)
- alternative methods of pollution control that may reduce emissions
- whether the discharge could be to another receiving environment (eg, into water rather than air).

### The complaints/compliance record

For an existing industry applying for consent renewal or expanding in scale, the complaints history will be a relevant factor.

When it comes to air quality, the most frequent complaints are about dust and odour. The Ministry for the Environment provides separate guidance for assessing dust and odour impacts, which should be followed if these have the potential to persist or occur (Ministry for the Environment, 2001a and 2003, respectively). Clearly, where a complaints record indicates there are existing community concerns regarding an air quality issue relevant to an application, a higher level of assessment would be expected.

Similarly, where an existing industrial development is seeking consent for expansion or alteration, the consent condition compliance record should be examined (eg, compliance with stack emission limits). Where compliance has been poor, the engineering design should be improved.

Overall, the level of assessment expected is likely to be higher for an industry with a poor compliance record.

## Airshed designation under the national environmental standards for air quality

At the time of publication, 69 areas throughout New Zealand have been gazetted as airsheds under the provisions of the Standards. Of these, around 30 are likely to exceed the national ambient air quality standard for $PM_{10}$ and are therefore subject to controls on the granting of resource consents. It is likely that any industrial development within these airshed areas that shows any significant increase in $PM_{10}$ emissions will require a Tier 3 assessment. For up-to-date information on airshed designations, contact the appropriate regional council.

## The existing air quality

Existing air quality is an important consideration in any air quality assessment. The Tier 1 preliminary assessment should determine what information is available (if any) on existing air quality, and how this compares to relevant air quality criteria.

## The physical geography of the receiving environment

The physical geography of an area can affect the dispersion of pollutants, and is a particularly important consideration in dispersion modelling. The preliminary assessment should identify whether there are any significant topographical features that may affect dispersion.

Features such as coasts and mountainous terrain require more complex predictive modelling techniques than, for example, flat inland sites. These considerations are well covered in the *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004a), which is a companion guide to this document. A qualitative consideration is briefly covered in section 5.

## Regional and district plan requirements

The Tier 1 assessment should include a review of the relevant regional and district plans to identify any objectives, policies or rules that should be considered.

## The sensitivity of the receiving environment

Adverse effects on air quality can be exacerbated by the sensitivity of the receiving environment. An assessment of the sensitivity of the receiving environment requires an assessment of land use and the likely sensitivity of the local population to air emissions.

Table 6.1 provides a general classification of the sensitivity of various land uses to discharges of contaminants into air. Because land uses are the key criteria for classifying the sensitivity of the receiving environment, district plan zonings can have a large influence on an area's sensitivity. Higher-sensitivity land uses will require a higher level of assessment.

**Table 6.1: Types of land use/location and the sensitivity of the receiving environment**

| Land use | Reasons for sensitivity | Rating |
|---|---|---|
| Hospitals, schools, childcare facilities, rest homes | People of high sensitivity (including children, the sick and the elderly) are exposed.<br>People are likely to be exposed continuously (up to 24 hours, seven days a week). | High |
| Residential | People of high sensitivity (including children and the elderly) are exposed.<br>People cherish a stress-free environment at home and have the view that 'my house is my castle'.<br>People may be present all times of the day and night, both indoors and outdoors.<br>Visitors to the area are unfamiliar with any discharges and are more likely to be adversely affected (which can cause embarrassment to residents and raise awareness of the problem). | High |
| Open space recreational | These areas are used for outdoor activities and exercise, in circumstances where people tend to be more aware of the air quality.<br>People of all ages, physical conditions and sensitivity can be present. | High |
| Tourist, cultural, conservation | These areas can have high environmental values, so adverse effects are unlikely to be tolerated. | High |
| Commercial, retail, business | These areas have a similar population density to residential areas as people of all ages and sensitivity can use them.<br>Commercial activities can also be sensitive to other uses (eg, food preparation affected by volatile organic compounds emissions from paint manufacture).<br>There can be embarrassment factors for businesses with clients on their premises. | Medium to high |
| Rural residential/ countryside living | Population density is lower than in residential areas, so the opportunity to be adversely affected is lower. However, people of high sensitivity can still be exposed at all times of the day and night.<br>Often people move into these areas for a healthier lifestyle and can be particularly sensitive to perceived health risks. | Medium to high |
| Rural | A low population density means there is a decreased risk of people being adversely affected.<br>People living in and visiting rural areas generally have a high tolerance for rural activities and their associated effects. Although these people can be desensitised to rural activities, they are still sensitive to other types of activities (eg, industrial activities). | Low |
| Heavy industrial | Adverse amenity effects tend to be tolerated as long as the effects are not severe.<br>Many sources discharge into air, so there is often a mix of effects.<br>People who occupy these areas tend to be adult and in good physical condition, so are more likely to tolerate adverse effects, particularly if the source is associated with their employment. | Low |
| Light industrial | These areas tend to be a mix of small industrial premises and commercial/retail/ food activities. Some activities are incompatible with air quality impacts (such as paint sprayers requiring a dust-free environment), while others will discharge to air. | Low |
| Public roads | Roads users will typically be exposed to adverse effects from industrial sources for only short periods of time. | Low |

**Tier 1 preliminary assessment − recommendations**

Tier 1 represents the simplest check as to whether a discharge to air might cause adverse effects. The criteria are conservative and provide a simple checklist. If there is any doubt, the assessment should proceed to Tier 2, or be discussed with council officers.

# 7 Tier 2 Screening Assessment

The Tier 2 assessment is a relatively simple screening exercise to determine whether a proposal is likely to result in exceedances of ambient air quality criteria, in particular the national ambient air quality standards.

The aim of a screening assessment is to provide conservative estimates of air quality impacts, which may not be completely accurate but can provide confidence that a project will not result in significant air quality impacts. The recommended screening assessment process is based on the methods most commonly used in New Zealand.

The Tier 2 and Tier 3 assessments use essentially the same tools and techniques, but a Tier 2 assessment uses conservative assumptions so it can be undertaken relatively quickly and easily. Users who are not familiar with the assessment process should read this section in conjunction with section 8 (Tier 3 assessments).

A Tier 2 assessment (see Figure 7.1) would be suitable for a small-scale activity, which may be located in an area where there are sensitive receptors nearby or close to a more sensitively zoned area. Discharges to air may have the potential to give rise to off-site effects if poorly managed or during process upsets. Monitoring of emissions or processes may be required for existing facilities to ensure that offsite human health, environmental or amenity effects are avoided. Air pollution control equipment may need to be installed, along with the implementation of best practice operating procedures.

## 7.1 National environmental standards for air quality

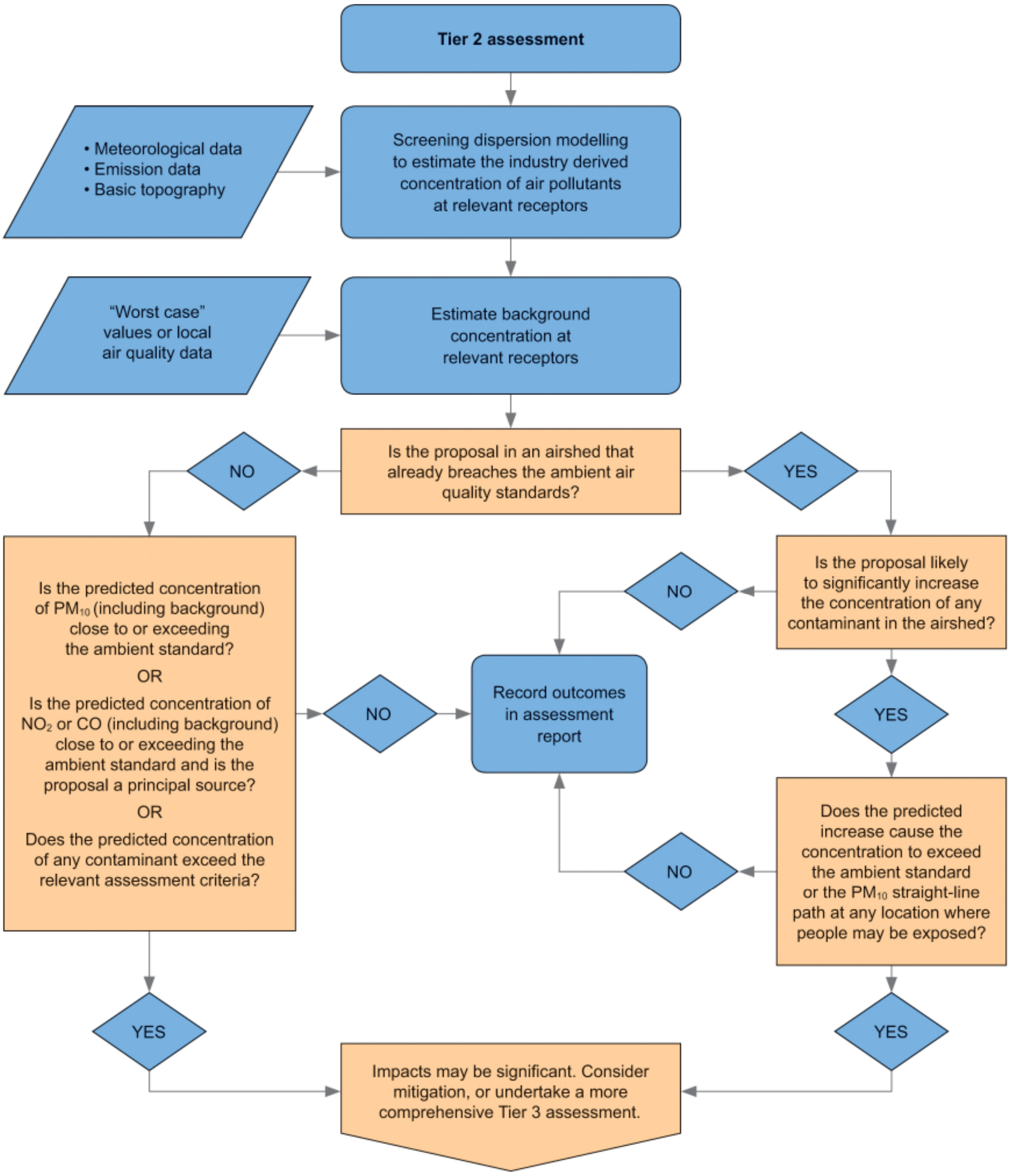
Special care is needed for any assessment in an airshed that breaches the national ambient air quality standards. In particular, within an airshed that breaches the $PM_{10}$ standard, it is likely that any proposal resulting in a significant increase in $PM_{10}$ emissions will require mitigation or not be allowed. Any significant increase in emissions at a location that already breaches a national ambient air quality standard would generally require a detailed Tier 3 assessment. Consultation with the regional council is recommended before undertaking any detailed Tier 3 assessment, however, particularly in an airshed that breaches the Standards.

## 7.2 Characterising the discharges to air

Characterising the discharges to air for a Tier 2 assessment is essentially the same as for a Tier 3 assessment (see section 8.1), with a level of detail appropriate to the nature and scale of the proposal. However, to ensure conservatism, a Tier 2 assessment should be based on maximum proposed emission rates, and the assessment should include enough detail to demonstrate that the emission rates assumed are conservative. This may involve:

- developing an emissions inventory for the site, and noting the nature and composition of the air discharges, including (where available) an estimation of the quantities of pollutants emitted – some emission testing may be required to assist in compiling this inventory
- assessing the engineering and operational controls in place to control discharges to air – this may require some compliance testing for existing plant to show that the equipment is operating satisfactorily
- reviewing the performance standards for proposed new control equipment included as part of the development.

**Figure 7.1: Tier 2 assessment process**



## 7.3 Exposure estimates

### 7.3.1 Estimating ground-level concentration of air pollutants

Atmospheric dispersion modelling is used to estimate the maximum ground-level concentration of pollutants. The *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004a) includes detailed guidance on all aspects of dispersion modelling.

A Tier 2 screening assessment will generally be based on simple techniques and relatively crude assumptions, with the aim of ensuring conservative estimates. It is recommended that a Tier 2 assessment should:

- use a steady-state Gaussian plume dispersion model, such as Ausplume
- use worst-case meteorology – either a screening meteorological data set or measured worst-case conditions
- be based on maximum normal emission rates.

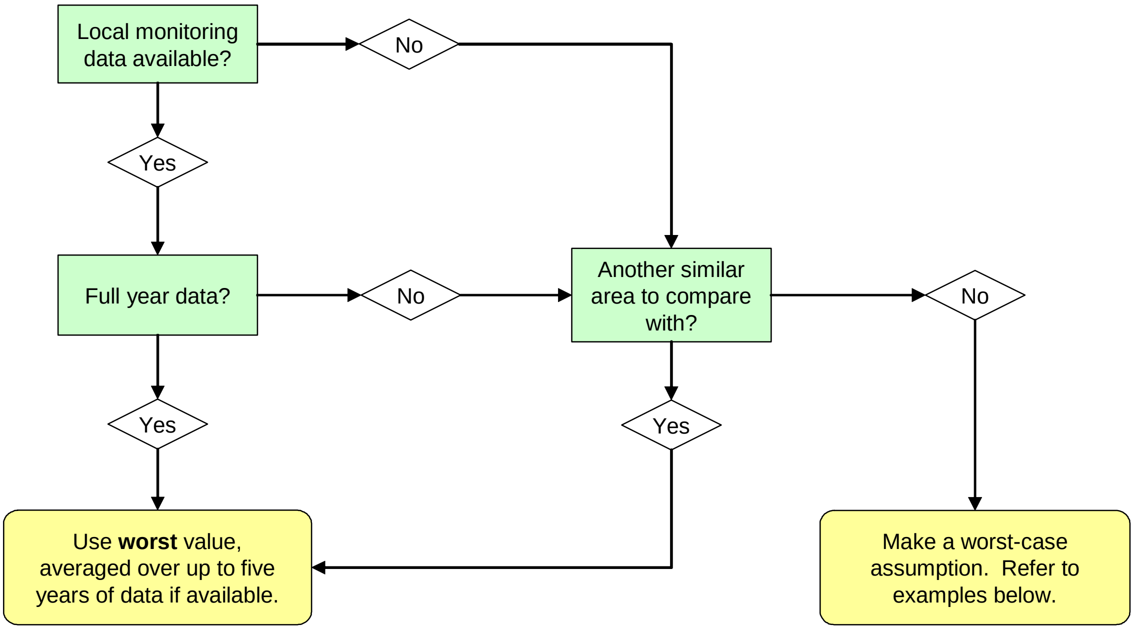
Note that the use of screening meteorological data has limitations that need to be understood. They will generally only give an indication of the theoretical worst case one-hour concentration. They cannot give (a) concentrations at other averaging times, (b) any idea of the frequency of occurrence, (c) anything but a very crude idea of the location of the peak values, (d) possible concentrations in extreme geographical or meteorological situations. It is always preferable to use a local, validated, meteorological data set, and these are available for many regions, particularly the major cities.

### 7.3.2 Background concentrations

Although it is important to assess the concentration of air pollutants as a result of the proposal, the RMA requires an assessment of the overall end result – the cumulative effect. This means that the modelled concentrations must be added to background concentrations discharged by other sources.

The *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004a) includes guidance for accounting for background concentrations (in section 6.4 of that guide). For a Tier 2 assessment it is generally appropriate to make worst-case assumptions about background air quality. On this basis, a recommended approach for a Tier 2 assessment is outlined below. This approach is very conservative, and a more detailed assessment may be required if this results in a prediction of unacceptable air quality effects. This is discussed further for the Tier 3 assessment procedure.

**Figure 7.2: Determining background concentration for a Tier 2 process**




Local monitoring data may be available from the local regional council. If such data are not available, the most straightforward options are as follows.

**1. Compare the location with somewhere similar**

If the area does not have significant large sources, and does not have any complex geographical or meteorological features, then it can be assumed that the air quality will be similar to another area of similar population density, emission sources and meteorology. This method requires that such an area can be identified, and that monitoring data are available.

**2. Make a worst-case assumption**

In the absence of air quality data from local or similar areas, it might be necessary to simply guess the existing air quality. The safest guess is to assume a concentration at the upper end of what might be feasible. Some examples are provided in Table 7.1. It is important to ensure that the 'existing air quality without project' concentration selected is appropriate and relevant to the location of the proposed project. For example, to avoid 'double counting' it is important to select existing air quality data from an area that is not influenced by the discharge under consideration, if the assessment includes dispersion modelling to predict the impact of any existing and proposed additional discharges.

**Table 7.1: Examples of existing $NO_2$, $PM_{10}$ and CO concentration 'without project'**

| Area where estimate of background air quality is required | Pollutant | Value to assume | Justification for worst-case assumption, based on review of data to 2004 (extracted from various council monitoring reports and web site data in mid-2005) |
|---|---|---|---|
| An urban area with a significant wood- or coal- burning problem (eg, a gazetted airshed) | $NO_2$ 1 hr | 150 ($\mu g/m^3$) | 10-year average of maxima, Packe Street, Christchurch = 124.<br>3-year average of maxima, Coles Place, Christchurch = 110.<br>1-year maximum, fire station, Nelson = 148. *Christchurch and Nelson represent the worst case for areas with significant domestic heating pollution.* |
| | $PM_{10}$ 24 hr | 100 ($\mu g/m^3$) | Christchurch, Nelson, Timaru, Masterton, Mosgiel, Arrowtown, Richmond and Kaiapoi have all recorded peaks of over 100 (the highest is 252 in Christchurch in 2002). |
| | CO 8 hr | 8 ($mg/m^3$) | The highest values recorded in Christchurch have been slightly above 8. |
| Area with poor dispersion (eg, urban canyon) within 5 m of a busy intersection or congested area (with over 10,000 vehicles per day and/or wood or coal burning) | $NO_2$ 1 hr | 340 ($\mu g/m^3$) | 4-year average of maxima Khyber Pass = 343. *Khyber Pass is a peak traffic monitoring data for $NO_2$ (traffic approx 30,000 vehicles/day, air quality monitoring < 5 m from roadside)* |
| | $PM_{10}$ 24 hr | 80 ($\mu g/m^3$) | Even smaller centres that have poor dispersion can record high values (Reefton 55, Nelson 165, Wainuiomata 57, Upper Hutt 60). |
| | CO 8 hr | 10 ($mg/m^3$) | The highest values recorded in Auckland have been slightly above 10. |
| Area within 20 m of vehicle routes of over 10,000 per day, or within 100 m of a motorway | $NO_2$ 1 hr | 140 ($\mu g/m^3$) | 10-year average of maxima, Auckland Penrose = 139.<br>2-year average of maxima, Peachgrove Road, Hamilton = 133. *Penrose and Peachgrove Road have the highest maximum $NO_2$ levels of all data reviewed except for Khyber Pass.* |
| | $PM_{10}$ 24 hr | 70 ($\mu g/m^3$) | There are not many sites in this category with monitoring results, but Auckland's Khyber Pass has recorded 81, almost certainly largely due to traffic. |
| | CO 8 hr | 5 ($mg/m^3$) | 4-year average of maxima, Peachgrove Road, Hamilton = 4.75.<br>Maxima at peak traffic sites in Rotorua and Tauranga are also less than 5. |
| Urban area that doesn't have significant wood-burning problem and no vehicle routes of over 10,000 vehicles per day within 20 m, or motorways within 100 m | $NO_2$ 1 hr | 50 ($\mu g/m^3$) | Hastings, less than 1 year of data, maximum = 36.<br>Napier, less than 1 year of data, maximum = 66.<br>Wellington, all sites, all years, maximum = 53. *These sites have some traffic influence, so represent a worst-case assumption for urban areas without significant traffic.* |
| | $PM_{10}$ 24 hr | 40 ($\mu g/m^3$) | Residential neighbourhood monitoring sites in Hawke's Bay and Bay of Plenty have recorded occasional exceedances of the $PM_{10}$ standard, although averages of maxima taken over several years tend to be lower than 40. |
| | CO 8 hr | 2 ($mg/m^3$) | Maximum concentrations measured at neighbourhood sites in Upper Hutt, Lower Hutt and Masterton are typically 2 or less. |
| Rural area, or urban area that is very open with low population density | $NO_2$ 1 hr | 15 ($\mu g/m^3$) | Masterton 2-year average of maxima = 13.5. *There are no results available from rural monitoring sites. Masterton is the lowest result for a 'residential neighbourhood' site, so this is a worst-case assumption for a rural area.* |
| | $PM_{10}$ 24 hr | 15 ($\mu g/m^3$) | This is a typical maximum concentration when no obvious sources occur upwind. |
| | CO 8 hr | 0 ($mg/m^3$) | With no local sources, CO concentrations are generally very low, and can be taken as effectively zero. |

## 7.4 Assessing the effects

To assess whether significant air quality impacts are likely, the estimated concentrations of pollutants are compared to assessment criteria (discussed in section 5). For the most common pollutants, the primary criteria are the national environmental standards for air quality and the New Zealand *Ambient Air Quality Guidelines*. As noted in section 5, air quality objectives in regional plans should also be considered as these take precedence if they are more stringent than the national ambient air quality standards or guidelines.

The maximum ground-level concentration (including background) predicted by the screening methodology should be compared to the relevant assessment criteria. This comparison should be made for locations where people may be exposed for the relevant averaging period.

A Tier 3 assessment should be undertaken if:

- the predicted concentration (including background) of nitrogen dioxide or carbon monoxide exceeds the assessment criteria, and the industry-derived concentration is a 'principal source' of the exceedance (the meaning of principal source is discussed in section 5), or
- the proposal is within an airshed that does not already breach the $PM_{10}$ standard, and the predicted concentration (including background) exceeds the assessment criteria for $PM_{10}$, or
- the proposal is within an airshed that already breaches the $PM_{10}$ standard, and the proposal is predicted to significantly increase the concentration of $PM_{10}$ in the airshed; and/or the predicted concentration, including background, exceeds the straight-line path (or curved-line path) (factors to consider when determining significance are discussed in section 5), or
- the predicted concentration (including background) of any other contaminant exceeds the relevant assessment criteria.

The requirements of the Standards are summarised in previous sections. If there is doubt (eg, about whether the predicted increase in $PM_{10}$ is significant), a Tier 3 assessment should be undertaken. A Tier 3 assessment should also be undertaken if the Tier 2 assessment is inconclusive for any reason.

The aim of a Tier 2 assessment is to provide a conservative estimate of the likely air quality impacts of a proposal. If these criteria are exceeded, this does not necessarily mean the air quality impacts will be unacceptable. It simply means a more accurate assessment should be undertaken. Mitigation options, or alternative options that do not exceed the criteria, could be considered at this stage, although further assessment may show these are not required.

## 7.5 Reporting a Tier 2 assessment

The results of a Tier 2 assessment should be documented for inclusion into any assessment of environmental effects, and to provide the basis for a Tier 3 assessment, where necessary. The report should summarise the findings of the Tier 2 assessment, including the basis for the emission information, air quality information, any assumptions, and their justification. Recommended reporting requirements are given in section 4.4.

**Tier 2 screening assessment − recommendations**

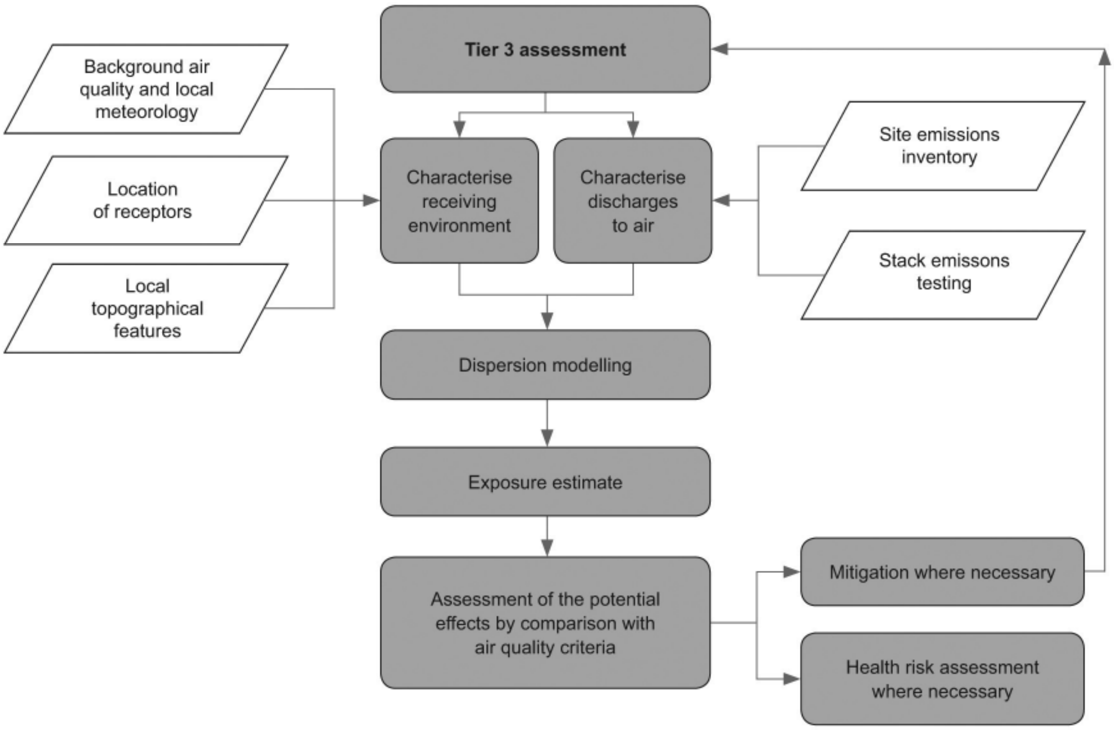
Tier 2 provides for the next level of assessment. It is distinguished from Tier 1 in that most Tier 1 processes will be permitted activities or have trivial discharges. Tier 2 processes, on the other hand, are likely to be discretionary activities and need a more quantified level of assessment. Some guidance is given on the likely features of a Tier 2 assessment, although different regions may have different specific requirements. If there is any doubt, discuss with the council consenting officer.

# 8 Tier 3 Full Assessment

The aim of a Tier 3 assessment is to provide reasonably accurate estimates and a detailed assessment of the likely air quality impacts associated with a proposal. This is usually done through the use of detailed emission information, a topographical profile, dispersion modelling and background air quality and meteorological data. For any aspect of the assessment where detailed information is not available, or is not required, it is appropriate to adopt the conservative assumptions discussed for Tier 2 assessments.

An overview of the Tier 3 assessment is shown in Figure 8.1.

**Figure 8.1: Tier 3 assessment process**




## 8.1 Characterising the discharges to air

Characterising the discharges to air includes:

- identifying all air discharges associated with the development (they may be point sources such as stacks and vents, area sources such as ponds or disturbed soils, or volume sources such as fugitive emissions from buildings)
- describing the sources of the discharge (including all process factors influencing the quantity and nature of the discharges)

- detailing the nature of the emissions (pollutant types, concentrations and mass emissions, emission temperatures, velocities, particle sizes, etc)
- detailing the measures employed to prevent and minimise the discharges.

The following discussion offers guidance on the type of information that should be provided to describe the proposed development and the potential sources of air emissions.

### 8.1.1 Description of the proposal

The description of the proposal should be sufficient to enable a full understanding of the application from an air discharge consent viewpoint, and should also provide sufficient information to ascertain whether any other consents are required.

The depth of information required will vary depending on the type of activity, although for industrial activities the following should generally be provided:

- a detailed process flow diagram or, if more appropriate, a process and instrumentation (P&D) diagram showing all existing and/or proposed plant and equipment included in the proposal, including emissions control equipment and emission points
- a written summary of the process flow from raw materials to final product, focusing on aspects that give rise to emissions to air
- details of alternatives considered and reasons for their rejection
- details of any relevant historical information, including past changes to the activity
- details of any proposed changes to an existing activity
- any relevant timeframes or constraints for undertaking the activity
- details of all emissions control equipment, including design-criteria calculations and design drawings
- details of potential upset/emergency conditions, including their influence on emissions
- any mitigation and/or preventive measures undertaken on site for both ordinary and accidental emissions to air, including management techniques (eg, management plans), alarms, interlocks, monitors and control equipment
- maximum and normal processing capacities
- maximum and normal ratings, capacities and throughput of all major plant equipment, including boilers, air discharge control equipment, driers, mixing tanks and crushing plant
- details of any materials-handling procedures and mitigation measures in place for raw, intermediate, by-product and finished materials.

Because the application is defined by the process description, consent can only be granted for what is applied for. Therefore, all details possible relating to current and proposed operations should be included to enable all matters to be properly considered. Any proposed changes to an existing process should be highlighted.

Consent applicants should recognise that data provided in an assessment will often form the basis for setting the consent conditions. For example, fuels in a combustion process may be limited to those identified in the application, or dispersion-modelled emission rates may be adopted as stack emission limits. It is therefore important that any application reasonably reflects all anticipated operational scenarios for a development in order to provide for the desired flexibility.

### 8.1.2 Defining the discharge for dispersion modelling

Section 4.1 of the *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004a) provides a description of the information required to define the variety of discharge points for dispersion modelling.

An assessment of emissions from industry to air should also address abnormal or uncommon emission scenarios, including start-up, shut-down, upset conditions and emergency release. These scenarios often result in elevated emissions, or emissions of chemical intermediates that would not normally be released. It is often appropriate to assess these using a risk-based (probabilistic) approach; that is, considering not only the consequences of the release but also the likelihood of it occurring. Consideration of these occurrences is often tailored to a specific situation; for example, considering only short-term average assessment criteria commensurate with the duration of exposure.

Where a project goes through different stages of development, such as in a mine or an industrial process with anticipated production growth, these project-life operating and emission changes should also be addressed in the assessment.

*Compliance Monitoring and Emissions Testing of Discharges to Air* (Ministry for the Environment, 1998) provides guidance for obtaining pollutant emission rate and concentration data by measuring an existing source. If the assessment will be based on previous monitoring results, the data collection method should be audited against the methods specified in the guide.

It is important to note that although measured emissions data are more representative than estimates from process data (eg, emissions factors or engineering calculations), they too are typically only accurate to within ±15%. Variations in process can further add another ±10%, so that what is measured and modelled as 1.0 g/s may in fact be as high as 1.3 g/s or as low as 0.8 g/s. This may have a significant impact on downwind concentration estimates. The *Good Practice Guide for Atmospheric Dispersion Modelling* addresses this by recommending the use of a maximum emission rate to cover the worst-case discharge of concern.

Proprietary process simulation software can also provide useful emissions data (eg, GT PRO for gas turbine emissions). A number of air quality professionals also make use of combustion calculation software.[4]

As noted above, the Ministry for the Environment provides guidance on both characterising release points for the purpose of dispersion modelling and on emissions monitoring (Ministry for the Environment, 2004a and 1998, respectively).

---

[4] For instance, Flue 2, for the generation emission data from combustion processes. The freeware is available from Terry Brady Consulting Limited (terry@ebg.pl.net).

# 8.2 Characterising the receiving environment

## 8.2.1 Existing air quality

Information on existing air quality is essential for assessing the effects of new industrial developments. It is not just the increase in air quality attributed to the industry, but rather the cumulative impact of any increase to existing pollution levels and how that compares with the appropriate air quality criteria that requires assessment.

### When existing air quality data are required

Existing air quality should be considered in all assessments of discharges to air. The level of detail and accuracy required is influenced by the:

- **nature of the discharge** – large discharges or discharges of pollutants of high toxicity, which may have the potential to adversely impact the environment, would be expected to require a thorough assessment of the existing air quality
- **anticipated air quality** – areas that are anticipated to have poor air quality due to a combination of existing emission sources and/or adverse terrain or meteorology would be expected to require a more robust definition of the existing air quality
- **sensitivity of the receiving environment** – where discharges have the potential to affect highly sensitive receiving environments (see Table 6.1), existing air quality would be expected to be well-defined.

It is the combination of these considerations that determines the extent to which existing air quality should be addressed. A small emission of a low-toxicity pollutant within a commercial/ light industrial area, for example, might only require a qualitative statement on existing air quality identifying the reasons existing air quality is anticipated to be good. Conversely, a large-scale industrial source with the potential to have an impact on residential suburbs might be expected to provide good-quality, representative and quantitative air quality data.

As well as the generic considerations identified above, in situations where a proposal might result in increased $PM_{10}$ emissions within a gazetted airshed (as defined under the Standards), existing air quality is likely to be given greater attention.

### Identifying existing data

The range of options for generating air quality monitoring data, ranked in order by the increasing effort required to obtain the data, are:

- use surrogate data from locations with air quality characteristics representative of the area of interest
- use existing monitoring data sets for the area of interest
- use atmospheric dispersion modelling to predict air pollutant concentrations due to existing sources (as well as the concentrations due to the proposed development)
- commission a monitoring programme specifically for the purposes of the consent.

Pre-existing air quality data can be obtained from a range of sources. The consenting authority will usually have the best knowledge of the full range of data available within its region, and will also be able to provide an opinion as to whether the pre-existing data are sufficient for the assessment proposed.

The range of air quality data sources is identified in section 6.4.1 of the *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004a). Atmospheric dispersion modelling may be the preferred approach for estimating existing air quality where:

- there are a small number of existing emission sources in the area for which reliable emission data are available
- any contribution to ambient levels from other hard-to-characterise sources (such as vehicle emissions, domestic fires or dust from wind erosion) is negligible.

This situation would be unlikely to occur in urban areas of New Zealand. Again, the *Good Practice Guide for Atmospheric Dispersion Modelling* provides advice on the appropriate application of dispersion models.

Overall, the pollutants released from the proposal and the assessment criteria that are available for those pollutants determine the type of existing air quality data required for any assessment.

## Reviewing existing data

Guidance on assessing the quality of currently available ambient air quality data as well as quality assurance and control procedures for the collection of new air quality data is provided in the Ministry for the Environment's (2000) *Guide to Air Quality Monitoring and Data Management*. The assessment criteria often include requirements for the air quality monitoring technique to be used. For example, the Standards contain specific requirements for the monitoring of pollutants within gazetted airsheds. The Ministry for the Environment's *Ambient Air Quality Guidelines* also contain recommended monitoring methods.

The use of such methods reduces uncertainty and minimises inaccuracy. Before using existing air quality data in an assessment, it is important that the monitoring technique and protocols be audited against the requirements of the Standards and the *Guide to Air Quality Monitoring and Data Management* to demonstrate that the existing air quality data are of appropriate quality.

The location of a monitoring site and the time of monitoring also affect how representative existing air quality data might be. The site should be representative in terms of location (ideally, within the affected airshed), but also representative in terms of land use and physical setting. The specific location of the monitoring site (eg, its proximity to major sources such as roads and other industry) will also be important.

The time of the monitoring is also relevant, in that data collected at the site in previous years may not be representative if the character of the area has changed markedly since monitoring was last undertaken. For example, historical data from an area that has experienced significant population growth and commercial expansion (and hence increased vehicle and potentially industrial emissions) may no longer be representative of current levels.

Trends in air quality should be considered, and it is preferable for several years of data to be analysed so that any improvement or deterioration of the air quality of an area can be ascertained. As a minimum, one year of data could be used if there are other longer-term monitoring sites in similar locations which can be used to provide an indication of long-term trends. Ideally, 10 years of data should be used to determine trends.

As noted above, monitoring data should be reviewed with reference to the monitoring method identified in Schedule 2 of the Standards and other Ministry for the Environment guidance (Ministry for the Environment, 2000a, 2002 and 2004a).

### 8.2.2 The built environment

Sensitivity to air quality will vary with land-use type. For example, residential land use (including schools) will typically have greater sensitivity than an industrial setting.

The land use surrounding a proposed development should be reviewed and described in any assessment of air quality impacts. The review will provide both an indication to any developer of the likely acceptability of, or objection to, a proposal and a guide to the depth of consultation required. The sensitivity will also be one factor that influences the level of assessment of environmental effects required for a proposed development.

Land-use zoning must also be reviewed in the relevant district plan to ascertain whether the proposal (in its proposed location) is permitted. District plans provide maps that generally zone the district by land-use types. District plans also provide rules that identify the limitations on land use, either within those zones or in the wider district.

Authors of district plans and developers should also be aware of the issue of 'reverse sensitivity'. Reverse sensitivity relates to sensitive land uses encroaching on, for example, industrial facilities. Allowing such encroachment is seen as having potentially adverse effects on the health, safety or amenity values of people, as well as potentially adversely affecting the economic and safe operations of industries.

Case precedents in the Environment Court (see *ARC vs ACC*, RMA10/97) mean that new designations of sensitive land uses within the vicinity of industry may be turned down on the basis of reverse sensitivity. The use of buffers minimises the effects of reverse sensitivity, and it is recommended that buffers be owned by the industry creating the discharge.

## 8.3 Exposure estimates

### 8.3.1 Dispersion modelling

Atmospheric dispersion models are used to estimate contaminant concentrations downwind of a discharge source. The prediction of pollutant concentrations using atmospheric dispersion models has been covered in detail in the *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004a). This contains guidance on the application of models for a range of emission types, and meteorological and terrain scenarios. Of particular note is Recommendation 59, which deals with the issue of model accuracy and how it should be dealt with in a regulatory context.

## 8.4 Assessing the effects

### 8.4.1 Incorporating background concentrations

Background air quality data and predicted pollutant concentrations must be considered together against the selected assessment criteria. Adding the background data and predicted results to provide an estimate of the cumulative impact for comparison with the selected assessment criteria is reasonable for annual average concentrations. For short-term concentrations, this simplistic approach is appropriate where the criteria are not breached, although it is a very conservative approach and a more accurate assessment may be necessary where compliance is an issue.

The above approach can lead to an overly conservative assessment due to issues relating to the spatial and temporal coincidence of background and predicted concentrations, as follows.

- **Spatial co-incidence problems** – it is often difficult to know whether the background data are representative of the point at which the modelled peak occurs. In general, they will not be located in the same place, so adding the two will overestimate actual future concentrations.
- **Time co-incidence problems** – both modelled and background concentrations vary with the time of day due to factors such as meteorological patterns, operational variations and changes in background emission sources (eg, winter emissions from home heating and/or peak traffic emissions). In most cases, the peak caused by a point-source emission does not occur at the same time as the background peak, so adding the two together may again overestimate the future concentration.

For the highest percentiles (ie, concentration values close to the peak short-term concentration of a year’s worth of such concentration predictions), simple addition can overestimate the source contribution, and in general the overestimate is more severe for the higher percentiles.

The best predictive assessment technique is to use hourly, sequential ambient air quality monitoring data that are recorded in the airshed of interest, and then add the hour-by-hour predicted concentrations. These predicted concentrations should be made using meteorological data recorded at the same time as the recorded air quality data. Where data are available, such an approach is recommended.

It is rare for all this data to be available, however, and the UK Environment Agency study has investigated some alternative approaches. A simpler approach, which gave better accuracy than some and equal accuracy to the best alternative statistical approach, was to add the predicted short-term average concentration to twice the annual average background concentration.

This approach will not generally be applicable for pollutants such as $PM_{10}$, for which more locally specific techniques could be used. For example, if the $PM_{10}$ levels are known through monitoring in some nearby location that has obvious geographical and emissions similarities, then this can be used as a proxy for the background concentration.

### 8.4.2 Accumulation

Many of the effects assessments discussed so far are based on various standards, guidelines and criteria relating to acceptable concentrations in the air. However, some discharges have the potential to deposit on the surface and accumulate over the entire lifetime of the discharge. These are often in the form of particulates, but they can be gaseous.

A common example is mercury, which is a component in coal and is discharged in both particulate and gaseous (vapour) phases. Although the current ambient concentration guideline may be met, under some circumstances − such as a very long lifetime for the discharge (20 years or more), in particularly sensitive areas (eg, near a market garden), or in particularly difficult terrain (eg, near a hill) − there may be accumulated effects due to deposition that allow mercury to build up in the soil to unacceptable levels.

Mercury is one example, but the situation applies to all other heavy metals, many toxic organics that do not degrade rapidly, and other contaminants that might have effects as well as being non-degradable. These factors should be evaluated, and modelling can be used to assess potential accumulation rates. Assessing the actual effects can be more difficult, since for some compounds the long-term effects are not well known. A more detailed account can be found in the Ministry for the Environment’s guide on ecosystem effects (Ministry for the Environment, 2000b).

### 8.4.3 Atmospheric chemistry

The chemical transformation of emissions during transport in the atmosphere can be another important consideration. For example, the perception of odour can change between the source and the receiving environment due to chemical transformation, although there is no practical way to assess this effect.

Perhaps the most commonly encountered issues with regard to atmospheric chemistry are:

- the oxidation of NO to $NO_2$ when $NO_x$ (oxides of nitrogen) are released from industrial emissions
- the formation of the secondary pollutant ozone ($O_3$) following release of $NO_x$ and volatile organic compounds (VOCs) from industrial and other anthropogenic sources
- the formation of secondary particulates from sulphur and nitrogen discharges.

Methods for assessing these issues were discussed and identified in section 4.3.6 and Appendix C of the *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004a).

To estimate $NO_2$ concentrations from modelled $NO_x$ concentrations, the methodology proposed in Appendix C of that guide is recommended. This is a simply applied, conservative approach based on the US EPA $O_3$-limiting method, together with knowledge of the available background $O_3$ concentrations within air masses moving off the oceans and across New Zealand. Since the publication of the *Good Practice Guide for Atmospheric Dispersion Modelling*, further analysis has been conducted and a refined methodology developed. This is detailed in Appendix 2, with examples.

The formation of $O_3$ following the release of $NO_x$ and VOCs from anthropogenic sources is a large-scale regional effect, affecting rural areas surrounding major urban centres (where the precursor chemicals $NO_x$ and VOCs are released). The estimation of $O_3$ creation is technically complex due to the wide range of chemical reactions involved. Individual industrial emissions would not normally be expected to have a significant impact on $O_3$ creation in isolation from other urban sources, and only large industrial emissions sources of $NO_x$ and/or VOCs might be expected to have a discernible additional effect. Typically, only major industrial emission sources in, or near, large urban areas might be expected to assess such effects.

Complex models are available to assess the photochemical production of $O_3$, and consenting authorities might find such tools useful for airshed management of $O_3$. These tools are also available for developers for assessing potential effects of large-scale industrial emission sources of $NO_x$ and VOCs in major urban areas.

Section 4.3.6 of the *Good Practice Guide for Atmospheric Dispersion Modelling* recommends using models such as CALGRID and UAM-V. These are identified as having sufficiently complex chemistry schemes to enable examination of small changes in urban emissions generally associated with an individual industrial source.

A further model to consider is the (Australian) Commonwealth Scientific and Industrial Research Organisation (CSIRO) IER-Reactive Plume Model. The model is identified in the NSW Department of Environment and Conservation's *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC, 2001 and 2005). The model is identified as being suitable for predicting the effects of industrial source emission on ground-level $O_3$ concentrations.

### 8.4.4 Composition of minor constituents in New Zealand air

Some computer dispersion models require a knowledge of the baseline concentrations of constituents in the air. The standard global values can be found in many textbooks, but some of these are out of date and others are slightly different for New Zealand conditions. Table 8.1 gives some recent values (2003), many of which have been measured very accurately.

These values are based on measurements by NIWA at the Baring Head Clean Air Station, near Wellington, and are representative of values for uncontaminated air that has not passed over New Zealand (ie, only measurements made in clean southerly winds are included) (available from www.niwa.co.nz).

**Table 8.1: Clean air background concentrations of some atmospheric gases in New Zealand**

| Gas | Mean value | Unit | Accuracy +/- | Seasonal range | Comment |
|---|---|---|---|---|---|
| Carbon dioxide ($CO_2$) | 368 | ppm | 1.0 | 1.0 | Increasing at 0.4% per year |
| Carbon monoxide (CO) | 0.055 | ppm | 0.005 | 0.015 | Strong season and space variation |
| Nitrous oxide ($N_2O$) | 0.316 | ppm | 0.001 | 0.001 | Little space and time variation, increasing at 0.6% per year |
| Methane ($CH_4$) | 1.75 | ppm | 0.01 | 0.03 | Local sources can bias (eg, strong agricultural sources) |
| Hydrogen ($H_2$) | 0.70 | ppm | 0.01 | 0.01 | Reasonably constant |
| Sulphur dioxide ($SO_2$) | 0.016 | ppb | 0.012 | 0.016 | Maximum in summer, practically zero in winter |
| Nitrogen dioxide ($NO_2$) | < 0.5 | ppb | 0.5 | na | Estimated from urban monitoring |
| Ozone ($O_3$) | 30 | ppb | 2.0 | 15 | Highest New Zealand levels are often in clean air, and are strongly seasonal. This level is 'natural'. |
| Particulates (as $PM_{10}$) | 1.0 | $\mu g/m^3$ | 0.1 | 1.0 | All sea salt |
| Chlorofluorocarbon (CFC12) | 0.50 | ppm | 0.05 | 0.01 | Recent global increase |
| Benzene ($C_6H_6$) | 0.05 | ppb | 0.01 | na | Can be zero in ultra clean air, over 30 ppb in city contaminated air |
| Other toxics | < dl | | est. | na | Not measured, but most are below detection limits for the most sensitive equipment |
| Nitrogen ($N_2$) | 780,900 | ppm | est. | – | Not measured routinely in New Zealand |
| Oxygen ($O_2$) | 209,400 | ppm | est. | – | Not measured routinely in New Zealand |
| Argon (Ar) | 9,300 | ppm | est. | – | Not measured routinely in New Zealand |
| Other inert gases | 20 | ppm | est. | – | Not measured routinely in New Zealand |

## 8.4.5 Non-human health considerations

### Air pollution effects on ecosystems

Section 4 of the *Ambient Air Quality Guidelines* (Ministry for the Environment, 2002) provides critical levels for protecting ecosystems from sulphur dioxide, sulphate particulate, nitrogen dioxide, ammonia, ozone and fluoride. *The Effects of Air Contaminants on Ecosystems and Recommended Critical Levels and Critical Loads* (Ministry for the Environment, 2000b) provides some guidance on methods for calculating pollutant deposition rates from predicted or ambient monitoring results, and guidance for assessing whether a discharge is likely to cause adverse effects on ecosystems.

In Europe and North America the effects on sensitive ecosystems of acid deposition and elevated pollutant concentrations from industrial and other anthropogenic sources have been subject to legislative controls for some decades. Similar effects in New Zealand are not so evident, although they have been reviewed in a number of Ministry for the Environment technical reports (eg, Ministry for the Environment, 1999c and 2000b).

Much of the work has drawn on knowledge of the effects on non-New Zealand (North American and northern European) plant species. The recommended critical levels and loads and the provisional guidance on assessing deposition and its effects given in *The Effects of Air Contaminants on Ecosystems* is based on this knowledge. There is scant information on either the effects of air pollutants on native New Zealand species or the current level of pollutant deposition or concentration in New Zealand's natural environments. The robustness of any assessment of air pollution effects on ecosystems in New Zealand is therefore very vulnerable to these knowledge gaps. Despite these limitations, it is good practice to assess potential effects on ecosystems for any significant source that may have an impact on sensitive ecosystems.

### Global climate change

Sections 104E and 104F of the RMA place climate change outside the remit of consenting authorities in their consideration of discharge consents. The assessment of effects of greenhouse gas emissions from industry on global climate change is therefore outside the scope of this document. Policy measures to control the emission of greenhouse gases are developed and led by the Ministry for the Environment.

### Ozone depletion

The 1987 Montreal Protocol is an international agreement under which substances that deplete the ozone layer are being phased out.

The ozone layer, which sits about 15–30 kilometres above the Earth, reduces the amount of dangerous ultraviolet light that reaches the Earth from the Sun. Too much ultraviolet light can cause skin cancer and cataracts in people. It also distorts plant growth, damages the marine environment and leads to the breakdown of materials such as plastics.

New Zealand has ratified the Montreal Protocol and implemented its objectives through the Ozone Layer Protection Act 1996 and the Ozone Layer Protection Regulations 1996. This legislation controls ozone-depleting substances to prevent their release to the atmosphere through bans on their import and use, etc. Site-specific assessments of the effects of releasing such substances to the atmosphere should therefore not be necessary. The full list of ozone-depleting substances can be found in the Regulations.

### 8.4.6 Comparing model results with air quality criteria

Once all the above have been considered, the final step in the assessment is to compare the predicted results with the selected criteria. As noted in section 5, it is important to ascertain both the short-term and long-term impacts of discharges to air. For most assessments this will necessitate the use of both the national ambient air quality standards (one-hour and 24-hour standards) and the national ambient air quality guidelines (annual guidelines). In all cases, as noted in section 5, the selection of air quality criteria should be justified. In doing so the purpose of the standard or guideline should be clearly stated. *None* of the criteria provided in section 5 are levels that may be 'polluted up to'. It is also important to recognise the limitations of dispersion modelling when predicting impacts.

For relevant averaging times the model results for maximum, 99.9th percentile and 99.5th percentile concentrations should be given. As a rule of thumb, modelling using less than a 24-hour average (eg, one hour) should present maximum and percentile concentrations, whereas averaging times of 24 hours or more should only show the maximum concentration levels.

The recommended procedure in the *Good Practice Guide for Atmospheric Dispersion Modelling* requires consideration of meteorology when assessing worst-case impacts. (This is reproduced in full below.)

**Recommendation 53**

For the purpose of comparing modelling results to an evaluation criterion:

a) run the model for the minimum period of one full year of meteorological data where possible (ie, 8,760 hours)

b) identify the receptor(s) that are most highly impacted and those that are most sensitive

c) for the receptor(s), report the 99.9 percentile value of the predicted ground-level concentration as the maximum ground-level concentration likely to occur.

Provide an indication of the representativeness of the 99.9 percentile value ground-level concentration by also presenting a number of other percentile values (eg, maximum, 99.5th and 99th percentile values).

Use the frequency of exceedances to indicate the frequency of 'pollution events' that exceed the evaluation criterion being used.

Source: Ministry for the Environment, 2004a.

**The above recommendation applies to one-hour time averages only**. Following are a few examples.

- For sulphur dioxide, nitrogen dioxide and ozone, compare the highest 99.9 percentile predicted concentrations for all receptors with the one-hour national ambient air quality standards. A number of other percentile values (eg, 99.5th and 99th percentiles) should also be reviewed. The maximum predicted concentrations for all receptors should then be compared with the relevant eight-hour, 24-hour or annual average guidelines.
- For carbon monoxide, compare the maximum predicted concentrations for all receptors with the national ambient air quality standard of 10 $mg/m^3$ as an eight-hour average.
- For $PM_{10}$, compare the maximum predicted concentrations for all receptors with the national ambient air quality standard of 50 $\mu g/m^3$ as a 24-hour average. Similarly, compare the maximum predicted annual concentration for all receptors (if more than one year of meteorological data are used) with the national ambient air quality guideline of 20 $\mu g/m^3$ as an annual average.

The review of other percentile values is very important because it furthers our understanding of how meteorology (and other factors) affect the maximum downwind concentrations.

### Use monitoring data instead?

In the UK, modelled results may be compared with monitoring data. The guideline describes the uncertainties in model inputs as potential causes of disagreements between model results and long-term monitoring data. The use of multiple years of meteorological data for the model runs is recommended. It is also recommended that source information, and in particular emission estimates, be reviewed when monitoring results do not agree with model predictions.

The US EPA points out the difficulty in precisely modelling concentrations at an exact location for a specific time. The uncertainties in both the source and meteorological data limit the use of these event comparisons in identifying biases in the dispersion model. The US EPA Guideline on Air Quality Models permits the use of monitoring data for existing facilities if model estimates are not available. In such cases, the applicant is required to demonstrate with at least one year of valid monitoring data that model results are not applicable. Decisions on the number and locations of the monitors are made on a case-by-case basis.

## 8.5 When a health risk assessment is required

In some situations it may be necessary to undertake a more comprehensive air pollution health risk assessment as part of a detailed study. This would include determining exposure and dose via a number of different pathways (inhalation, dermal, ingestion, etc), assessment of dose-response data, and characterisation of the health risks from the exposure and dose assessments.

The air quality criteria discussed in section 5 are all designed to protect public health. In most circumstances it is appropriate to assess the potential health effects of discharges to air from industry by comparing model predictions with these criteria. An air pollution health risk assessment is typically only required if the national ambient air quality standards or guidelines are breached, or are close to being breached.

Health risk assessment should not be confused with health impact assessment, which may be required for significant projects or strategies. Health impact assessment is a formal approach used to predict the potential health effects of a policy or project, with particular attention paid to impacts on health inequalities. Guidance on undertaking health impact assessments for policy development is available from the Public Health Advisory Committee (www.nhc.govt.nz/PHAC/phac_pubs.html).

Circumstances in which a more comprehensive air pollution health risk assessment is recommended include when:

- there is a significant discharge of contaminants with no clear threshold for adverse effects
- community consultation outcomes and/or plan provisions require it
- there is a significant discharge and/or background concentration of contaminants that are toxic, carcinogenic, teratogenic, mutagenic or bioaccumulative
- background ambient air concentrations already approach or exceed national ambient air quality standards or guidelines, or regional objective levels.

The circumstance identified in the last bullet point needs special consideration. In this case it may be necessary to ensure that air quality is not further degraded as a result of the proposal (by implementing offsets, for example).

Health risk assessments are specialised tasks and are typically only undertaken for large, or particularly toxic, discharges. It is recommended that expert assistance be sought for any full health risk assessment.

## 8.6 Accuracy

Air quality assessment is a highly technical process. By way of illustration, it relies on:

- monitoring ambient air quality
- monitoring meteorology
- numeric prediction of meteorology by prognostic and diagnostic models
- monitoring stack gas and other source emissions
- estimating emissions (combustion calculations, simulations, etc)
- numeric prediction of plume dispersion in the atmosphere.

Accuracy is improved by adopting good practice techniques and equipment. The areas identified above are largely covered in the Ministry for the Environment good practice guides on ambient monitoring, emissions monitoring (Ministry for the Environment, 1998) and dispersion modelling (Ministry for the Environment, 2004a) (see Figure 1.2 in section 1).

Standard quality control techniques, such as the use of calculation checking and aspects as basic as checking that model data are correctly input, are extremely important and should be used. It is also recommended that within an assessment report each aspect of an assessment be auditable and repeatable so that the approach, assumptions and calculations can be independently reviewed.

In summary, an assessment report should include, or be supported by, supplementary reports or data including:

- emissions testing reports
- ambient monitoring reports
- equipment specifications
- model output files
- all input data
- copies of spreadsheets and calculations
- electronic model data input files, etc.

When using dispersion models in situations where there is a reasonable degree of uncertainty about any input parameters, sensitivity analysis should be undertaken. Model runs should be carried out simulating the higher and lower boundaries of expected input parameters (such as emissions estimates or stack temperature), as well as the best estimate. Such sensitivity analysis can improve the confidence in an assessment. This is particularly important where there is vulnerability to adverse effects at the upper boundary of input estimates.

For example, a process might be new and emission levels based on simulation. Sensitivity analysis might be undertaken by modelling both the expected and the more unlikely upper estimate emissions. Where such analysis predicts ambient concentrations to be above the assessment criteria for the upper case estimate only, a management response would be expected. The management response might require continuous emissions monitoring under a consent condition to verify the best estimate of emissions, with an associated emission management response agreed in the event that the upper emission estimate is subsequently found to be accurate.

## 8.7 Reporting a Tier 3 assessment

The results of a Tier 3 assessment should be included in any assessment of environmental effects. The report should summarise the findings of the assessment, including the basis for process information, air quality information, any assumptions and their justification. Section 4.4 describes the recommended content of an assessment report. The size and nature of the report will depend on the project, but for any Tier 3-type assessments each of the sections described should be included.

**Tier 3 full assessment − recommendations and summary**

Tier 3 represents the highest level of assessment, and would generally only be used for

(a) large or significant discharges
(b) very toxic discharges or
(c) very sensitive receiving environments.

This section outlines:

- the methods and details required to describe the discharge characteristics
- requirements for adequately characterising the existing environment
- modelling (although details are covered in the separate *Good Practice Guide for Atmospheric Dispersion Modelling*)

- methods for assessing effects against air quality criteria, and also on ecosystems
- chemical transformations where relevant (eg, NO to $NO_2$ conversion, ozone, etc)
- potential ecosystem effects
- options for conducting a full health risk assessment (although the details are beyond the scope of this document)
- reporting requirements (basically the same structure as for Tiers 1 and 2, only more extensive).

# Appendix 1: Assessment Checklist

To help identify the level of assessment required for any proposed discharge to air, a simple checklist has been provided below. This should be used by the applicant and the council as a prompt for discussion at the pre-application meeting about the appropriate level of assessment. The consenting authority should be able to help complete any outstanding aspects, such as the consenting requirements and background monitoring data.

## Checklist: Preparation for a pre-application meeting

### 1 Details

1.a Site:
1.b Source:
1.c Process description:
1.d Site description:

### 2 Scale of development

| | | |
|---|---|---|
| 2.a | Raw material input: | |
| 2.b | Product output: | T/day, MW, etc |
| 2.c | Typical scale for sector: | Range: |

### 3 Pollution prevention measures to be adopted

| | | | | | |
|---|---|---|---|---|---|
| ☐ | Clean technologies | ☐ | Abatement measures | ☐ | Offsets |
| ☐ | Stacks | ☐ | Buffer zones | ☐ | Other |

3.a Provide outline of measures to be adopted:
3.b Identify other measures considered and rejected:

### 4 Air emission complaints/non-compliances

Known complaints/non-compliance related to proposed activities: Yes / No

4.a If Yes provide details.

### 5 Pollutants to be released

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ☐ | $SO_2$ | kg/hr | ☐ | $NO_2$ | kg/hr | ☐ | TSP/dust | kg/hr |
| ☐ | Odour | kg/hr | ☐ | $PM_{10}$ | kg/hr | ☐ | Other (eg, VOC) | kg/hr |

## 6 Airshed

Are processes being undertaken within an airshed gazetted for the purposes of the national environmental standards? Yes / No

6.a If Yes supply details of consenting provisions.

## 7 Existing air quality

Are representative air quality data available for the area affected by the proposal? Yes / No

7.a If Yes provide levels relative to the relevant air quality criteria.

## 8 Physical geography

8.a Describe the physical geography of the receiving environment (use map if required). Identify the scale and proximity of geographic features (hills, coast, etc).

8.b Outline meteorological characteristics (eg, wind direction, speed, etc).

## 9 Land use and consent type

9.a Land use of the receiving environment (identify sensitive areas; eg, schools, hospitals).

9.b Land-use zoning of the development site (see district plan).

9.c Resource consent activity type (permitted, discretionary, etc; see regional plan).

## 10 Affected parties

10.a Have you consulted the neighbours and other potentially affected parties?

10.b Written approval supplied by potentially affected parties?

# Appendix 2: NO to $NO_2$ Conversion

This is an update of the conversion methodology given in the *Good Practice Guide for Atmospheric Dispersion Modelling* (Ministry for the Environment, 2004a). It is broadly consistent with that methodology, but contains more details, based on more recent analysis of $NO_x$ monitoring, and some examples.

## Practical methods to estimate nitrogen dioxide concentrations from nitrogen oxide levels

### Introduction

Emissions of nitrogen oxides are generally estimated in terms of the composite $NO_x$, made up of nitric oxide and nitrogen dioxide (NO and $NO_2$); ie, $NO_x = NO + NO_2$. For most combustion sources, including vehicle emissions and discharges from power stations, the emission will be more than 90% NO, which oxidises quite slowly to $NO_2$ in the atmosphere. The contaminant of interest is $NO_2$, which is included in the national environmental standards for air quality (the Standards) because of its health effects and its potential to degrade visibility. Robust estimates of $NO_2$ concentrations in most cases must be derived from information about emissions of $NO_x$ from nearby sources, and several methods for doing this are well established (eg, Cole and Summerhays, 1979).

However, this appendix is aimed at practitioners, or those with responsibility for demonstrating compliance with the Standards for ambient $NO_2$ concentrations. The national ambient air quality standard for $NO_2$ is set at 200 $\mu g/m^3$ (one-hour average) with nine exceedances allowed per year (Ministry for the Environment, 2004a). In New Zealand, for most sites and most time periods, the $NO_2$ concentrations will be well below the $NO_2$ standard, and the estimates by the methods outlined in this document are all that will be required to demonstrate full compliance. If these methods show possible exceedances of the $NO_2$ standard, then more sophisticated monitoring and modelling will be necessary. This approach is consistent with a Tier 2 process.

Some Auckland monitoring sites are known to have $NO_2$ exceedances (eg, Queen Street, Khyber Pass and Penrose). In other cities, future industrial and roading projects pose a potential $NO_2$ problem. For these cases, where there are known or potential exceedance problems the simple, empirical and conservative methods outlined in this Appendix may not be the most appropriate, and specialised monitoring and interpretation will be required. Here two methods are outlined for practical (but very conservative) estimation of a relationship between $NO_2$ and $NO_x$ for the assessment of $NO_2$ compliance from observed or modelled $NO_x$, particularly when monitoring information is sparse or not available and the need for a Tier 2 screening assessment of an emission source is indicated.

If $NO_x$ emissions are known, together with the corresponding meteorological information, dispersion models can simulate the spread of $NO_x$ as if it were an un-reactive gas (ie, the total number of molecules of $NO_x$ does not change through the dispersion and oxidation process). However, the determination of the fraction of this $NO_x$ that is $NO_2$ requires a model that either simulates chemical transformations or uses some empirically determined formula for the $NO_2$–$NO_x$ relationship. Even when a sophisticated model is available to simulate the oxidation of NO to $NO_2$, knowledge of the oxidants taking part in such reactions (eg, ozone, volatile hydrocarbon products) is still unlikely to be adequate as model input.

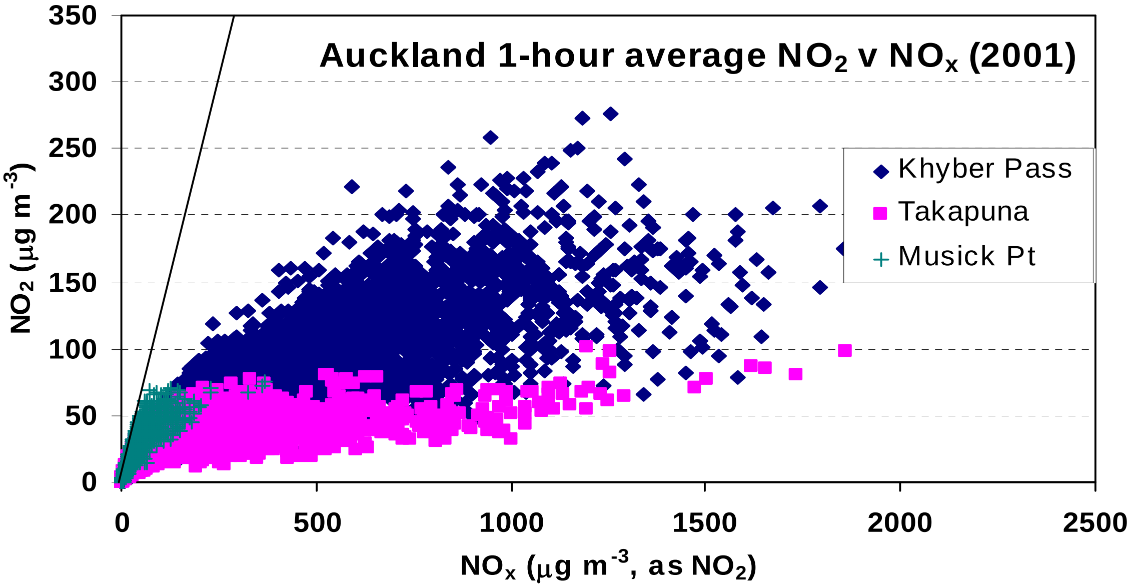
Hourly average $NO_x$ and $NO_2$ data are used here, but the methods outlined are also suitable for other averaging times (eg, 24 hours).

## Relationship between $NO_2$ and $NO_x$ measurements

Ambient $NO_x$ and $NO_2$ concentrations are routinely monitored at several locations in New Zealand within or close to major urban areas. Figure A2.1 shows scatter plots of $NO_2$ and $NO_x$ one-hour concentrations at three different types of urban site in Auckland in 2001, and is typical of other recent years.

- Khyber Pass is close to a congested urban intersection. This is a problem $NO_2$ site of the sort mentioned above, and needs specialist and detailed analysis rather than the simple approach taken here (which is appropriate for most sites).
- Takapuna is a typical urban area with commercial and light industrial activity.
- Musick Point, although not strictly urban, is frequently downwind of the Penrose industrial area and the busy Southern Motorway.

**Figure A2.1: Relationship between $NO_2$ and $NO_x$ one-hour average concentrations at three Auckland sites in 2001**




Notes: The straight line represents the complete oxidation of NO, so that $[NO_2] = [NO_x]$.

For a site like Musick Point near a large city, 9% of all points on the plot in Figure A2.1 are at very low $NO_x$ levels (less than 25 µg/m$^3$), with $NO_2$ somewhat less, although the $NO_2$:$NO_x$ ratio is often high because the dispersion and oxidation of distant emissions is well established. For Khyber Pass, the figures are typical of a congested traffic intersection in a major city, although none of the 80% of observations of $NO_x$ below 500 µg/m$^3$ represent exceedances of the $NO_2$ standard (which is 200 µg/m$^3$ as a one-hour average).

## Methods for $NO_2$ estimates: deducing local concentrations plus background

Total $NO_2$ concentrations are usually calculated as the sum of estimated $NO_2$ from known local sources $[NO_2]_{est}$ and background $NO_2$ concentrations $[NO_2]_{bkd}$ from all other sources:

$$[NO_2] = [NO_2]_{est} + [NO_2]_{bkd}$$

The methods proposed below are used for estimating $NO_2$ concentrations at a receptor due to a local $NO_x$ emission (ie, $[NO_2]_{est}$). Approaches to estimate background $NO_2$ concentrations, or $[NO_2]_{bkd}$, have been discussed elsewhere (Ministry for the Environment, 2004a). For most of New Zealand, where background air is of rural or marine origin and has very small concentrations of $NO_2$, the appropriate background value to use is zero. Where there are industries or traffic upwind but beyond the immediate area being modelled for $NO_x$, there is the possibility of a higher 'background' concentration of $NO_2$.

## The total oxidation method

For the initial estimate, a total conversion of NO to $NO_2$ is assumed:

$$[NO_2]_{est} = [NO_x]_{mod}$$

where $[NO_x]_{mod}$ is the $NO_x$ concentration (µg/m$^3$, expressed as $NO_2$) at the receptor, observed or determined by a dispersion model, due to the known $NO_x$ emission under consideration. Thus if $NO_x$ is known or modelled, there is a method for estimating $NO_2$.

The plots of observed $NO_2$ and $NO_x$ concentrations in Figure A2.1 show that complete oxidation is always a *very* conservative assumption and will always result in significant overestimates of $NO_2$ concentrations, especially where oxidation cannot be completed for more elevated $NO_x$ concentrations. The method gives a very conservative estimate of likely compliance with the $NO_2$ standard and the possible number of exceedances. If adequate compliance without exceedances is indicated with this approach, no further estimates or calculations are necessary.

If the simple assumption of complete oxidation does not give confidence that compliance with the $NO_2$ standard is adequate (eg, modelled or observed concentrations are close to, or exceeding, the $NO_2$ standard), the practitioner should move to the ozone-limiting method outlined in the section below for lower (but still conservative) estimates of $NO_2$ concentrations.

## The ozone-limiting method

An approach based on the ozone-limiting method has been proposed to estimate $NO_2$ concentrations from modelled $NO_x$ in New Zealand (Ministry for the Environment, 2004a).

The effect of ozone limiting is shown in the time series in Figure A2.2. Musick Point is about 10 km down the Tamaki River from the main industrial areas and motorways of South Auckland and is often downwind from them. The site experiences distinct diurnal changes in pollutant concentrations. A background condition is evident in Figure A2.2, with $O_3$ about 60 µg/m$^3$ and very small amounts of $NO_x$ (<<10 µg/m$^3$). An assumption of a zero or very low $NO_2$ background would be justified here. During pollution events, especially in late mornings, $O_3$ is almost completely removed and replaced by $NO_2$, and in some cases an excess of un-reacted NO can be identified.

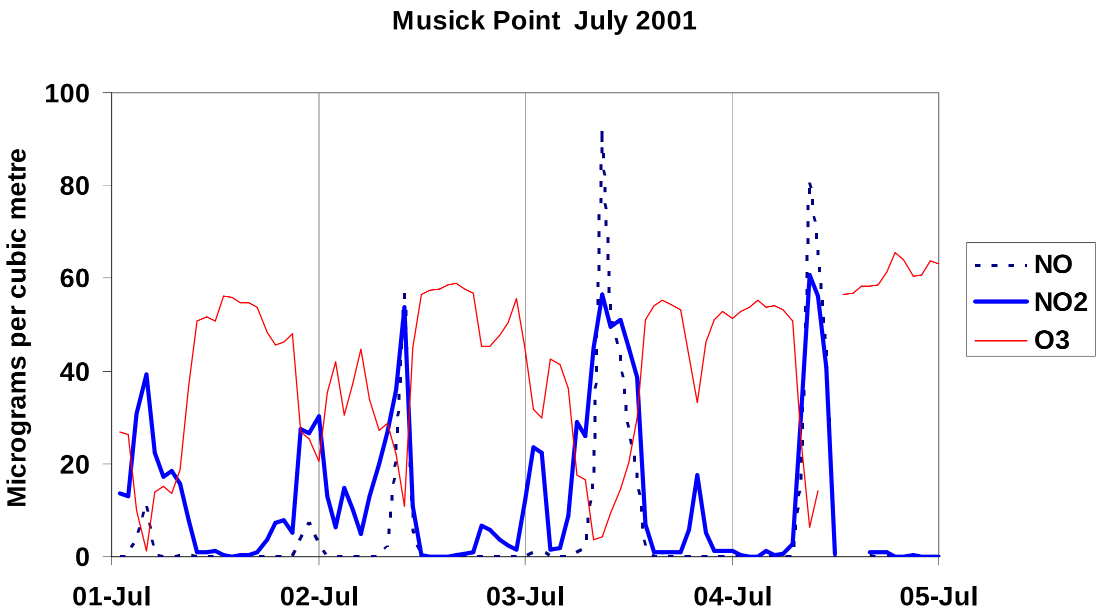
The usual approach (eg, Ministry for the Environment, 2004a) is modified here to estimate $NO_2$ at a receptor. The estimate is then the sum of $NO_2$ emitted at the local source plus the maximum concentration of $NO_2$ that can be produced from NO using the available ozone:

$$[NO_2]_{est} = [NO_x]_{mod} \text{ x } F(NO_2) + 72$$

where $F(NO_2)$ is the mass fraction of $NO_2$ in the $NO_x$ emission from the source under consideration, and the first term represents $NO_2$ from the local source arriving un-oxidised at the receptor. Concentrations are all in µg/m$^3$, expressed as $NO_2$.

In the equation, 72 µg/m$^3$ is the upper limit for $NO_2$ formed by oxidation of NO by the maximum background $O_3$ concentration. $O_3$ concentrations in air coming off the ocean are quite predictable and show a seasonal variation, with the highest concentrations occurring during winter. At Baring Head near Wellington, NIWA has recorded maximum winter concentrations of about 35 ppb (75 µg/m$^3$) and maximum summer concentrations of about 20 ppb (43 µg/m$^3$). This maximum winter $O_3$ concentration is sufficient to produce 72 µg/m$^3$ of $NO_2$ by oxidation of NO. When $[NO_x]_{mod} < 72$ µg/m$^3$ then $[NO_2]_{est} = [NO_x]_{mod}$ is used, as outlined in the total oxidation method above (ie, a total conversion of NO to $NO_2$).

**Figure A2.2: A time series of four winter days of $NO_x$ and $O_3$ at Musick Point**




Notes: Background $O_3$ concentration is about 60 µg/m$^3$, which is removed during production of $NO_2$ from NO. $NO_2$ is limited to about 60 µg/m$^3$ during this time. Backgrounds of both NO and $NO_2$ are close to zero.

Validation at several monitoring sites in Auckland and Christchurch has shown that taking 10% $NO_2$ in $NO_x$ emissions results in conservative $NO_2$ estimates using the ozone-limiting method, particularly for elevated $NO_x$ concentrations, at most sites. An example of this is shown for Takapuna in Figure A2.3. The overestimate using the ozone-limiting method results from the combined effect of the actual percentage of $NO_2$ in $NO_x$ being less than 10%, together with scavenging of both $NO_2$ and $O_3$ by vegetation and other surfaces, plus the establishment of the photochemical reaction, which eventually tends to reduce the $NO_2$ concentration.

## 24- hour averages

When an assessment over 24-hour averaging periods is required it is advisable to use hourly data and rolling 24-hour averaging for the ozone-limiting method. This takes into account major diurnal fluctuations in the three main components of interest ($NO_2$, NO and $O_3$) and enables a meaningful result. Even in the sequence of pollutant events over several days shown in Figure A2.2, the 24-hour average never exceeds 20 µg/m$^3$, although the corresponding ozone average remains between 35 and 50 µg/m$^3$. Ozone-limiting assessments will thus still be conservative. This condition – fresh air cleaning out the results of pollution − is fortunately still common in New Zealand.

## What next?

The methods above are useful where data for assessments are sparse and confidence is low. However, where there are well-defined emission data (maybe a small number of large sources) and sound meteorology, more precise modelling can be applied. The dispersion model Calpuff has a chemistry module that handles $NO_x$ transformations using default reaction rates and reagent ratios taken from the ambient ratio method. This will still be very conservative in the small windy cities of New Zealand but should provide good confidence in the assessment.

A realistic estimate of the fraction of $NO_2$ in the emitted $NO_x$ is important to the success of the methods here. For most combustion sources (eg, power stations, vehicle emissions) the value of 10% $NO_2$ in $NO_x$ emissions is usually considered a sufficiently conservative estimate.

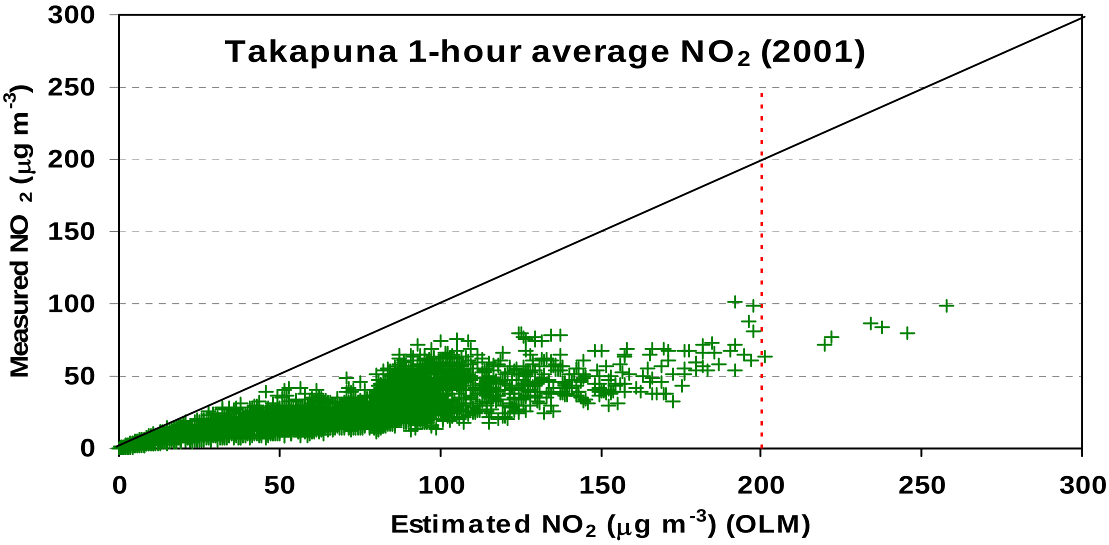
Generally, the oxidation of NO to $NO_2$ takes time to occur, during which time dispersion should have also occurred so that $NO_2$:$NO_x$ ratios should not be too high (ie, less than 10%). There is, however, evidence (eg, Carslaw and Beevers, 2005) of $NO_2$:$NO_x$ ratios in some vehicle emissions even higher than 20%. Roadside monitoring adjacent to traffic congestion (eg, Khyber Pass Road) frequently indicates high $NO_x$ concentrations with similarly high $NO_2$:$NO_x$ ratios over 20% (see Figure A2.1). For this reason, sites such as this need more detailed monitoring and analysis than the simple methods outlined in this Appendix to assess compliance issues. Such monitoring and analysis can assist, in particular, with understanding the role of idling or slow-moving diesel engines and heavy vehicle engines under short-term loads (eg, accelerating uphill).

## Summary

Two methods have been described here for estimating $NO_2$ concentrations from modelled or measured $NO_x$. The total oxidation method, assuming a total conversion of NO to $NO_2$, always generates very conservative results, especially for elevated $NO_x$ concentrations. By assuming 10% $NO_2$ in $NO_x$ emissions, the ozone-limiting method results in conservative $NO_2$ concentrations at most sites. It should be noted that this method underestimates $NO_2$ concentrations for some cases with nearby traffic sources of $NO_x$ (eg, at Khyber Pass Road), in which the $NO_2$ proportion in $NO_x$ emissions may be higher than 10%. An improved estimate of the $NO_2$ percentage in the $NO_x$ emission becomes important in these cases and it would be more appropriate to use site-specific $NO_2$ and $NO_x$ monitoring data rather than the methods of estimation outlined here.

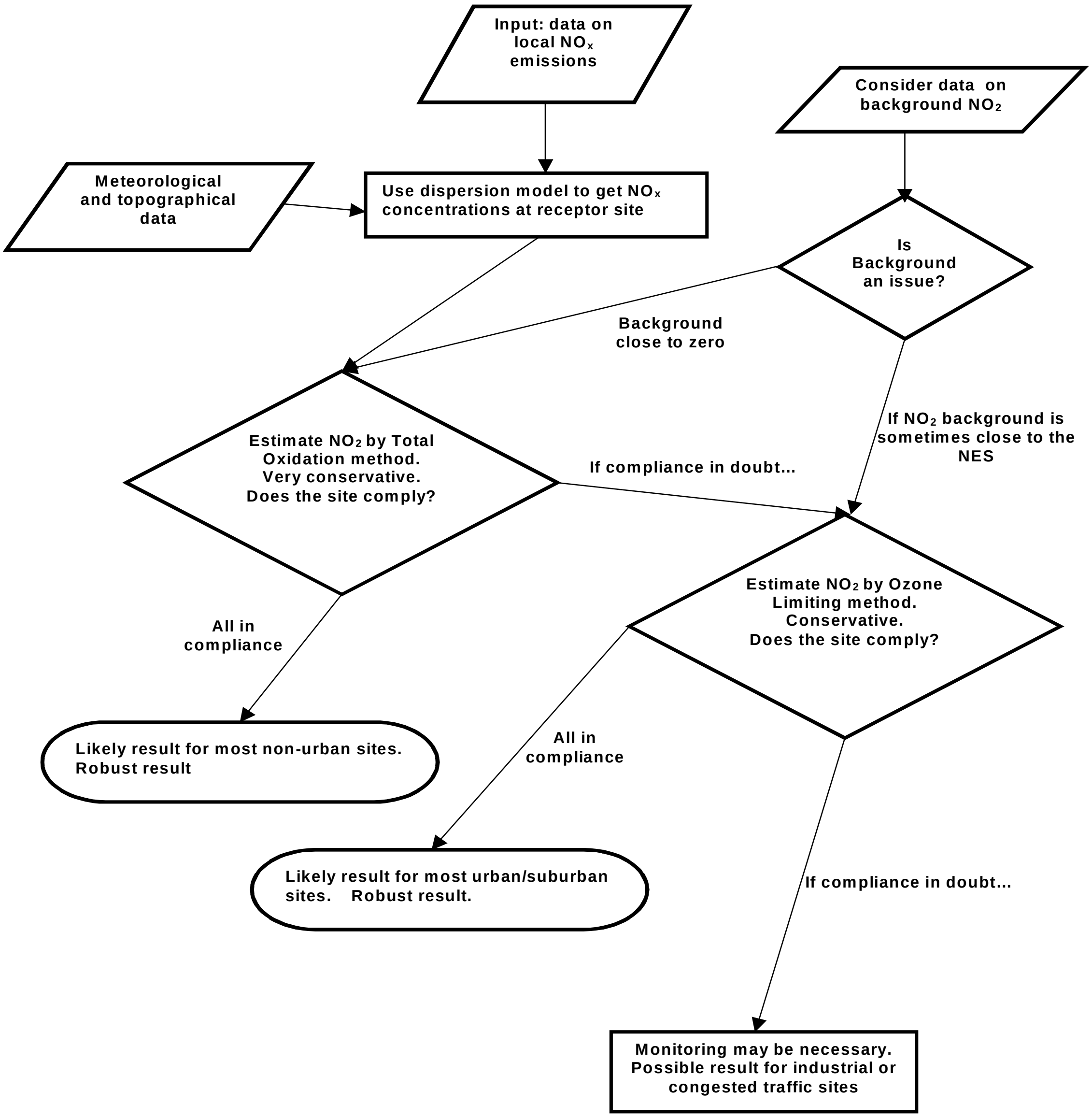
Where the ozone-limiting method also indicates the possibility of exceedances (eg, in the Khyber Pass record in Figure A2.1), a programme of real observations of $NO_2$ is necessary to robustly determine the extent of the problem and monitor the success of measures taken to reduce it. Figure A2.4 is a flow diagram for the methods outlined.

**Figure A2.3: Comparison between measured and modelled $NO_2$ one-hour concentrations at Takapuna in 2001**




Notes: Assumes 10% $NO_2$ in all $NO_x$ emissions. The straight line represents the case where measured [$NO_2$] = estimated [$NO_2$].

**Figure A2.4: Summary of method for determining compliance with the $NO_2$ standard**




Notes: For $NO_2$ at a receptor site using information from local $NO_x$ emissions.

# References


Auckland Regional Council. 2002. *Assessing Discharges of Contaminants into Air (Draft)*. Technical Publication 152. Auckland Regional Council: Auckland.

Carslaw DC, Beevers SD. 2005. Estimations of road vehicle primary $NO_2$ exhaust emission fractions using monitoring data in London. *Atmospheric Environment* 39: 167–77. Thomson Scientific.

Cole HS, Summerhays JE. 1979. A review of techniques available for estimating short-term $NO_2$ concentrations. *Journal of the Air Pollution Control Association* 29: 812–17. Air Pollution Control Association: Pittsburgh.

Department of Environment and Conservation [NSW]. 2002. *Protection of Environmental Operations (Clean Air) Regulations.* Australian Government Department of Heritage and Environment: Canberra.

Ministry for the Environment. 1998. *Compliance Monitoring and Emission Testing of Discharges to Air*. Ministry for the Environment: Wellington.

Ministry for the Environment. 1999a. *A Guide to Preparing a Basic Assessment of Environmental Effects*. Ministry for the Environment: Wellington.

Ministry for the Environment. 1999b. *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand*. Ministry for the Environment: Wellington.

Ministry for the Environment. 1999c. *The Effects of Air Pollution on New Zealand Ecosystems*. Air Quality Technical Report No. 4. Ministry for the Environment: Wellington.

Ministry for the Environment. 2000a. *Good Practice Guide for Air Quality Monitoring and Data Management*. Ministry for the Environment: Wellington.

Ministry for the Environment. 2000b. *The Effects of Air Contaminants on Ecosystems and Recommended Critical Levels and Critical Loads*. Air Quality Technical Report No. 15: Review of Ambient Air Quality Guidelines. Ministry for the Environment: Wellington.

Ministry for the Environment. 2001a. *Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emissions*. Ministry for the Environment: Wellington.

Ministry for the Environment. 2002. *Ambient Air Quality Guidelines.* Ministry for the Environment: Wellington.

Ministry for the Environment. 2003. *Good Practice Guide for Assessing and Managing Odour in New Zealand*. Ministry for the Environment: Wellington.

Ministry for the Environment. 2004a. *Good Practice Guide for Atmospheric Dispersion Modelling.* Ministry for the Environment: Wellington.

Ministry for the Environment. 2004b. *Your Rights as an Affected Person: An Everyday Guide to the Resource Management Act Series*. Ministry for the Environment: Wellington.

Ministry for the Environment. 2005. *The Updated Users Guide to Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004* (including amendments 2005). Ministry for the Environment: Wellington.

Ministry for the Environment. 2006a. *An Everyday Guide to the Resource Management Act Series 2.2 Consultation for Resource Consent Applications*. Ministry for the Environment: Wellington.

NSW Department of Environment and Conservation. 2001, revised 2005. *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*. Department of Environment and Conservation: Sydney.

Victoria State Environment Protection Policy (Air Quality Management). Revised 2001. No. S19, Gazette 9/2/1999. Victorian Government: Melbourne. www.epa.vic.gov.au/about_us/legislation/air.asp