Ambient air quality (nitrogen dioxide) monitoring network

Operating manual 2017–18

NZ TRANSPORT AGENCY
WAKA KOTAHI

New Zealand Government

More information

NZ Transport Agency

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Document management plan

1) Purpose

This management plan outlines the updating procedures and contact points for the document.

2) Document information

Document name	*NZ Transport Agency Ambient Air Quality (Nitrogen Dioxide) Monitoring Programme – Operating Manual 2017/18*
Document number	SP/M/023
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Document owner	Greg Haldane
Document sponsor	Greg Haldane

3) Amendments and review strategy

All corrective action/improvement requests (CAIRs) suggesting changes will be acknowledged by the document owner.

	Comments	Frequency
Amendments (minor revisions)	Updates incorporated immediately they occur.	As required.
Review (major revisions)	Amendments fundamentally changing the content or structure of the document will be incorporated as soon as practicable. They may require coordinating with the review team timetable.	At least annually.
Notification	All users that have registered their interest by email to environment@nzta.govt.nz will be advised by email of amendments and updates.	Immediately.

4) Other information (at document owner's discretion)

There will be occasions, depending on the subject matter, when amendments will need to be worked through by the review team before the amendment is actioned. This may cause some variations to the above noted time frames.

5) Distribution of this management plan

Copies of this manual management plan are to be included in the NZ Transport Agency intranet at the next opportunity and sent to: Greg Haldane

Record of amendment

Amendment number	Description of change	Effective date	Updated by

Foreword

The NZ Transport Agency (Transport Agency) is a Crown agency responsible for, among other things, managing almost 11,000 kilometres of state highways. The state highway system accounts for about 12 per cent of New Zealand's roads and around half of the 45.6 billion vehicle kilometres New Zealanders travel each year[1]. Motor vehicles travelling on roads emit an array of air pollutants which can contribute to harmful effects on human health and smog formation.

Section 96(1)(a) of the Land Transport Management Act requires that the Transport Agency exhibit a sense of social and environmental responsibility. The Transport Agency promotes an accessible and safe transport system that contributes positively to New Zealand's economic, social and environmental welfare and is committed to acting in an environmentally and socially responsible manner.

Giving effect to this policy, the Transport Agency's Environmental Plan[2] presents approaches and implementation plans for a range of environmental and social impacts arising from the state highway network. The specific objectives for improving air quality include:

A1. Understand the contribution of vehicle traffic to air quality.

A2. Ensure new state highway projects do not directly cause national environmental standards for ambient air quality to be exceeded.

A3. Contribute to reducing emissions where the state highway network is a significant source of exceedances of national ambient air quality standards.

Annual assessment of vehicle emissions from the state highway network is undertaken using data gathered from selected sites using passive samplers to measure nitrogen dioxide (NO_2) as a surrogate. The overall aim is to see a decreasing trend in NO_2 concentrations measured at these sites.

This manual describes the methodology adopted in the current contract period (2017/18) for undertaking NO_2 passive sampling for monitoring air quality impacts of the state highway network. The manual outlines the objectives, principles, procedures and applications of the Transport Agency's NO_2 national network passive sampling programme with details on who does what, how and when.

The principles outlined in this manual are also applicable to passive sampling undertaken on behalf of the Transport Agency for air quality monitoring used in assessing the effects of state highway asset improvement projects.

[1] MoT (2017). *The New Zealand vehicle fleet, annual fleet statistics 2016*, Ministry of Transport, August 2017.

[2] NZTA (2008). *Environmental plan: Improving environmental sustainability and public health in New Zealand*, version 2, NZ Transport Agency, June 2008.

Contents

1.0 Introduction

1.1 Overview

Scope

Ambient air quality monitoring is undertaken to assess and manage potentially adverse effects that may be associated with the state highway network.

This chapter briefly covers the development of the national network from 2007 to date, outlines the purpose of this operating manual, and summarises the contents of the chapters which follow.

In this chapter

1.2 Background

Development of the network

Annual assessment of vehicle emissions from the state highway network is undertaken using data gathered from selected sites using passive samplers to measure nitrogen dioxide (NO_2) as a general proxy for air pollution from motor vehicles. In addition, passive sampling is regularly employed as a screening method to indicate existing levels of air quality when assessing state highway asset improvement projects.

The NZ Transport Agency (Transport Agency) instigated the national NO_2 passive monitoring programme in 2007 with 53 locations monitored throughout New Zealand, focussing mainly on state highway sites. In 2009, the network was expanded to include more background and local road sites, with a further expansion in 2010. In 2016, passive samplers were deployed at 129 locations.

Roles

The successful operation of the national network is a collaborative effort between various parties as follows:

- The Transport Agency plays a strategic role by funding the majority of the sites and setting key indicators for performance and delivery.
- The Consultant acts on behalf of the Transport Agency and engages the Contractor to operate the network. The Consultant liaises with the Contractor on day to day issues and is responsible for highlighting any relevant or important matters that may require the Transport Agency's attention.
- The Contractor has the primary responsibility for operating the national network in accordance with the best practice procedures outlined in this manual and ensuring that all key indicators for performance and delivery are met to ensure high quality data. The Contractor in turn engages a suitably qualified laboratory to analyse the passive samplers and also liaises with field sub-contractors to undertake the exchange of tubes for sites around the country.

Emission Impossible Ltd (EIL) has been the Consultant (on behalf of the Transport Agency) since 2013/14 and continues in this role for 2017/18. Watercare Services Ltd (WSL) has been the Contractor for the national network since its inception in 2007 and continues in this role for 2017/18.

WSL liaises with a number of field subcontractors – either network consultants engaged by the regional Transport Agency offices to assist with other tasks (eg Opus, Higgins etc) or Transport Agency network asset management staff or council staff (eg Environment Canterbury) – to undertake the monthly sample exchange in locations around the country.

WSL also engages the Scientific Services Laboratory of Staffordshire County Council (SCC) to supply and analyse the exposed passive samplers.

1.3 Purpose

Purpose

This manual presents the objectives, principles, procedures and applications of passive sampling of nitrogen dioxide (NO_2) undertaken on behalf of the Transport Agency.

The primary emphasis in this manual is to provide details on who does what, how and when as related to the Transport Agency's national network of passive samplers but the principles outlined also apply to passive sampling undertaken as part of project monitoring for assessment of state highway asset improvement projects.

Intended audience

This manual has two intended audiences:

- Transport Agency staff who are responsible for commissioning and reporting on national network or project monitoring of NO_2 using passive sampling
- air quality providers engaged by the Transport Agency to undertake national network or project monitoring of NO_2 using passive sampling.

1.4 Contents

Why passive sampling is undertaken	Chapter 2 explains why passive sampling is undertaken on behalf of the Transport Agency and how the data are utilised.
How passive sampling works	Chapter 3 summarises how passive sampling works and its advantages and disadvantages relative to other air quality monitoring techniques.
Where passive samplers are employed	Chapter 4 outlines where passive monitoring is currently undertaken and the criteria used to decide where to locate samplers.
How the monitoring is undertaken	Chapter 5 describes the processes followed for deploying and analysing the samplers.
How the results are processed and managed	Chapter 6 reviews the data processing and quality assurance procedures followed, including the criteria used for dealing with missing or invalid data.
How the results are reported and stored	Chapter 7 discusses how the data are reported, stored and accessed.
Who is responsible for which activity	Chapter 8 covers the roles and responsibilities of all the parties involved in supporting and operating the national passive sampling network.
Who is responsible for funding the network	Chapter 9 covers how the national network is funded within the Transport Agency and co-funding arrangements with external agencies, such as regional councils.
Reference material	Chapter 10 contains a glossary of all technical terms, a list of all abbreviations and complete bibliography of all references that appear in the manual (combined from the individual lists at the end of each chapter).
Useful examples	Chapter 11 consists of various appendices which provide useful examples of relevant documentation and reports together with details for the current field and laboratory subcontractors.

2.0 Why monitor air quality?

2.1 Overview

Introduction

This chapter describes why air quality monitoring of the state highway network is undertaken by the Transport Agency and how the data are utilised.

In this chapter

2.2 Transport Agency air quality objectives

The state highway system

The NZ Transport Agency (Transport Agency) is a Crown entity responsible for, among other things, managing almost 11,000 kilometres of state highways. The state highway system accounts for about 12 per cent of New Zealand's roads and around half of the 45.6 billion vehicle kilometres New Zealanders travel each year (MoT 2017). Motor vehicles travelling on roads emit an array of air pollutants which can contribute to harmful effects on human health and smog formation.

The Transport Agency's environmental and social policy

Section 96(1)(a) of the Land Transport Management Act requires that the Transport Agency exhibit a sense of social and environmental responsibility. The Transport Agency promotes an accessible and safe transport system that contributes positively to New Zealand's economic, social and environmental welfare and is committed to acting in an environmentally and socially responsible manner.

The Transport Agency's environmental plan

Giving effect to this policy, the Transport Agency's Environmental Plan presents approaches and implementation plans for a range of environmental and social impacts arising from the state highway network (NZTA 2008). The specific objectives that the Transport Agency has for improving air quality include:

A1. Understand the contribution of vehicle traffic to air quality.

A2. Ensure new state highway projects do not directly cause national environmental standards for ambient air quality to be exceeded.

A3. Contribute to reducing emissions where the state highway network is a significant source of exceedances of national ambient air quality standards.

NO_2 as a proxy for vehicle emissions

Motor vehicles produce a complex mix of contaminants. It is not feasible to monitor all of these, so the Transport Agency has identified one pollutant, nitrogen dioxide (NO_2) as a proxy for motor vehicle pollutants. This is consistent with the recommendations of the World Health Organisation (WHO 2006) which states that:

> *Nitrogen dioxide concentrations closely follow vehicle emissions in many situations, so nitrogen dioxide levels are generally a reasonable marker of exposure to traffic-related emissions.*
>
> *Health risks from nitrogen oxides may potentially result from nitrogen dioxide itself, correlated exhaust components such as ultrafine particles and hydrocarbons, or nitrogen dioxide chemistry products, including ozone and secondary particles.*

2.2 Transport Agency air quality objectives continued

NO_2 as a proxy for vehicle emissions (continued)

Nitrogen oxides incorporate several species that exist in the atmosphere, which collectively are referred to as NO_x and result principally from fossil fuel combustion, when nitrogen in the air that is used to burn the fuel gets oxidised.

The most common NO_x compounds are nitrogen dioxide (NO_2) and nitric oxide (NO). NO is the primary product emitted directly but this is eventually oxidised by other pollutants present in ambient air to form NO_2.

Motor vehicles are a major source of NO_x emissions in most parts of New Zealand.

Annual assessment of the state highway network

Annual assessment of vehicle emissions from the state highway network is undertaken using data gathered from selected sites using passive samplers to measure NO_2.

The overall aim is to see a decreasing trend in NO_2 concentrations measured at these sites.

Development of the national network

The Transport Agency's national network was first commissioned in 2007 with 52 locations monitored throughout New Zealand. In 2009, the Transport Agency expanded the network to include background and local road locations, with sampling undertaken at 86 locations. The network was further expanded in 2010 to include more local road and background monitoring sites and in 2016, passive samplers were deployed at 129 locations.

Project monitoring

All state highway asset improvement projects require an assessment of the current air quality in the project vicinity in order to evaluate the project's impacts on future air quality (NZTA 2014).

Where suitable data do not already exist, passive sampling of NO_2 is often employed as part of a specific pre-project monitoring campaign.

2.3 Comparison with guidelines

Health-based standards and guidelines

Relevant health-based standards and guidelines for NO_2 are shown in the table below, covering a range of averaging periods from short term (1-hour) to long term (annual) exposure.

New Zealand has 1-hour and 24-hour values for ambient NO_2 concentrations set in the National Environmental Standards (NES) and the Ambient Air Quality Guidelines (AAQG) (MfE 2011 and MfE 2002 respectively). The NES ambient limits apply anywhere in a region that is in the open air and where people are likely to be exposed. The regulations are designed to provide a guaranteed minimum level of health protection for New Zealanders. For NO_2 the NES is 200µg/m³ (1-hour average). There is also an AAQG for NO_2 of 100µg/m³ as a 24-hour average. There are no health-based New Zealand guidelines associated with exposure to NO_2 for periods of time longer than 24 hours. However, the WHO has an annual average guideline for NO_2 of 40µg/m³ (WHO 2006).

NO_2 ambient air quality standards and guidelines

Contaminant	Averaging period	Standard or guideline[3]	Concentration	Annual allowable exceedance
Nitrogen dioxide (NO_2)	1-hour	NES	200µg/m³	9
	24-hour	AAQG	100µg/m³	-
	Annual	AAQG[4]	30µg/m³	-
	Annual	WHO	40µg/m³	-

Transport Agency assessment criteria

The passive monitoring undertaken measures monthly average NO_2 concentrations but these are not directly comparable to short-term standards and guidelines. However, a 2008 review of regional council monitoring results suggests that any site which exceeds the annual average WHO guideline is also likely to exceed the NES 1-hour standard for NO_2 (NIWA 2008). This means that, through careful choice of sampling sites and the use of passive samplers as screening devices, locations where standards and guidelines are most likely to be exceeded due to motor vehicle emissions can be identified.

[3] Refer to the glossary for definition of these terms

[4] This is a critical level for protecting ecosystems and is not a health-based guideline.

2.3 Comparison with guidelines continued

Transport Agency assessment criteria (continued)

The WHO Global Update of Air Quality Guidelines report highlights that health effects may occur at levels below this guideline, and recommends that a lower guideline should be used if NO_2 is monitored as an indicator of overall pollution levels (WHO 2006). WHO states that:

> *Evidence from animal toxicological studies indicates that long-term exposure to nitrogen dioxide at concentrations above current ambient concentrations has adverse effects. In population studies, nitrogen dioxide has been associated with adverse health effects even when the annual average nitrogen dioxide concentration complied with the WHO annual guideline value of 40µg/m³. Also, some indoor studies suggest effects on respiratory symptoms among infants at concentrations below 40□g/m³.*
>
> *The present guideline was set to protect the public from effects on health of nitrogen dioxide gas itself. The rationale for this is that, because most abatement methods are specific to nitrogen oxides, they are not designed to control other co-pollutants and may even increase their emissions.*
>
> ***If, instead, nitrogen dioxide is monitored as a marker for the concentrations and risks of the complex combustion-generated pollution mixtures, an annual guideline value lower than 40µg/m³ should be used instead.***

Because the Transport Agency network is measuring NO_2 as a "marker for the concentrations and risks of the complex combustion-generated pollution mixtures" (as highlighted above), it may be appropriate to consider a lower annual guideline. Although the WHO does not specify an appropriate lower annual guideline, this recommendation has been taken into consideration in the development of the Transport Agency criteria for assessment of passive monitoring results, which are summarised in table which follows.

Transport Agency assessment criteria for annual average NO_2 passive monitoring results

Contaminant	Annual average concentration	Descriptor	Notes
Nitrogen dioxide	≥40µg/m³	High	Identifies locations where the WHO annual NO_2 guideline may be exceeded and air quality effects of motor vehicles need further investigation.
	30µg/m³ to 39.9µg/m³	Medium	Identifies locations where air quality may be degraded because of motor vehicle emissions and may cause adverse effects.

2.4 How the network data are utilised

Where the network data fit into TRAMS

The Transport Agency funds a substantial amount of air quality measurements, predictions and assessments through projects, network management, complaint investigations and research.

The Transport Agency has developed a Transport-Related Air Quality Monitoring System (TRAMS) database (NZTA 2017) to collate all relevant air quality data commissioned by the Transport Agency (including the national passive NO_2 data) so that greater utilisation can be made of it, significantly increasing value-for-money.

Collation of data is providing the Transport Agency with a national overview of transport-related air quality work, allowing more informed policy development and better prioritisation and focus on critical areas of the state highway network.

2.5 References

1. MfE (2002) *Ambient air quality guidelines, 2002 update*. Air Quality Report No 32 prepared by the Ministry for the Environment and the Ministry of Health, May 2002.
2. MfE (2011) *Resource Management (National Environmental Standards for Air Quality) Regulations 2004*. Prepared by the Ministry for the Environment, June 2011.
3. MoT (2017) *The New Zealand vehicle fleet, Annual fleet statistics 2016*. Prepared by the Ministry of Transport, August 2017.
4. NIWA (2008) *The determinants of levels of secondary particulate pollution and nitrogen dioxide in urban New Zealand – Part 1*. NIWA Report AKL2008-053 prepared for the Foundation for Research, Science and Technology, July 2008.
5. NZTA (2008) *Environmental plan: Improving environmental sustainability and public health in New Zealand*, version 2. NZ Transport Agency, June 2008.
6. NZTA (2014) *Guide to assessing air quality impacts from state highway projects*, version 2.0, DRAFT. NZ Transport Agency, December 2014.
7. NZTA (2017) *Transport-Related Air Quality Monitoring System (TRAMS).* Web-based tool available from https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/, NZ Transport Agency, 2017.
8. WHO (2006) *Air quality guidelines global update 2005: Particulate matter, ozone, nitrogen dioxide, and sulphur dioxide*. Prepared by the World Health Organisation, October 2006.

3.0 How does passive sampling work?

3.1 Overview

Introduction

This chapter summarises the operating principles of nitrogen dioxide (NO_2) passive diffusion samplers or tubes and their advantages and disadvantages relative to other air quality monitoring techniques.

In this chapter

3.2 Operating principles of passive samplers

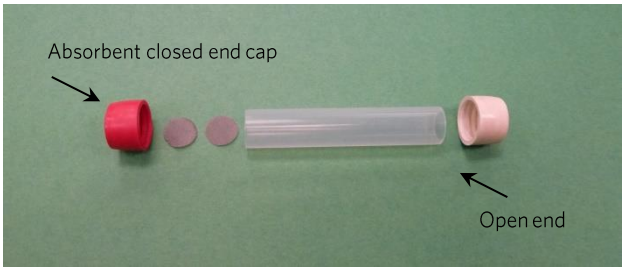
Sampler description

The passive samplers described in this manual are nitrogen dioxide (NO_2) passive diffusion tubes (shown below).

The NO_2 passive diffusion tubes are acrylic or polytetrafluoroethylene (PTFE) tubes approximately 7cm long with an internal diameter of 1cm and machined ends to attach tight fitting caps.

Two stainless steel mesh discs coated with triethanolamine (TEA), which absorbs NO_2, are located at the closed end of the tube and held in position by an opaque coloured cap. The coloured end cap helps to prevent the degradation of the NO_2 absorbed TEA complex by sunlight. The open end of the tube has a clear or white removable cap which is used as a lid to seal the diffusion sampler before and after exposure.

Components of a passive diffusion tube



Molecular diffusion

Passive diffusion tubes collect NO_2 by molecular diffusion.

Molecular diffusion is the movement of gas molecules (NO_2) from a region of higher concentration (open end of the tube) to a region of lower concentration (absorbent end of the tube). The diffusion flow rate of NO_2 through the tube is described by Fick's first law of diffusion.

At the end of the sampling period, the resulting concentration of NO_2 is a function of the amount of NO_2 absorbed by the tube, the diffusion coefficient for NO_2 in air and the length of time the tube has been exposed (typically one month).

3.3 Advantages and disadvantages of passive sampling

Passive samplers are ideal for screening

Passive samplers have many advantages over other monitoring methods as they are affordable, simple to use, discrete and can be clipped onto most road furniture (eg road signs and street lamps).

Passive sampling techniques are 'screening' methods and are useful for spatial and temporal assessments. However, any elevated NO_2 concentrations identified by passive sampling techniques are only indicative of a potential air quality issues. These 'hot spots' would require more accurate and precise monitoring from a reference method such as the continuous chemiluminescence analyser to confirm these findings for compliance monitoring.

The following table summarises the advantages and disadvantages of passive sampling compared to other air quality monitoring methods (DEFRA 2009).

Comparison of passive sampling with other methods

Method	Advantages	Disadvantages
Passive sampling	Low cost – simple. Useful for updating and screening assessment studies, and to supplement automatic monitoring for detailed assessments.	Indicative measurements only – inferior precision and accuracy to automatic methods. Laboratory analysis required. In general, only provide weekly or longer averages.
Photochemical and optical sensor systems	Can be used portably.	Sensitivity can be low. May only provide spot measurements.
Active (semi-automatic) sampling	Low cost – relatively easy to operate (although care must be taken with filter handling and conditioning).	Usually only provide daily averages. Some methods are labour intensive. Filter conditioning and weighing may be required. Laboratory analysis may be required.
Automatic point monitoring	Provide high resolution data. On-line data collection possible.	Trained operator required. Regular calibration required. Regular service and maintenance costs.
Remote optical/long-path monitoring	Provide path or range-resolved data. Useful near sources. Multi-component measurements possible.	Relatively expensive and trained operator required. Regular calibration required. Data not readily comparable with point measurements.

3.4 References

1. DEFRA (2009) *Local air quality management, Technical guidance LAQM TG09.* Prepared by the Department for Environment, Food and Rural Affairs, February 2009.

4.0 Where is monitoring undertaken?

4.1 Overview

Introduction

This chapter outlines where passive sampling is currently undertaken and the criteria that determine where sites are located. It also outlines the site identification/classification procedures and the required documentation.

In this chapter

4.2 Siting criteria

Overview

The sites are spread across each Transport Agency region and each regional council or unitary authority area throughout New Zealand. The sites are generally intended to measure exposure to road vehicle emissions at locations:

- that are sensitive to adverse air pollution effects (ie sites are generally within 50m of either a school or residential areas)
- where elevated concentrations are most likely to occur (see the site specific 'intra-regional' criteria which follows).

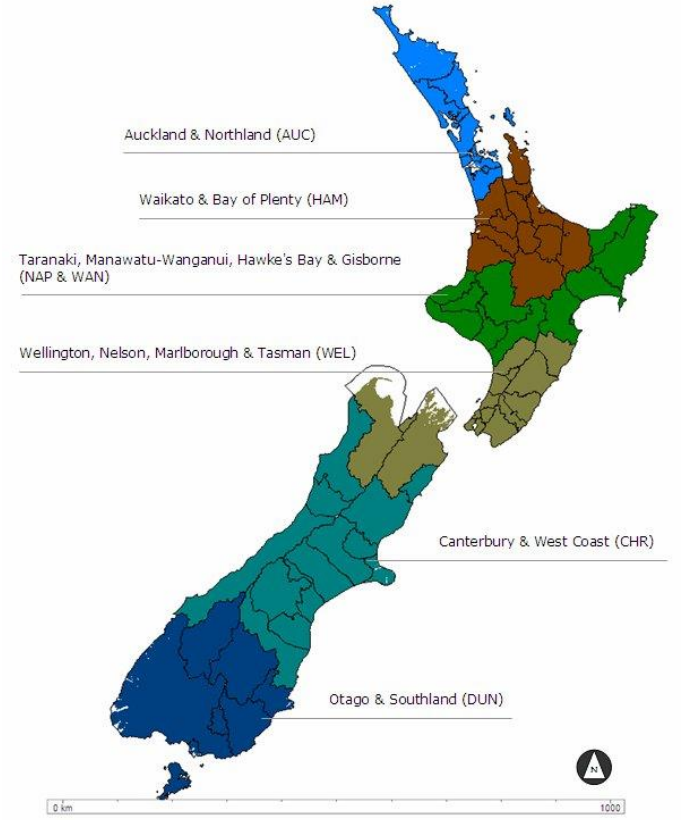
Original Transport Agency operating regions

When the national network was instigated in 2007, the Transport Agency operations were grouped under six regions, as listed and displayed below:

1. Auckland and Northland (AUC)
2. Waikato and Bay of Plenty (HAM)
3. Taranaki, Manawatu-Wanganui, Hawke's Bay and Gisborne (NAP and WAN)
4. Wellington, Nelson, Marlborough and Tasman (WEL)
5. Canterbury and West Coast (CHR)
6. Otago and Southland (DUN).

These original regions are reflected in the first three letters of the site identification (ID) codes.

Map of the original Transport Agency regions



4.2 Siting criteria continued

Inter-regional criteria

The inter-regional criteria used to select national network monitoring sites include:

- a minimum number of sites to be included in each regional council or unitary authority area. These local authorities have general responsibility for air quality management in NZ.
- a number of sites in each region to reflect the risk of being exposed to elevated levels of air pollution arising from vehicles using the state highway network, based on the population of the main urban areas or 'monitoring zones'
- non-state highway 'comparison' sites or 'site types' to be included in each monitoring zone (ie sites near local roads and in urban background locations)
- location of gazetted 'airsheds', ie areas designated by regional councils or unitary authorities that are likely to exceed the NES.

Intra-regional criteria

The intra-regional criteria used to select national network monitoring sites include:

- sections of the state highway network with the highest traffic flows in the region (typically where the annual average daily traffic (AADT) count is greater than 20,000 vehicles per day)
- sections of the state highway network with elevated congestion (based on 'level of service' indicators)
- areas where Transport Agency projects are planned or under construction
- a number of state highway, local road and urban background sites based on the population within the monitoring zone (see below).

Population classes

Population is used to define the number of state highway, local road and urban background sites in each monitoring zone because it is a surrogate measure of risk to exposure from road vehicle emissions. The table below shows the number of state highway and local road sites recommended for each population range listed. At least one urban background site should be installed in each monitoring zone with a population over 45,000.

Monitoring zone population (000's)	Number of sites	
	State highway	Local
> 200	6	4
150 – 200	5	3
100 – 150	4	2
75 – 100	3	1
70 – 75	2	0
< 70	1	0

4.3 Installation requirements

Siting requirements

Once a general site location has been decided, a number of specific installation requirements must be met before the site is commissioned and passive sampling commenced.

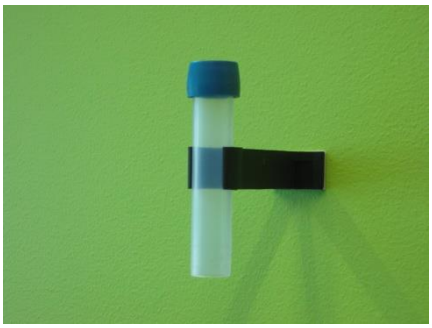
The passive diffusion samplers should be sited to open sky, exposed to freely flowing air with no overhanging vegetation or buildings. The opening of the passive diffusion sampler must not be obstructed or exposed to extreme wind speeds during sampling (ie a building corner).

Passive diffusion sampler tubes must be positioned vertically with the white lower cap removed and the exposed end facing down during sampling as shown below. A permanent plastic tube holder can be fixed to various surfaces so that the sampler can be changed easily. The holder can be mounted at the air quality monitoring site with a cable tie or double sided tape. Spacers are not required due to the design of the holder.

The passive diffusion samplers are intended to measure exposure to road vehicle emissions and should be attached to suitable road furniture at locations that are:

- within approximately 50m of a sensitive receptor location which is sensitive to adverse air pollution effects (ie a school or residential area)
- at a height of between 2 to 5m above the ground. Ideally, samplers should be placed at breathing height but to reduce vandalism they are typically placed at a height of 2 to 4m and no higher than 5m.

Orientation of an exposed passive sampler



Co-location with continuous analysers

Several sites in the national network are co-located with continuous NO_x analysers operated by the local authority to establish the accuracy of the monthly sampler results relative to the corresponding monthly continuous analyser results. The continuous NO_x analysers are operated in accordance with AS3580.5.1:2011 and are a reference method used to determine compliance with the NES.

These locations also employ triplicate passive diffusion tubes to check the precision or repeatability of the results by comparing the monthly variation between triplicate samplers. The triplicate tubes are positioned as close as possible to the sample inlet of the continuous NO_x analyser.

4.4 Site classifications

Overview

Sites are classified by monitoring zone and site type. Each site is also allocated a unique site identification code.

Monitoring zones

Transport Agency monitoring zones have been established for each main urban area in New Zealand (as defined by Stats NZ 2017), as well as for Taupo, Otaki, Blenheim, Greymouth and Queenstown, and are shown in the table below.

NZ region	Monitoring zone	2013 Population (000's)
Northland	Whangarei	53.6
Auckland	Auckland – Northern	288.0
	Auckland – Western	217.1
	Auckland – Central	450.9
	Auckland – Southern	425.8
Waikato	Hamilton	180.6
	Cambridge	18.4
	Te Awamutu	15.8
	Taupo	23.1
Bay of Plenty	Tauranga	125.7
	Rotorua	55.8
Gisborne	Gisborne	35.2
Hawke's Bay	Napier	60.6
	Hastings	67.0
Taranaki	New Plymouth	54.8
Manawatu / Wanganui	Wanganui	39.3
	Palmerston North	81.5
Wellington	Otaki	6.0
	Kapiti	40.7
	Upper Hutt	39.0
	Lower Hutt	100.5
	Porirua	53.5
	Wellington	196.5
Nelson & Tasman	Nelson	63.3
Marlborough	Blenheim	30.1
Canterbury	Christchurch	369.2
West Coast	Greymouth	9.9
Otago	Dunedin	115.1
	Queenstown	12.1
Southland	Invercargill	49.3

4.4 Site classifications continued

Site types

Monitoring sites in the Transport Agency national network are classified as:

1. **State highway** sites:
   - located within 100m of the road being monitored (ie the main source of vehicle emissions)
   - AADT>20,000 or known hot spot.
2. **Local road** sites:
   - located within 50m of the road being monitored
   - AADT>20,000 or known hot spot.
3. Urban **background** sites:
   - located more than 100m from a state highway
   - located more than 50m from a busy local road
   - ideally co-located with a continuous monitoring station.

Site identification code

Each site is allocated a unique code according to a site convention.

The site identification (ID) convention system is based on the original six Transport Agency operating regions (as shown in section 4.2). Site IDs are abbreviated using the first three letters of a main city from each region.

The site ID numbering lists the sites in a general chronological order. For example, a new group of sites or a project is added in no particular order to the last available site ID for that particular region.

4.5 Site metadata

Importance of metadata

Site metadata is necessary to interpret the air quality monitoring results.

The required metadata list below should be recorded for each site and the information stored electronically. The format of the site metadata reports or datasheets should be approved by the Transport Agency and include the relevant details listed below (see Appendix A for an example). The site parameters listed below are similar to those recommended in the *Good Practice Guide for Air Quality Monitoring and Data Management* (MfE 2009).

List of required metadata to be recorded for each monitoring site

Parameters	Explanation
Site identification	Consists of a three letter and three number regional system
Source name	Street name of the probable source of vehicle emissions
Site name (short)	Street name of the site
Site name (full)	Source name/street name for roadside sites and street name for background sites
Site location	Street address of site
Coordinates	New Zealand Transverse Mercator (NZTM) and New Zealand Map Grid (NZMG)
Region	Regional council or unitary authority region, eg Manawatu/Wanganui
Monitoring zone	Transport Agency monitoring zone, as described in section 4.4, eg Kapiti
Area	Suburb or town
Site type	State highway (SH), local road or urban background
National network	National network or non-network site
Intersection (Y or N)	Is the site within 50m of an intersection (a place where two or more roads cross at grade or with grade separation) involving a local road or a state highway or both?
SH	Relevant nearest state highway
Nearest SH	Distance to the edge of the nearest state highway (m)
Nearest SH direction	Direction of the nearest state highway
Nearest local road	Distance to the edge of the nearest local road (m)
Nearest local road direction	Direction of the nearest local road
Sensitive receptor type	Short description, ie residential housing or school name
Nearest sensitive receptor	Distance to the nearest sensitive receptor, ie a school or residential area (m)
Sensitive receptor location	Street address of the sensitive receptor
Monitoring period	Including the commissioning month and the last month before decommissioning
Height	Height of the sampler location above ground (m)
Trees	Distance from the nearest tree (m)
Parameters monitored	All contaminants/variables monitored
Site notes	Additional description, eg located at a monitoring station or relocation details
Site photos	Digital image of the monitoring site and surrounding area for context
Site map	Street map showing the monitoring site location

4.6 Site relocations and decommissioning

Relocation protocols

There are times when a site may need to be relocated or decommissioned. For example, it may be the target of vandalism, prove difficult to access for monthly sampler exchanges or not be representative of the site type to be monitored.

In these situations, the Transport Agency will decide if a site may need to be relocated to a more appropriate location.

The following indicate the protocols that should be followed if a site is relocated. The steps recommended depend on the length of time that the site has been in operation.

- If the site is relocated **within the first four months of monitoring**, the site and corresponding data should be noted but tagged invalid. A new site record should be created for the new location but no link needs to be made to the previous site due to insufficient previous data.
- If the site is relocated **after four months of monitoring**, a new site record should be created. Site notes should be added to the site records stating the reasons for moving the sampler, the dates involved in the relocation of the site, the site ID of relocated site and the site ID of the previous location.
- If a site is relocated **after one year of monitoring**, simultaneous monitoring for a period of two months should be undertaken at the site to be decommissioned and at the new relocated site to enable some cross-comparison of results.

4.7 References

1. Stats NZ (2017). See http://nzdotstat.stats.govt.nz/wbos/index.aspx for 2013 base populations for the different urban area classifications, accessed August 2017.
2. MfE (2009). *Good practice guide for air quality monitoring and data management*. Prepared by the Ministry for the Environment, Wellington.

5.0 How is the monitoring undertaken?

5.1 Overview

Introduction

This chapter describes the processes followed for undertaking the monthly monitoring and covers all steps from placing the samplers in the field through to receiving the sample analysis results from the laboratory.

As introduced in section 1.2, the successful operation of the national network is a collaborative effort between various parties as follows:

- the NZ Transport Agency
- the Consultant who liaises between the Transport Agency and the Contractor
- the Contractor who is responsible for operating the national network in accordance with the best practice procedures outlined in this manual.

A full description of the roles and responsibilities of each of these parties is covered in chapter 8.

This chapter focusses on the procedures undertaken by the Contractor, who for the 2017/18 monitoring period is Watercare Services Ltd (WSL). WSL liaises with a number of field subcontractors to undertake the monthly sample exchange in locations around the country. WSL also engages the Scientific Services Laboratory of Staffordshire County Council (SCC) to supply and analyse the exposed passive samplers.

Procedures outlined in this chapter should be undertaken in accordance with the Local Air Quality Management Technical Guidance Document (DEFRA 2016). This guidance document is abbreviated in this chapter to LAQM TG16.

In this chapter

5.2 Scheduling

General schedule

Passive sampling is undertaken on a nominal monthly basis.

The diffusion tubes should be scheduled to be exposed within ± two days of the first Wednesday of each calendar month and also allow for evenly spread exposure periods. During January, diffusion tubes should be exposed within ± 2 days of the second Wednesday due to operator availability.

The annual sampling schedule is sent to the field subcontractors by the Contractor two weeks prior to the sampler installation.

Duration of monitoring

The ideal duration of sampling for an individual passive diffusion tube should be one calendar month. The monthly exposure time should be no longer than five weeks and no shorter than three weeks to be a valid sample.

However, exceptions may be approved where field subcontractors encounter logistical difficulties and are unable to exchange samplers in time. For example, if a sampler is exposed for two months during one season (ie during July to September for winter or January to March for summer), the concentration is applied to both months (ie both of the affected months are recorded with the same value). **All exceptions to the recommended duration of monitoring for the purposes of recording monthly averages must be approved by the Transport Agency to ensure data integrity.**

The overall duration of monitoring at a site should fit the purpose of the monitoring objective. However, LAQM TG16 recommends that NO_2 diffusion tube monitoring is carried out for at least a full calendar year to make an assessment against the annual averaged guidelines (DEFRA 2016).

5.3 Field sampling procedures

Overview

In 2017/18 over 20 different field subcontractors around the country carry out the field sampling procedures. These field subcontractors include:

- NZ Transport Agency network consultants, eg Opus
- the Contractor – Watercare
- Council staff.

Sample checking and preparation

The Contractor (WSL) receives new unused passive diffusion samplers from the analytical laboratory and quality checks these before dispatching three-monthly batches to the relevant field subcontractors. Upon receipt, the samplers are inspected and then stored in a refrigerator (at 4°C). Samplers that are damaged or contaminated in transit are not be used and are to be returned to the Contractor.

When planning a site visit, the sampling technician should take some spare samplers, end caps, cable ties and tube holders to replace any that are missing or damaged. The samplers should be used and analysed within the specified "use by" date – usually this is within 4 months of preparation.

Sample deployment

The following procedures should be followed when deploying a new unused sampler every month:

- Remove samplers from the refrigerator on the day that they are to be installed.
- Take samplers to the site using sealable bags and ensure each sample bag is clearly labelled with the appropriate site identification number originally supplied.
- Store samplers in a cool environment using a chilly bin or ice packs.
- At each site, record the site identification number, and the site name on the supplied field sheet (see Appendix B for an example).
- Remove the new unused sampler from the sample bag. With the sealed coloured cap on top, remove the bottom white or clear cap and clip the sampler into the holder. It is important to remember that the coloured cap is not to be removed.
- Ensure the sampler is positioned vertically with its open end downwards.
- Record the date and time of the start of the exposure period on the supplied field sheet, and sealable sample bag.
- Make a note in the 'Comments' box of any site irregularities (eg building or road works) on the field sheet.
- Record the field sampling technician's name, position and contact details responsible for the installation.
- Keep the end caps in the sealable sample bag, for use when the exposure period is completed.

5.3 Field sampling procedure continued

Sample collection

The following procedures should be followed when an exposed sampler is exchanged/collected every month:

- Transport the new batch of unexposed samplers to site, together with the end caps from the last batch, and field sheets for both batches.
- At each site, remove the exposed sampler from the sample holder and replace the end cap tightly.
- Place these removed samplers back into last month's sample bag.
- Record the time and date of the end of the exposure period on the previous field sheet, and sealable sample bag.
- Make a note of any site irregularities (building/road works) or anything else which might affect, or even invalidate, the sampler's results (for example sampler found on the ground, insects, dirt, or liquid inside the sampler) on the field sheet in the comments box.
- Record the field sampling technician's name, position and contact details responsible for the exchange.
- Store the samplers and supplied field sheet in a refrigerator until they can be returned to the Contractor to organise the analysis. This should happen as soon as possible. Samplers should be couriered overnight (not on Fridays) to the address detailed on the field sheet insulated in bubble wrap or equivalent packaging.

Travel blank

A travel blank is transported and analysed with each batch of samplers to ensure that contamination of the samplers has not occurred in transit. Travel blanks are transported with the samplers to be exposed and stored in a refrigerator over the sample exposure period. The travel blanks are then transported again on the collection of the exposed batch and then the entire batch is sent for analysis.

Commissioning new sites or relocating sites

The following procedures should be followed when a new location or a relocation is required or when requested by the Contractor:

- Position the monitoring site as outlined in this manual.
- Mount the new tube holder into position by threading the supplied cable ties through the holder with the smooth side facing the clip and fastening it to the appropriate fixture.
- Record the site metadata details on the supplied site metadata sheets (see Appendix A for an example).
- Take clear digital landscape photos of the monitoring site and surrounding area. Email the photos to the Contractor.

5.4 Sample shipping and analysis

Storage and shipping

After the samplers are exposed and returned to the Contractor, they are stored in a cardboard box in a refrigerator. Once all of the monthly samplers have been received, the exposure dates, times and any comments from the field sheets are manually entered into a spreadsheet or data sheets formatted by the laboratory. The hard copies of the field sheets are filed by region and stored for up to ten years at the Contractor.

The monthly used samplers are sorted by region and securely packed in a cardboard box with bubble wrap. This data sheet is sent as a hardcopy with the samplers and also via email to the laboratory. The samplers and datasheet are sent to the laboratory with additional shipping instructions such as “samples returned for analysis”, and “non-dangerous goods”.

Analysis method

NO_2 is determined spectrophotometrically by a variation of the Saltzman reaction. Preparation of a calibration graph allows the amount of absorbed nitrite to be determined and by applying a constant factor. This is calculated from Fick’s Law and using the tube dimensions and the hours of exposed, then the ambient NO_2 concentration can be calculated.

The Contractor subcontracts the sample analysis to a suitably qualified laboratory (SCC). The Laboratory should meet the following criteria:

- The Laboratory should have accreditation for the analysis.
- The Laboratory should carry out the analysis according to the harmonized method, AEA/ENV/R/2504 Issue 1a. (AEA 2008).
- The Laboratory should participate in a proficiency scheme for NO_2 tubes.

Laboratory results

The results from the Laboratory are returned to the Contractor in PDF and Excel format.

All results in ppb are converted to µg/m³ using New Zealand standard conditions of temperature (0°C) and pressure (1atm).

All air quality data are reported as New Zealand standard time (NZST).

5.5 Health and safety

Compliance with Minimum Standard Z/5

All field and laboratory procedures must be undertaken in accordance with the requirements outlined in the Transport Agency's *Minimum Standard Z/5 – Health and Safety Compliance Notice* (NZTA 2017).

The Consultant shall ensure that the Contractor finalises a Method Statement that covers the management of the contracted works in relation to:

- compliance with the current Health and Safety in Employment Act and other safety legislation
- traffic in or adjacent to the works
- health and safety of people including employees, subcontractors (including the contracted Laboratory) and others who might be affected by the works.

Given the relatively small scale of the contract (less than $200k) the Method Statement may be covered by standard operating procedures.

The Consultant shall be responsible for ensuring that the Method Statement is appropriate given the scale and objectives of the project.

5.6 References

1. AEA (2008) *Diffusion tubes for ambient NO_2 monitoring: Practical guidance for laboratories and users*. Prepared by AEA Energy and Environment for the Department for Environment, Food and Rural Affairs and the Devolved Administrations, February 2008.
2. DEFRA (2016) *Local air quality management, Technical guidance LAQM TG16*. Prepared by the Department for Environment, Food and Rural Affairs, April 2016.
3. NZTA (2017) *Minimum Standard Z/5 – Health and Safety Compliance Notice, version 6*. Prepared by NZ Transport Agency, March 2017.

6.0 How are the data processed?

6.1 Overview

Introduction

This chapter reviews the data processing and quality assurance procedures followed, including the criteria used for dealing with missing or invalid data.

All procedures outlined in this chapter should be undertaken in accordance with the *Good Practice Guide for Air Quality Monitoring and Data Management* (MfE 2009) and the *Local Air Quality Management Technical Guidance Document* (DEFRA 2016). The former is abbreviated in this chapter to the Monitoring GPG and the latter to LAQM TG16.

In this chapter

6.2 Monitoring performance targets

Targets

The Transport Agency has a single target for measuring the performance of the monitoring undertaken for the national network as follows:

75% valid data for averaging

Where

$$\text{\% valid data for averaging} = \frac{\text{no of valid data pts obtained} * 100}{\text{total no of data pts in the averaging period}}$$

Valid data is a measure of the quantity of the data recorded. A requirement for 75% ensures that the data are representative of what might occur at that site over a whole year – ie both winter and summer.

The LAQM TG16 recommends a minimum annual data capture rate of 75% for NO_2 screening studies.

Implications

A 75% valid data target means:

- A sampler must be exposed for **at least 75% but no more than 125% of the available time in a given month to enable calculation of a monthly average**, eg for months with 31 days, the minimum exposure time is 23.25 days (558 hours) and the maximum is 38.75 days (930 hours).
- A site must have **at least two valid monthly averages for a season** to enable calculation of seasonal averages. Although sampling for only two months out of three months equates to only 67% valid data, this is considered sufficient for seasonal screening.

  As mentioned in section 5.2, there have been occasions when samplers have been exposed for two months during one season and the resulting concentration then applied to both months (ie both months have been recorded with the same value). In these rare exceptions, a seasonal average could be calculated on the basis of a sampler exposed for two months only if the third month was not valid but this would have to be approved by the Transport Agency.
- A site must have **at least nine valid monthly averages and at least one valid monthly average each for winter and summer** in a calendar year to enable calculation of an annual average.

"Winter" is classified as July, August and September of the current year, whilst "summer" is classified as January, February and March of the current year.

Note: Although LAQM TG16 includes a method for "annualising" data for sites with less than 75% valid data, **annualisation is not applied to the Transport Agency data**.

6.3 Data review and validation

Routine monthly checks

Each month, the monthly analysis results are reviewed to examine the validity of the data. These routine checks as described below:

- Depending on the number of days in the month, the valid exposure time should typically be no longer than five weeks and no shorter than three weeks.
- All concentrations less than 10µg/m³ and greater than 40µg/m³ are further examined to determine the validity of the sampler.
- Concentrations less than 3µg/m³ are rare even at urban background sites and therefore any values below this limit are considered invalid.
- The triplicate sites test for precision using the coefficient of variation (CV) (see the next sub-section below) from the three individual monthly results. If the CV value is greater than 30% then one or more of the samplers is consider suspicious and is invalidated.
- If more than 5% of the individual monthly results are deemed invalid then the results for the entire batch are further investigated.
- The CV value (see next section) is calculated for each site over the calendar year to identify any suspiciously high or low values that might be invalid. If the CV value becomes greater than 40% the monthly result is further examined.

Coefficient of variation (CV) calculations

The coefficient of variation (CV), also known as the relative standard deviation, is used both to indicate the precision between individual samplers at a triplicate site and to identify outliers in the monthly data for an individual site.

The CV is calculated according to:

$$\text{CV (\%)} = \frac{\text{standard deviation of the sampler results} * 100}{\text{mean of the sampler results}}$$

From LAQM TG16, diffusion tubes are considered to have "good" precision where the CV of duplicates or triplicates, based on eight or more individual periods during the year is less than 20%, and the overall average CV of all monitoring periods is less than 10%. Diffusion tubes are considered to have "poor" precision where the CV of four or more individual periods is greater than 20% and/or the average CV is greater than 10%. The distinction between "good" and "poor" precision is an indicator of how well the same measurement can be reproduced.

Since 2007, the average CV for triplicate sites in the Transport Agency network has been less than 8.0. The CV has been less than 20% for just under 95% of the triplicate samples, indicating that the precision of the passive samplers is good.

6.3 Data review and validation continued

Further checks

Results flagged as part of the routine checks undergo additional checks such as:

- rechecking field sheets and possibly contacting the field subcontractors for clarification
- comparing with monthly results from the previously monitored years (if available)
- contacting the laboratory to double check the results.

Correction for travel blanks

The purpose of the travel blanks is to identify possible contamination of diffusion tubes while in transit or in storage. Accordingly, the results are not meant to be routinely subtracted from those of the exposed tubes.

The travel blanks are generally close to the limit of detection of the laboratory (currently 1.1µg/m³ for SCC) so **results are not blank corrected**.

Comparison with continuous readings

The accuracy of the passive results can be checked by a linear regression between the monthly sampler results and the corresponding monthly continuous analyser results. This is usually conducted over one calendar year. A regression equation with a slope greater than one would indicate an over-read of the passive diffusion samplers and a slope less than one would indicate an under-read of the passive diffusion samplers.

In the UK, a bias adjustment factor is used to adjust passive monitoring results to make them directly comparable with the results gained from continuous monitoring methods. This standard formula, taken from LAQM TG16 is shown below:

$$\text{bias adjustment factor} = \frac{\text{continuous monitor } NO_2 \text{ average}}{\text{passive tube } NO_2 \text{ average}}$$

Results to date from the Transport Agency national network together with Auckland Council findings (ARC 2007) suggest that the relationship between passive and continuous monitoring results is not consistent. Consequently, **the application of adjustment factors is not undertaken**. For reporting purposes, the values from passive samplers are presented without any adjustment in order to maintain consistency among the passive data.

Due to differences in the methodologies, the passive results are not expected to exactly match those measured using a continuous analyser. However, data from both methods are expected to demonstrate a similar pattern in the temporal and spatial distributions.

6.3 Data review and validation continued

Calculation of averages for triplicate samplers

Triplicate passive samplers are co-located with regional council continuous NO_2 monitors at several monitoring sites. **Annual average results for these sites are calculated as follows depending upon the amount of valid data**:

- If **all three** individual triplicate results **have at least 75%** valid data, then average all three results.
- If **only two of three** individual triplicate results **have at least 75%** valid data, then average the two results only.

Annual averages are not reported if two of three individual triplicate results have less than 75% valid data, or where all three individual triplicate results have less than 75% valid data.

6.4 Treatment of invalid or missing values

Criteria for classifying data as invalid

All data are treated as being valid and are retained in the data record unless there is a justifiable and defensible reason for invalidating them.

Examples of circumstances that would invalidate data for the Transport Agency national network include:

- sampler contaminated with dirt, insects or spiders
- sampler found on the ground
- unusual activity nearby (i.e. fires or significant changes in traffic flow)
- spurious results that are significantly higher or lower than expected (as explained previously).

Missing values

No monitoring record is ever complete. Inevitably, there are periods of missing data some of which are planned (eg downtime due to for sample exchange) but most of which are unforeseen.

Examples of circumstances resulting in missing data for the Transport Agency national network include:

- sampler went missing during the monitoring period
- sampler went missing in transit to the Contractor
- sampler returned without a sample cap.

Documentation

The reason for a particular datum being invalid or missing is recorded in the corresponding month of the monthly report. The reason for missing data is also recorded on the corresponding field sheet, datasheet and laboratory report.

All invalid or missing data are shown as a blank cell or empty entry. Data are displayed this way in the annual summary of the monthly report and in the final dataset stored in the data warehouse.

6.5 References

1. ARC (2007) *Nitrogen dioxide in air in the Auckland region.* ARC Technical publication no 346 prepared by the Auckland Regional Council, December 2007
2. DEFRA (2016) *Local air quality management, Technical guidance LAQM TG16.* Prepared by the Department for Environment, Food and Rural Affairs, April 2016.
3. MfE (2009). *Good practice guide for air quality monitoring and data management.* Prepared by the Ministry for the Environment, Wellington.

7.0 How are the data reported and stored?

7.1 Overview

Introduction

This chapter discusses how the data are data are reported, stored and accessed.

All procedures outlined in this chapter should be undertaken in accordance with the *Good Practice Guide for Air Quality Monitoring and Data Management* (MfE 2009) where applicable.

In this chapter

7.2 Reporting formats

Time formats

For all of the NO_2 passive data, the time and date are reported in New Zealand Standard Time (NZST) which means monitoring averaging periods are consistent irrespective of whether daylight saving is in force.

Significant figures and rounding protocols

The NO_2 results are reported up to one decimal place (or the nearest 10^{th} of a $\mu g/m^3$), eg $35.2\mu g/m^3$.

When the value following the significant digit is less than 5, the digit should be retained. If the value is equal to or greater than 5, the digit should be rounded up.

Examples:

20.44	rounds to	20.4
20.45	rounds to	20.5
20.46	rounds to	20.5

Results typically do not exceed three significant figures.

Implications for reporting exceedances and classifying high or medium sites

An exceedance occurs when the reported concentration is above the standard or guideline, after rounding to the significant digit. For the national network results, that means any site which reports an annual average NO_2 concentration of $40.1\mu g/m^3$ (averaged across at least nine months in a calendar year and rounded to one decimal place) records an exceedance of the WHO annual guideline of $40.0\mu g/m^3$.

In addition, sites are classified as "high" or "medium" based on their annual average NO_2 concentration (as discussed in section 2.3). This means that:

- Any site which reports an annual average NO_2 concentration between $30.0\mu g/m^3$ and $39.9\mu g/m^3$ is classified as a "medium" site.
- Any site which reports an annual average NO_2 concentration of $40.0\mu g/m^3$ or higher is classified as a "high" site.

7.3 Data supply

Overview

Data (in the form of Excel spreadsheets) are supplied regularly to the Transport Agency as follows:

- monthly data
- annual data
- site metadata.

Data are typically supplied for a calendar year (ie January to December).

Monthly data

Monthly data are issued monthly within two months of the end of the month in question. (The lag is due to the time taken to get the samplers shipped and analysed). The data are supplied in the form of an Excel workbook comprising the following:

- a series of monthly worksheets (one for each month, eg Jul17) presenting:
  - the site details
  - the length of exposure (in hrs)
  - the raw results for the month in the current year (eg Jul17)
  - the results for the same month in previous years (eg Jul15, Jul16, Jul17 etc. if available
  - any relevant comments.
- an annual summary sheet for the results to date in the current calendar year (eg Monthly Summary 2017) showing:
  - the site ID only
  - the monthly validated results to date for the current calendar year
  - the CV based on the monthly results to date
  - the % valid data for the valid monthly averages to date.

See Appendix C for examples.

A brief list of any site anomalies that occurred each month is also supplied via email. The purpose of the list is to explain the monthly comments further by adding more information about possible issues that may have occurred and any resolutions that may have been identified.

7.3 Data supply continued

Annual data

Annual data are issued annually, two months after receiving the last analysis report for December of the previous year. The data are supplied in the form of an Excel workbook comprising the following sheets:

- a metadata report (eg 2007–2016 Metadata) with all details for all sites that have ever been in the national network (regardless of whether they are still current) covering:
  - the site ID and name
  - the northings and eastings (NZMG and NZTM)
  - the month the site was commissioned/decommissioned
  - the Transport Agency monitoring zone, region and area
  - the site type and distances to the nearest SH, local road and receptors.
- a series of annual summary sheets (eg Monthly Summary 2017) for each calendar year since 2007 (same as the annual sheets issued monthly).

See Appendix D for examples.

One off data requests

One off data requests should be actioned within two weeks of the request.

Site metadata

Metadata sheets (see Appendix A) are issued two months after receiving the last sampling details. However, a summary of the metadata information is submitted within the first month to verify the suitability of the site.

Due to improvements in the state highway network, the metadata for each current site is checked when a site metadata report is prepared to ensure that the distances to state highways and local roads are accurate. In some cases, re-alignments of the state highway network have resulted in a monitoring site changing its site type from being a state highway site to a local road site or vice versa. Any revisions to site metadata are highlighted in the site metadata report.

7.3 Data supply continued

Uploading to TRAMS

Annual data are uploaded annually into the Transport Related Air Quality Monitoring System (TRAMS) database, two months after receiving the last analysis report for December of the previous year.

The data are supplied in the following format:

- site ID
- coordinates (NZMG and NZTM)
- site name
- exposure time (hrs)
- raw results (µg/m³)
- validated results (µg/m³)
- percentage of valid data for the calendar year
- any relevant comments.

The intention is to eventually upload the monthly data into TRAMS so it can be accessed more easily and by a wider audience, thereby replacing the monthly data spreadsheets.

Uploading to MapHub

Annual data are uploaded annually into MapHub, two months after receiving the last analysis report for December of the previous year.

The data are summarised into the following format:

- NO_2 annual averages with columns for:
  - the site ID and name
  - whether part of the national network (Y)
  - the northings and eastings (NZMG only)
  - the annual average
  - the link to the metadata file as a PDF
  - explanatory comments about data validity.
- NO_2 winter averages with columns the same as for the NO_2 annual average but with the winter averages for each year calculated based on monthly readings for July, August and September of that year.
- NO_2 summer averages with columns the same as for the NO_2 annual average but with the summer averages for each year calculated based on monthly readings for January, February and March of that year.

7.3 Data supply continued

Revising the NO_2 spatial regression model

NIWA has developed an NO_2 spatial regression model which is used to predict annual mean concentrations of NO_2 at any given location as a function of local traffic density.

This model is based on the results of NO_2 passive monitoring data from 45 Transport Agency sites in Auckland and is used in a screening tool to predict NO_2 concentrations as part of a Tier 2 Air Quality Screening Assessment (NZTA 2014).

Annual data should be supplied to NIWA when available at the end of each calendar year to enable the regression equations to be checked for currency and revised if necessary in the screening tool.

7.4 Reporting

Overview

Reports are supplied regularly to the Transport Agency as follows:

- monthly reports
- annual reports
- site metadata reports.

Note that for:

- annual averages, the monitoring year runs from January to December.
- seasonal averages, winter covers the months of July, August and September and summer covers the months of January, February and March.

Monthly report

Monthly reports are issued monthly within two months of the end of the sampling month in question.

The monthly report is essentially the Excel workbook containing the monthly data as described in section 7.3 and shown in Appendix C.

Annual report

Annual reports are issued annually within six months of the end of the year in question. (The lag is to enable all results to be analysed and for the preparation of the report itself). Annual reports cover all years to date since the national network monitoring began in 2007 (eg 2007–2016) and include the following chapters:

- Executive summary
- Introduction
- Methodology
- Results
- Trends
- Description of high NO_2 sites
- Conclusions
- References
- Glossary
- Appendices with metadata, annual average tables, seasonal average tables, and monitoring zone maps.

The annual reports are supplied in both MS-Word and PDF format. Examples of previous annual reports are available at https://www.nzta.govt.nz/resources/air-quality-monitoring/ (NZTA 2016).

7.4 Reporting continued

One off report requests

Simple one off requests should be actioned within two weeks of the request being agreed by the Transport Agency (in advance).

One off reports include as a minimum:

- an outline of sites (coordinates and a brief description of sites)
- results and associated monthly summaries.

More detailed one-off requests need to be assessed on a case by case basis and may be subject to cost recovery.

Metadata report

Site metadata reports are produced every three years or on request. Site metadata reports cover all years to date since the national network monitoring began in 2007 (eg 2007-2016) and include the following:

- an overview of the monitoring sites by monitoring zones for each year
- tables summarising the metadata details for each site
- national maps showing all network sites monitored in that year
- site metadata sheets for each individual site ordered by monitoring zone north to south across New Zealand.

The site metadata reports are supplied in both MS-Excel and PDF format.

Examples of previous site metadata reports are available at https://www.nzta.govt.nz/resources/air-quality-monitoring/ (NZTA 2013).

7.5 Where the data are stored

Processed data	The final processed data are stored as monthly averages on the Contractor's data storage system, together with the site ID for easy retrieval. These data are uploaded into TRAMS annually as part of the annual reporting process.
Raw data	All raw data and laboratory analysis reports are stored as annual Excel files on the Contractor's data storage system.
Site metadata	All site metadata files are stored on the Contractor's data storage system.
Data backups	All data and files stored by the Contractor on behalf of the Transport Agency are stored offsite, backed up every night and archived monthly.
Data access	All data held by the Contractor are treated as confidential. No data should be provided to outside parties without the prior consent of the Transport Agency. Note: Some outside parties may already have access to data records but only those which are publicly available in either TRAMS or MapHub.

7.6 Peer review and change protocols

Peer review

All data and reports supplied are subject to appropriate peer review and sign-off in accordance with the Contractor's in-house quality procedures.

Change protocols

Issues occasionally surface during quality assurance, peer review and general investigation which can suggest that data previously classified as "valid" may not be or has been reported incorrectly. Sometimes these issues only become apparent once longer data records or cross-site comparisons are available.

If concerns with the validity of data prove justified, the data are declared now invalid or amended and all of the following data records are updated accordingly:

- the Contractor's processed data records
- TRAMS
- MapHub.

At the same time, the Transport Agency is notified of the change (and the reasons for it) in case decisions need to be made about issuing an erratum to the annual report etc.

7.7 References

1. MfE (2009) *Good practice guide for air quality monitoring and data management*. Prepared by the Ministry for the Environment, Wellington.
2. NZTA (2013) *Ambient air quality (nitrogen dioxide) monitoring network – site metadata report 2007-2012*. Prepared by Watercare Services Ltd and Emission Impossible Ltd for NZ Transport Agency, August 2013.
3. NZTA (2014) *Guide to assessing air quality impacts from state highway projects, version 2.0, DRAFT*. NZ Transport Agency, December 2014.
4. NZTA (2016) *Ambient air quality (nitrogen dioxide) monitoring network – annual report 2007-2015*. Prepared by Emission Impossible Ltd for NZ Transport Agency, October 2016.

8.0 Who is responsible for what?

8.1 Overview

Introduction

The successful operation of the national network is a collaborative effort between various parties, principally the Transport Agency, the Consultant and the Contractor but others are involved on occasion.

This chapter covers who is responsible for what in the current 2017/18 period and highlights who in particular is responsible for key decisions in the process.

In this chapter

8.2 Role of the Transport Agency

Overall role

The Transport Agency plays a strategic role in the national network by funding the majority of the sites (see section 9.2) and setting key indicators for performance and delivery of the national network by the Consultant and the Contractor.

In previous years, the Transport Agency has also acted as the Consultant (liaising directly with the Contractor regarding day to day operations) but for the 2017/18 monitoring period is engaging Emission Impossible Ltd (through their IPA Contract) to act in this role on their behalf and only bring relevant or important matters to the Transport Agency's attention if they require a special decision.

The responsibilities of the Transport Agency are outlined in the following sections.

Where monitoring is undertaken

The Transport Agency is responsible for:

- indicating the general location and requirements of any new sites to the Consultant
- confirming the specific location of all new or re-located sites proposed by the Contractor via the Consultant
- undertaking an annual review of all monitoring priorities and confirming sites for on-going monitoring with the Consultant
- liaising with other stakeholders, such as regional councils, on securing approval and/or funding for co-located sites.

How monitoring is undertaken

The Transport Agency does not generally play an active role in decisions made regarding how the monitoring is undertaken.

The Transport Agency's expectation is that any decisions required are made on its behalf by the Consultant to ensure that the data are collected in accordance with the best practice procedures outlined in this manual to ensure high quality data.

How data are processed

Aside from setting the monitoring performance target of 75% valid data, the Transport Agency does not generally play an active role in other decisions made regarding the data processing and quality assurance.

The Transport Agency's expectation is that any decisions required are made on its behalf by the Consultant to ensure that the data are processed and quality assured in accordance with the best practice procedures outlined in this manual to ensure high quality data.

8.2 Role of the Transport Agency continued

How data are reported

The Transport Agency is responsible for:

- defining the frequency and nature of reporting of the results and confirming these requirements with the Consultant and the Contractor
- publishing the annual and site metadata reports and making them available on the Transport Agency's website
- supporting TRAMS, MapHub and the air quality section of the Highways Information Portal (https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/) to enable interested parties to access the data.

8.3 Role of the Consultant

Overall role

The Consultant plays a liaison role in the national network by acting on behalf of the Transport Agency in the day to day operation to ensure that all key indicators for performance and delivery are met and are in accordance with the best practice procedures outlined in this manual to ensure high quality data.

In previous years, the Transport Agency has also acted as the Consultant (liaising directly with the Contractor regarding day to day operations) but for the 2017/18 monitoring period is engaging Emission Impossible Ltd (through their IPA Contract) to act in this role on their behalf and only bring relevant or important matters to the Transport Agency's attention if they require a special decision.

The responsibilities of the Consultant are outlined in the following sections.

Where monitoring is undertaken

The Consultant is responsible for:

- working with the Contractor to ensure all site location issues are managed in accordance with the procedures outlined in this manual
- discussing the specific location of all new or re-located sites proposed by the Contractor with the Transport Agency
- discussing monitoring priorities and confirming sites for on-going monitoring with the Transport Agency
- communicating any important issues raised by the Contractor to the Transport Agency
- communicating any important decisions made by the Transport Agency to the Contractor.

How monitoring is undertaken

Unless directed by the Transport Agency otherwise, the Consultant is responsible for:

- working with the Contractor to ensure all field sampling and analysis issues are managed in accordance with the procedures outlined in this manual
- communicating any important issues raised by the Contractor to the Transport Agency
- communicating any important decisions made by the Transport Agency to the Contractor.

8.3 Role of the Consultant continued

How data are processed

Unless directed by the Transport Agency otherwise, the Consultant is responsible for:

- working with the Contractor to ensure all data processing and quality assurance issues are managed in accordance with the procedures outlined in this manual
- communicating any important issues raised by the Contractor to the Transport Agency
- communicating any important decisions made by the Transport Agency to the Contractor.

How data are reported

Unless directed by the Transport Agency otherwise, the Consultant is responsible for:

- working with the Contractor to ensure all reporting issues are managed in accordance with the procedures outlined in this manual
- ensuring that all data are regularly uploaded into TRAMS, MapHub and the air quality section of the Highways Information Portal (https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/) to enable interested parties to access the data
- communicating any important issues raised by the Contractor to the Transport Agency
- communicating any important decisions made by the Transport Agency to the Contractor
- preparing the annual report and the supporting spreadsheets
- updating of operating manual (this document) to cover the current contract period

8.4 Role of the Contractor

Overall role

The Contractor has the primary responsibility for operating the national network in accordance with the best practice procedures outlined in this manual and ensuring that all key indicators for performance and delivery are met to ensure high quality data.

The Contractor liaises with the Consultant on day to day issues and is responsible for highlighting any relevant or important matters that may require the Transport Agency's attention.

Watercare Services Ltd (WSL) has been the Contractor for the national network since its inception in 2007 and continues in this role for 2017/18 (through their IPA Contract).

WSL liaises with a number of field subcontractors – either network consultants engaged by the regional Transport Agency offices to assist with other tasks (eg Opus, Higgins etc) or Transport Agency network asset management staff or council staff (eg Environment Canterbury) – to undertake the monthly sample exchange in locations around the country.

WSL also engages the Scientific Services Laboratory of Staffordshire County Council (SCC) to supply and analyse the exposed passive samplers.

The responsibilities of the Contractor are outlined in the following sections.

Where monitoring is undertaken

The Contractor is responsible for:

- finding suitable locations for new or relocated sites which meet the Transport Agency's general siting criteria and recommending these to the Consultant for confirmation by the Transport Agency
- installing new sites, either directly or through field subcontractors
- liaising with other stakeholders, after formal approval gained by the Transport Agency, to undertake sampling at co-located sites
- decommissioning old sites, either directly or through field subcontractors
- advising the Consultant immediately of any issues affecting the performance of any monitoring site in the national network, eg situations which may require the site to be temporarily decommissioned or relocated
- ensuring that all supporting documentation is kept up to date and reflects the practices being undertaken.

8.4 Role of the Contractor continued

How monitoring is undertaken

The Contractor is responsible for:

- deploying and exchanging samplers on a monthly basis in accordance with the best practice procedures outlined in this manual
- sending and receiving samplers and associated documentation to field subcontractors
- subcontracting a Laboratory to analyse the samplers in accordance with the best practice procedures outlined in this manual, including:
    - arranging the shipping of samplers and supporting documentation to the Laboratory
    - receiving final results and supporting documentation from the Laboratory
    - liaising with the Laboratory with any issues over the analyses
    - tracking the Laboratory accreditation records and quality assurance procedures
- advising the Consultant immediately of any sampling or analysis issues which may compromise the quality of the results or the timeliness of its delivery
- ensuring that all supporting documentation is kept up to date and reflects the practices being undertaken.

How data are processed

The Contractor is responsible for:

- processing the data and undertaking quality assurance in accordance with the best practice procedures outlined in this manual
- ensuring that all monitoring performance targets are being met
- advising the Consultant immediately of any data processing/quality assurance issues which may compromise the validity of the results
- ensuring that all supporting documentation is kept up to date and reflects the practices being undertaken.

8.4 Role of the Contractor continued

How data are reported

The Contractor is responsible for:

- providing and reporting the monthly data to the Transport Agency, the Consultant and those Councils that provide financial or in-kind support
- providing and organising metadata sheets
- providing annual data and supporting information to the Consultant and the Transport Agency
- undertaking appropriate peer review before any data or reports are issued
- storing the raw and processed data in a database with regular and appropriate off-site backup
- advising the Consultant immediately of any reporting or storage issues which may compromise the frequency or accessibility of the results
- ensuring that all supporting documentation are kept up to date and reflects the practices being undertaken
- updating of operating manual (this document) to cover the current contract period.

8.5 Role of other subcontractors

Overall role

Other parties are involved in assisting with the national network as follows:

- field subcontractors for deploying and exchanging samplers (particularly for sites around the country)
- a specialist laboratory for analysing the passive samplers.

The field subcontractors comprise Transport Agency network consultants (eg Higgins), Transport Agency network asset management staff and Council staff, depending on the availability of resources in various areas. The cost of the services provided by the field subcontractors is generally covered by the field contractors themselves (some of whom operate under the Transport Agency's Network Outcomes Contract). The Network Outcomes Contract for the maintenance, operations and renewals of the state highway network in New Zealand includes requirements for contractors to assist with the national network sampling programme.

The Scientific Services Laboratory of Staffordshire County Council (SCC) has been engaged by the Contractor (WSL) as the specialist laboratory to analyse the exposed passive samplers since 2007 and continues in this role for 2017/18.

Appendix E lists the other subcontractors involved in assisting with the operation of the national network in 2017/18.

Role of field subcontractors

Field subcontractors are responsible for:

- deploying and exchanging the samplers sent by the Contractor in accordance with the best practice procedures outlined in this manual
- sending the exposed samplers together with any supporting documentation to the Contractor in a timely and agreed fashion
- advising the Contractor immediately of any field issues which may compromise the quality of the results or the timeliness of its delivery.

Role of the laboratory

The laboratory is responsible for:

- analysing the samplers sent by the Contractor in accordance with the best practice procedures outlined in this manual
- reporting the final results together with any supporting documentation to the Contractor in a timely and agreed fashion
- advising the Contractor immediately of any analysis issues which may compromise the quality of the results or the timeliness of its delivery.

9.0 How is the network funded?

9.1 Overview

Introduction

This chapter covers how the national network is funded within the Transport Agency and co-funding arrangements with external agencies, such as regional councils.

In this chapter

9.2 Transport Agency internal funding

System Design and Delivery Group funding	The national network was set up in 2007 and funding is managed by the System Design and Delivery Group of the Transport Agency.
Future funding priorities	The System Design and Delivery Group will review the funding of the national network on an annual basis; this will be undertaken in advance of and will inform the Request For Proposal(s) for services contracted for the subsequent financial year.

9.3 External funding

Council funding

When it was originally setup in 2007, the national network was funded solely by the Transport Agency.

However, following the expansion of the network to increase the coverage and type of sites in recent years, a number of councils have supported the network operation as follows:

- Auckland Council (AC)
- Environment Canterbury (ECan)
- Greater Wellington Regional Council (GWRC)
- Waikato Regional Council (WRC).

For the 2017/18 operating year, AC, GWRC and WRC are continuing to fund the operation of key network sites in their regions, while ECan is continuing to offer in-kind support for sites in Christchurch.

Acknowledgement

All third parties who contribute funding and in kind support will be acknowledged in the annual report.

10.0 Glossary and References

10.1 Overview

Introduction

This chapter contains a glossary of all technical terms, a list of all abbreviations and a complete bibliography of all references that appear in the manual.

Please note that each chapter also has the references sections (where applicable) summarising the references that relate to the particular topic under discussion.

In this chapter

10.2 Terminology

Ambient air	The air outside buildings and structures (including tunnels). This does not refer to indoor air, air in the workplace, or contaminated air discharged from a source.
Airshed	An area designated by a regional council or unitary authority for the purposes of managing air quality and gazetted by the Minister for the Environment
Area	The name of the suburb the monitoring site is located in (eg Porirua).
Asset improvement projects	New and improved infrastructure for state highways as defined in the Government Policy Statement on Land Transport Funding. These covers activities related to managing and delivering a State highway capital improvement programme.
Background site	A monitoring site which is located more than 100 metres from a state highway and more than 50 metres from a busy local road.
Co-located site	Co-location is a procedure used in air quality monitoring where two or more monitors or samplers are installed in the same location so the measurements can be compared. For example, co-locating a passive sampler with a continuous monitor at the same site.
Concentration	The amount of a substance in a mixture. The concentration is usually proportional to the observable intensity of effects. For air pollution, concentration is reported as either a volumetric measure (eg parts per billion, ppb) or as a mass measure (eg micrograms per cubic metre, $\mu g/m^3$).
Continuous monitoring	A "continuous" monitor is one that samples air at a discrete location using active air movement, ie pumping or purging. Continuous monitors are relatively expensive to buy, operate and maintain. They are used most often for compliance monitoring (ie assessing air quality against guidelines and standards for regulatory purposes) and are able to provide accurate data for averaging periods down to one-hour.
Diffusion tube	Diffusion tubes are common examples of passive samplers used in air quality monitoring. These are simple devices which consist of a grid impregnated with a chemical reagent which absorbs pollutants (eg NO_2) over the period of exposure and is then sent off to a lab to be analysed.
Emission	The release of a substance (eg an air pollutant) from a source (eg transport, industry or domestic fires). Emissions are often expressed in units per activity (eg grams per kilometre driven g/km or grams per kilogram fuel burnt g/kg).
Exceedance	An occasion when the concentration of an air pollutant exceeds a standard or permissible measurement.
Exposure	The concentration of air pollution experienced by a person for a set duration, usually expressed as a time averaged concentration (eg 1 hour average or annual average). Air quality guidelines and standards are usually set for two extremes of exposure – a short term or acute exposure level and a long term or chronic exposure level.

10.2 Terminology continued

Guideline value	A concentration value and averaging period (over which it applies) for assessing and managing ambient air quality.
Local authority	A regional council, unitary authority or territorial local authority
Local road	A road controlled by a Road Controlling Authority other than the Transport Agency.

Local road site	A monitoring site which is located within 50 metres of a busy local road (ie a road with an AADT>20,000 or which is known hot spot for traffic congestion).
Metadata	Metadata describes other data related to the monitoring site. It provides information such as where it is located, how far away it is from important features such as nearby roads or schools or trees etc.
Monitoring zone	Geographical zones established by the Transport Agency for the purposes of prioritising air quality monitoring. These are based on main and satellite urban areas across New Zealand as defined by Statistics NZ.
Passive sampling	A "passive" sampler is one that is samples air at a discrete location without using active air movement, ie pumping or purging. Passive samplers are cheap and relatively easy to install but are only able to provide data for long averaging periods, such as a month, rather than daily or more frequent periods. They are more commonly used for screening rather than regulatory monitoring.
Receptor	A location where any person may be exposed to pollution from the road for 1 hour or more, irrespective of whether or not that person is considered to be sensitive to the effects of air pollution e.g. an industrial or commercial building.
Region	Geographical regions established by the Transport Agency for the purpose of managing state highway assets.
Road furniture	Road furniture is a collective for objects and pieces of equipment installed on streets and roads for various purposes. It includes benches, traffic barriers, bollards, post boxes, phone boxes, streetlamps, traffic lights, traffic signs, bus stops, tram stops, taxi stands, public lavatories, fountains, watering troughs, memorials, public sculptures, and waste receptacles.
Highly sensitive receptor	A location where people or surroundings may be particularly sensitive to the effects of air pollution. Examples include residential houses, hospitals, schools, early childhood education centres, childcare facilities, rest homes, marae, other cultural facilities, and sensitive ecosystems.
Site code or ID	A unique code made up of three letters representing the Transport Agency region and three digits representing the number of the site in that region (eg WEL005 for the Titahi Bay Road site).
Site name	The name of the site, typically based on 'source' road (eg CMJ) and the 'receiver' address where the monitoring site is located (eg Canada Street).

10.2 Terminology continued

Site type	The classification that applies to the site as to whether it is a state highway site, a local road site or a background site.
Source	The road or state highway most likely contributing the most to the concentrations recorded at the site.
State highway site	A monitoring site which is located within 100 metres of a state highway.
Summer	Defined for the purpose of calculating a seasonal "summer" average as January, February and March of the same calendar year.
Triplicate site	A site where three passive samplers are installed next to each other to check the precision (or repeatability) of the results. The results are used to calculate the coefficient of variation (CV) which indicates the accuracy of the samplers.
Valid data	Data that have been through a process to remove any values that do not reflect actual conditions being monitored. For example, if a sampler is damaged or vandalised during the monitoring period then the result is declared invalid and cannot be used to calculate any seasonal or annual averages covering that period.
Winter	Defined for the purpose of calculating a seasonal "winter" average as July, August and September of the same calendar year.

10.3 Abbreviations

AADT	Annual average daily traffic flow in vehicles per day.
AAQG	Ambient air quality guidelines, produced by the Ministry for the Environment to protect human health and ecosystems.
AC	Auckland Council, formerly known as Auckland Regional Council
AEE	Assessment of environmental effects
ARC	Auckland Regional Council, now known as Auckland Council
CV	The coefficient of variation, also known as the relative standard deviation, is a measure of the accuracy of passive samplers.
DEFRA	UK Department for Environment, Food and Rural Affairs
ECan	Environment Canterbury Regional Council
GPG	Good practice guide
GWRC	Greater Wellington Regional Council
%HV	Proportion of heavy duty vehicles (ie vehicles with a gross vehicle mass of over 3.5 tonnes)
LAQM TG09	Local air quality management: Technical guidance produced by DEFRA in 2009
LAQM TG16	Local air quality management: Technical guidance produced by DEFRA in 2016
MfE	Ministry for the Environment
MoT	Ministry of Transport
NES	National environmental standards
NO	Nitric oxide, an air pollutant produced from the combustion of fossil fuels used in transport. NO is the primary product emitted directly but is eventually oxidised to NO_2 by other pollutants in the atmosphere.
NO_2	Nitrogen dioxide, an air pollutant produced from the combustion of fossil fuels used in transport. NO_2 can cause health effects such as retarded lung development in children and increased susceptibility to lung infections.
NO_x	Nitrogen oxides (also referred to as oxides of nitrogen) is the collective term for the group of compounds including NO and NO_2.
NZMG	New Zealand Map Grid is the old projection that has been used for 1:50,000 topographic mapping in New Zealand. It was replaced by the NZTM in 2001. The Transport Agency currently uses NZMG coordinates for Spatial Viewer.

10.3 Abbreviations continued

NZST	New Zealand Standard Time, the time in New Zealand without any daylight saving and officially 12 hours in advance of Coordinated Universal Time (UTC).
NZTA	New Zealand Transport Agency, abbreviated to the Transport Agency, is the agency responsible for the building and operation of New Zealand's state highway network, amongst other duties, since July 2008.
NZTM	New Zealand Transverse Mercator is the future projection that will be used for New Zealand's 1:50,000 and other small scale mapping.
ppb	Parts per billion, a measure of concentration
TRAMS	Transport-related air quality monitoring system, the Transport Agency database of air quality monitoring data relevant to the operation and improvement of the state highway network.
$\mu g/m^3$	Micrograms per cubic metre, a unit of concentration
WHO	World Health Organisation
WRC	Waikato Regional Council

10.4 Bibliography

1. AEA (2008) *Diffusion tubes for ambient NO_2 monitoring: Practical guidance for laboratories and users*. Prepared by AEA Energy and Environment for the Department for Environment, Food and Rural Affairs and the Devolved Administrations, February 2008.
2. ARC (2007) *Nitrogen dioxide in air in the Auckland region.* ARC Technical publication no 346 prepared by the Auckland Regional Council, December 2007.
3. DEFRA (2009) *Local air quality management, Technical guidance LAQM TG09*. Prepared by the Department for Environment, Food and Rural Affairs, February 2009.
4. DEFRA (2016) *Local air quality management, Technical guidance LAQM TG16*. Prepared by the Department for Environment, Food and Rural Affairs, April 2016.
5. MfE (2002) *Ambient air quality guidelines, 2002 update*. Air Quality Report No 32 prepared by the Ministry for the Environment and the Ministry of Health, May 2002.
6. MfE (2009). *Good practice guide for air quality monitoring and data management*. Prepared by the Ministry for the Environment, Wellington.
7. MfE (2011) *Resource Management (National Environmental Standards for Air Quality) Regulations 2004*. Prepared by the Ministry for the Environment, June 2011.
8. MoT (2017) *The New Zealand vehicle fleet, Annual fleet statistics 2016*. Prepared by the Ministry of Transport, August 2017.
9. NIWA (2008) *The determinants of levels of secondary particulate pollution and nitrogen dioxide in urban New Zealand – Part 1*. NIWA Report AKL2008-053 prepared for the Foundation for Research, Science and Technology, July 2008.
10. NZTA (2008) *Environmental plan: Improving environmental sustainability and public health in New Zealand, version 2*. NZ Transport Agency, June 2008.
11. NZTA (2013) *Ambient air quality (nitrogen dioxide) monitoring network – site metadata report 2007-2012*. Prepared by Watercare Services Ltd and Emission Impossible Ltd for NZ Transport Agency, August 2013.
12. NZTA (2014) *Guide to assessing air quality impacts from state highway projects*, version 2.0, DRAFT. NZ Transport Agency, December 2014.

10.4 Bibliography continued

13. NZTA (2016) Ambient air quality (nitrogen dioxide) monitoring network – annual report 2007–2015. Prepared by Emission Impossible Ltd for NZ Transport Agency, October 2016.

14. NZTA (2017) *Minimum Standard Z/5 – Health and Safety Compliance Notice, version 6*. Prepared by NZ Transport Agency, March 2017

15. NZTA (2017) *Transport-Related Air Quality Monitoring System (TRAMS).* Web-based tool available from https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/, NZ Transport Agency, 2017.

16. Stats NZ (2017). See http://nzdotstat.stats.govt.nz/wbos/index.aspx for 2013 base populations for the different urban area classifications, accessed August 2017.

17. WHO (2006) *Air quality guidelines global update 2005: Particulate matter, ozone, nitrogen dioxide, and sulphur dioxide*. Prepared by the World Health Organisation, October 2006.

11.0 Appendices

In this chapter

Appendix A Example site metadata sheets

LABORATORY SERVICES - QUALITY SYSTEM
Ambient Air Quality Passive Monitoring: Site Checks

Client:		**Site Name:**			
Site Code:		**Date:**		**Technician:**	

Site Commissioning Details

Location

Nearest Street Address					
Area		City		Region	
Map Ref (NZMG, Geo Datum 49)		E		N	
Nearest Sensitive Receptor - Name & Street Address (e.g. school)					

Supporting Information

Date(s) Commissioned	From		To		
Photos of Site Taken	Y / N		Location Map	Y / N	

Sampler Specifications

Criteria	Specification	Units	Site monitoring type for NZTA only			
			SH	Local	Background	Notes
Nearest Major Road or SH		m	<100 m	<50 m	> 50 m	
Nearest Sensitive Receptor		m	< 50 m	< 50 m	< 50 m	
Height Above Ground		m	2 - 5 m	2 - 5 m	2 - 5 m	
Nearest Trees		m	≥10m	≥10m	≥10m	

Other Site Descriptions
(i.e. topography, buildings, possible sources, etc)

Contacts

Name	Position	Telephone No. & Email

Notes
Any Enquires Contact:
Watercare Services Limited
52 Aintree Avenue, Airport Oaks, MANUKAU 2022
Telephone: +64 9 539 7600

Appendix A Example site metadata sheets continued

Site Name

Georges Dr

Site Code

NAP003

Region & Monitoring Zone

Hawke's Bay - Napier

Area

Marewa

Site Type

SH

Source

Hyderabad Rd

Site Location

3 Hyderabad Rd
Marewa, Napier

Map Reference

	Easting	Northing		Easting	Northing
NZMG	2845357	6182616	**NZTM**	1935394	5620994

Nearest Sensitive Receptor & Location

Residential Housing	Distance (m)
Hyderabad Rd	10

Nearest SH & Local Road (m) with Direction

SH 2	3	N	LR	70	E

National Network

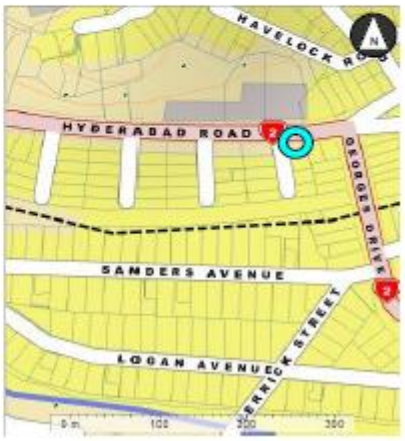
Y

Intersection

Y

Other Site Information

-



Height Above Ground (m)

3.0

Nearest Tree (m)

3.0

Monitoring Note(s)

Jan-07	Commissioned

Appendix B Example field sheet

Watercare - Air Quality Department NZTA

Nitrogen Dioxide Passive Sampling
NZTA NZ – AIR QUALITY MONITORING NETWORK

MONTH_____

Site Name	Site Number	Start Date & Time	End Date & Time

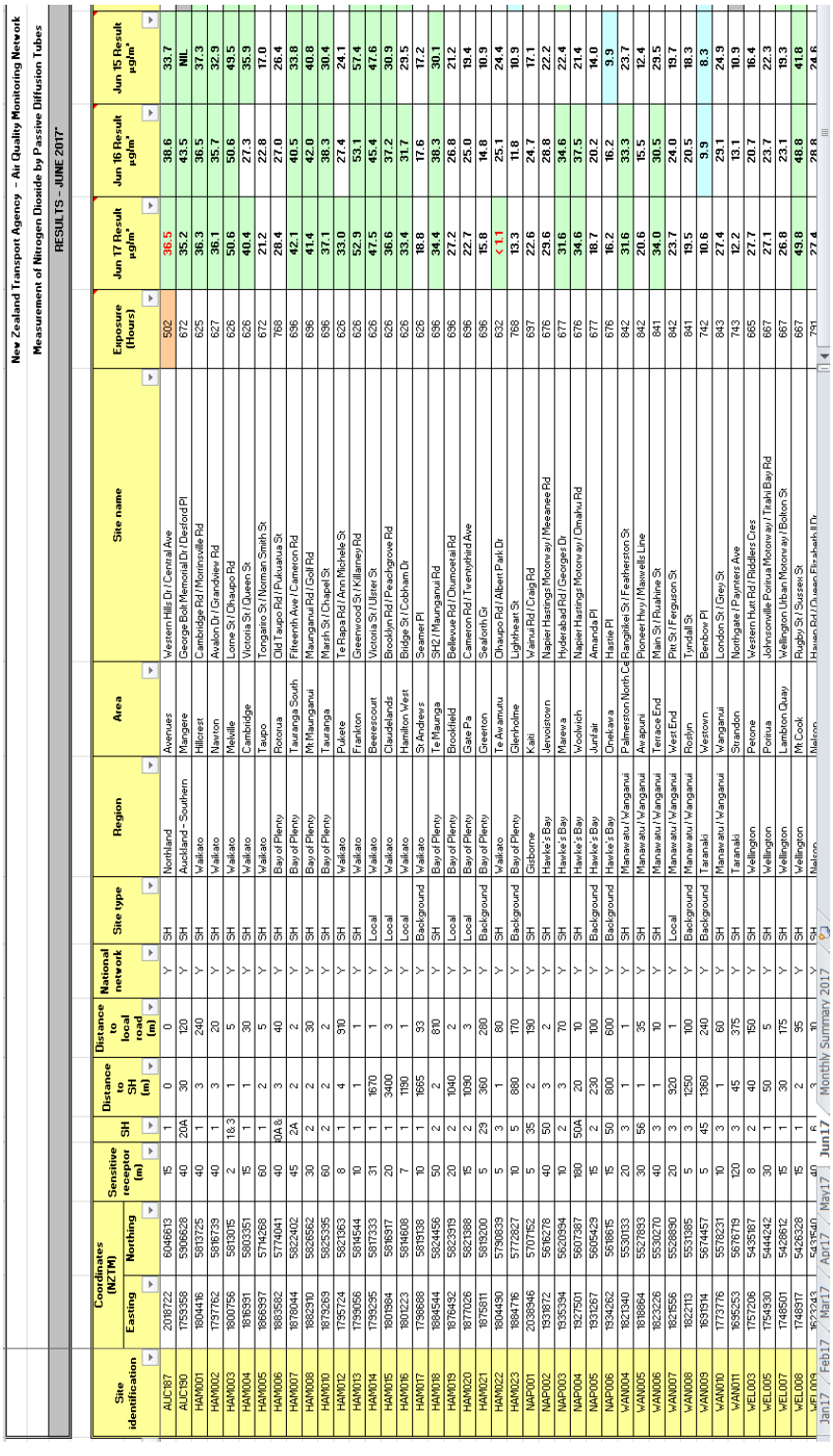
Comments

Technician Name	Contact Details

Please return to:
Watercare Services Limited
52 Aintree Avenue, Airport Oaks,
AUCKLAND
Attention: Kath McLeod
DD: (09) 539 7790

Watercare Services Ltd Photocopy Y / N

Appendix C Example monthly data spreadsheets



New Zealand Transport Agency – Air Quality Monitoring Network

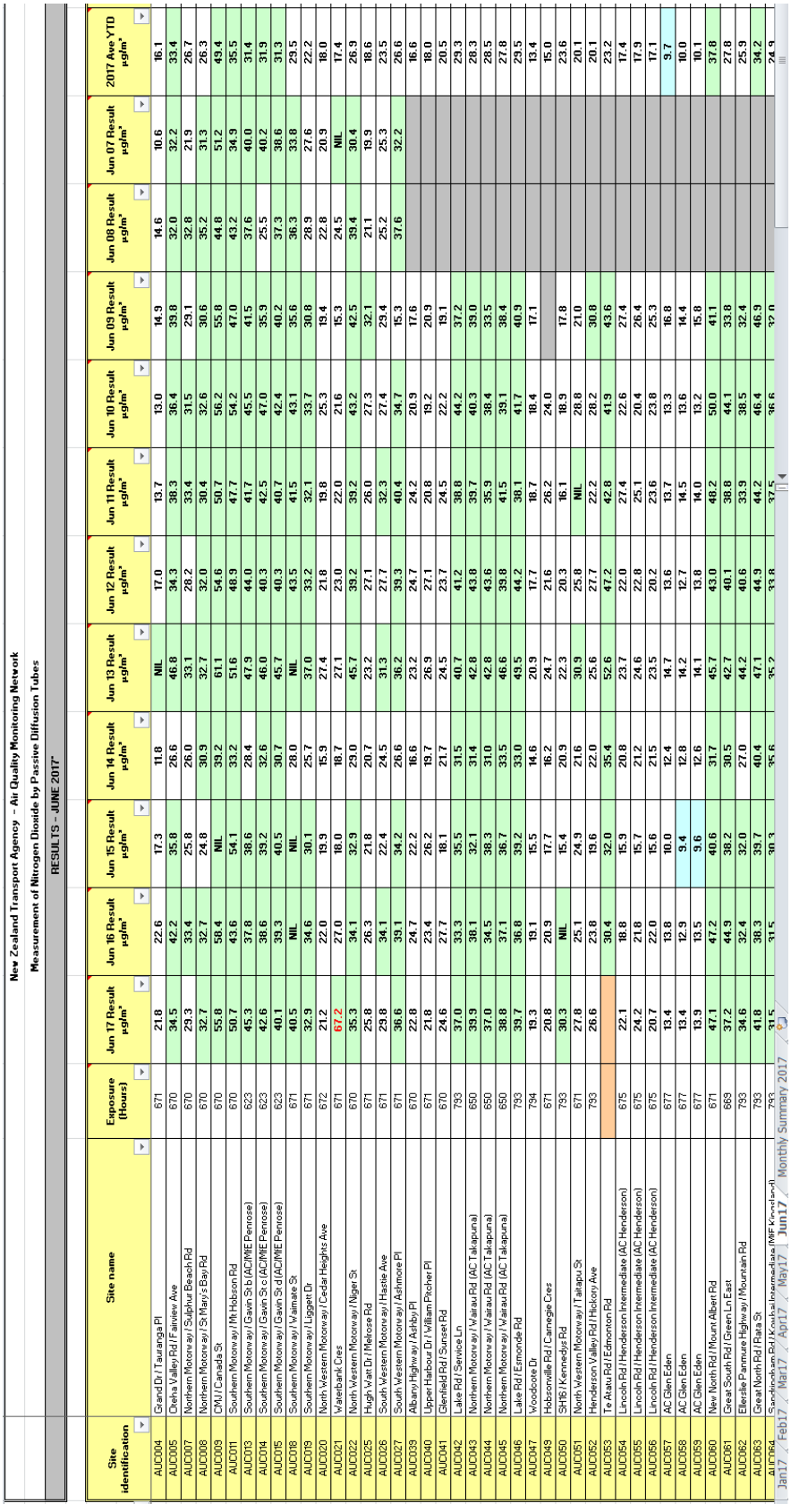
Measurement of Nitrogen Dioxide by Passive Diffusion Tubes

RESULTS – JUNE 2017*

Site identification	Coordinates (NZTM) Easting	Northing	Sensitive receptor (m)	SH	Distance to SH (m)	Distance to local road (m)	National network	Site type	Region	Area	Site name	Exposure (Hours)	Jun 17 Result µg/m³	Jun 16 Result µg/m³	Jun 15 Result µg/m³
AUC167	2018722	6046613	15	1	0	0	Y	SH	Northland	Avenues	Western Hills Dr / Central Ave	502	36.5	38.6	33.7
AUC190	1759358	5906628	40	20A	30	120	Y	SH	Auckland – Southern	Mangere	George Bolt Memorial Dr / Desford Pl	672	35.2	43.5	NIL
HAM001	1804416	5813725	40	1	3	240	Y	SH	Waikato	Hillcrest	Cambridge Rd / Morrinsville Rd	625	36.3	36.5	37.3
HAM002	1797762	5816739	40	1	3	20	Y	SH	Waikato	Nawton	Avalon Dr / Grandview Rd	627	36.1	35.7	32.9
HAM003	1800756	5813015	2	18.3	1	5	Y	SH	Waikato	Melville	Lorne St / Ohaupo Rd	626	50.6	50.6	49.5
HAM004	1816391	5803351	15	1	1	30	Y	SH	Waikato	Cambridge	Victoria St / Queen St	626	40.4	27.3	35.9
HAM005	1806397	5794268	60	1	2	5	Y	SH	Waikato	Taupo	Tongariro St / Norman Smith St	672	21.2	22.8	17.0
HAM006	1803582	5774041	40	40A.B	3	40	Y	SH	Bay of Plenty	Rotorua	Old Taupo Rd / Pukuatua St	768	28.4	27.0	26.4
HAM007	1878044	5822402	45	2A	2	2	Y	SH	Bay of Plenty	Tauranga South	Fifteenth Ave / Cameron Rd	696	42.1	40.5	33.8
HAM008	1882310	5826582	30	2	2	30	Y	SH	Bay of Plenty	Mt Maunganui	Maunganui Rd / Golf Rd	696	41.4	42.0	40.8
HAM010	1873269	5825395	60	2	2	2	Y	SH	Bay of Plenty	Tauranga	Marsh St / Chapel St	696	37.1	38.3	30.4
HAM012	1795724	5821363	8	1	4	310	Y	SH	Waikato	Pukete	Te Papa Rd / Ann Michele Dr	626	33.0	27.4	24.1
HAM013	1799056	5814544	10	1	1	1	Y	SH	Waikato	Frankton	Greenwood St / Killarney Rd	626	52.9	53.1	57.4
HAM014	1795235	5817333	31	1	1670	1	Y	Local	Waikato	Beerescourt	Victoria St / Ulster St	626	47.5	45.4	47.6
HAM015	1801984	5816317	20	1	3400	3	Y	Local	Waikato	Claudelands	Brooklyn Rd / Peachgrove Rd	626	36.6	37.2	30.9
HAM016	1801223	5814608	7	1	1190	1	Y	Local	Waikato	Hamilton West	Bridge St / Cobham Dr	626	33.4	31.7	29.5
HAM017	1798688	5819138	10	1	1665	93	Y	Background	Waikato	St Andrews	Seamer Pl	626	18.8	17.6	17.2
HAM018	1884544	5824456	50	2	2	870	Y	SH	Bay of Plenty	Te Maunga	SH2 / Maunganui Rd	696	34.4	38.3	30.1
HAM019	1876432	5823919	20	2	1040	2	Y	Local	Bay of Plenty	Brookfield	Bellevue Rd / Domoremai Rd	696	27.2	26.8	21.2
HAM020	1877025	5821388	15	2	1090	3	Y	Local	Bay of Plenty	Gate Pa	Cameron Rd / Twenythird Ave	696	22.7	25.0	19.4
HAM021	1875811	5819200	5	29	360	280	Y	Background	Bay of Plenty	Greerton	Seaforth Gr	696	15.8	14.8	10.9
HAM022	1804490	5790839	5	3	1	80	Y	SH	Waikato	Te Awamutu	Ohaupo Rd / Albert Park Dr	632	< 11	25.1	24.4
HAM023	1884716	5772827	10	5	880	170	Y	Background	Bay of Plenty	Glenholme	Lighthear St	768	13.3	11.8	10.9
NAP001	2038946	5707752	5	35	2	190	Y	SH	Gisborne	Kaiti	Wainui Rd / Craig Rd	697	22.6	24.7	17.1
NAP002	1931672	5916278	40	50	3	2	Y	SH	Hawke's Bay	Jervoistown	Napier Hastings Motorway / Meeanee Rd	676	23.6	28.8	22.2
NAP003	1935394	5620984	10	2	3	70	Y	SH	Hawke's Bay	Marewa	Hyderabad Rd / Georges Dr	677	31.6	34.6	22.4
NAP004	1927501	5607387	180	50A	20	10	Y	SH	Hawke's Bay	Woolwich	Napier Hastings Motorway / Omahu Rd	676	34.6	37.5	21.4
NAP005	1931267	5605429	15	2	230	100	Y	Background	Hawke's Bay	Jun1air	Amanda Pl	677	18.7	20.2	14.0
NAP006	1934262	5618615	15	50	800	600	Y	Background	Hawke's Bay	Onekawa	Hastie Pl	676	16.2	16.2	9.9
WAN004	1821340	5530133	20	3	1	1	Y	SH	Manawatu / Wanganui	Palmerston North	Ca Rangitikei St / Featherston St	842	31.6	33.3	23.7
WAN005	1818864	5527833	30	56	1	35	Y	SH	Manawatu / Wanganui	Awapuni	Pioneer Hwy / Maxwells Line	842	20.6	15.5	12.4
WAN006	1823226	5530270	40	3	1	10	Y	SH	Manawatu / Wanganui	Terrace End	Main St / Rushine St	841	34.0	30.5	29.5
WAN007	1821556	5528690	20	3	920	1	Y	Local	Manawatu / Wanganui	West End	Pitt St / Ferguson St	842	23.7	24.0	19.7
WAN008	1822113	5531385	5	3	1250	100	Y	Background	Manawatu / Wanganui	Roslyn	Tyndall St	841	19.5	20.5	18.3
WAN009	1831514	5614457	5	45	1360	240	Y	Background	Taranaki	Westown	Benbow Pl	742	10.6	9.9	8.3
WAN010	1773776	5578231	10	3	1	60	Y	SH	Manawatu / Wanganui	Wanganui	London St / Grey St	843	27.4	29.1	24.9
WAN011	1695253	5676719	120	3	45	375	Y	SH	Taranaki	Strandon	Northgate / Paynters Ave	743	12.2	13.1	10.9
WEL003	1757206	5435187	8	2	40	150	Y	SH	Wellington	Petone	Western Hutt Rd / Riddlers Cres	665	27.7	20.7	16.4
WEL005	1754330	5444242	30	1	50	5	Y	SH	Wellington	Porirua	Johnsonville Porirua Motorway / Titahi Bay Rd	667	27.1	23.7	22.3
WEL007	1748501	5428612	15	1	30	175	Y	SH	Wellington	Lambton Quay	Wellington Urban Motorway / Bolton St	667	26.8	23.1	19.3
WEL008	1748917	5426328	15	1	2	95	Y	SH	Wellington	Mt Cook	Rugby St / Sussex St	667	43.8	48.8	41.8
WEL009	1672243	5431540	40	A	3	10	Y	SH	Malton	Malton	Hauiru Rd / Queen Elizabeth Dr	791	27.4	28.8	24.6

Jan17 / Feb17 / Mar17 / Apr17 / May17 / Jun17 / Monthly Summary 2017

Appendix C Example monthly data spreadsheets continued



New Zealand Transport Agency – Air Quality Monitoring Network

Measurement of Nitrogen Dioxide by Passive Diffusion Tubes

RESULTS – JUNE 2017*

Site identification	Site name	Exposure (Hours)	Jun 17 Result µg/m³	Jun 16 Result µg/m³	Jun 15 Result µg/m³	Jun 14 Result µg/m³	Jun 13 Result µg/m³	Jun 12 Result µg/m³	Jun 11 Result µg/m³	Jun 10 Result µg/m³	Jun 09 Result µg/m³	Jun 08 Result µg/m³	Jun 07 Result µg/m³	2017 Ave YTD µg/m³
AUC004	Grand Dr / Tauranga Pl	671	21.8	22.6	17.3	11.8	NIL	17.0	13.7	13.0	14.9	14.6	10.6	16.1
AUC005	Otahha Valley Rd / Fairview Ave	670	34.5	42.2	35.8	26.6	46.8	34.3	38.3	36.4	39.8	32.0	32.2	33.4
AUC007	Northern Motorway / Sulphur Beach Rd	670	29.3	33.4	25.8	26.0	33.1	28.2	33.4	31.5	29.1	32.8	21.9	26.7
AUC008	Northern Motorway / St Marys Bay Rd	670	32.7	32.7	24.8	30.9	32.7	32.0	30.4	32.6	30.6	35.2	31.3	26.3
AUC009	CMJ / Canada St	670	55.8	58.4	NIL	39.2	61.1	54.6	50.7	56.2	55.8	44.8	51.2	43.4
AUC011	Southern Motorway / Mt Hobson Rd	670	50.7	43.6	54.1	33.2	51.6	48.9	47.7	54.2	47.0	43.2	34.9	35.5
AUC013	Southern Motorway / Gavin St b (AC/MIE Penrose)	623	45.3	37.8	38.6	28.4	47.9	44.0	41.7	45.5	41.5	37.6	40.0	31.4
AUC014	Southern Motorway / Gavin St c (AC/MIE Penrose)	623	42.6	38.6	39.2	32.6	46.0	40.3	42.5	47.0	35.9	25.5	40.2	31.9
AUC015	Southern Motorway / Gavin St d (AC/MIE Penrose)	623	40.1	39.3	40.5	30.7	45.7	40.3	40.7	42.4	40.2	37.3	38.6	31.3
AUC018	Southern Motorway / Waimaire St	671	40.5	NIL	NIL	28.0	NIL	43.5	41.5	43.1	35.6	36.3	33.8	29.5
AUC019	Southern Motorway / Liggett Dr	671	32.9	34.6	30.1	25.7	37.0	33.2	32.1	33.7	30.8	28.9	27.6	22.2
AUC020	North Western Motorway / Cedar Heights Ave	672	21.2	22.0	19.3	15.3	27.4	21.8	19.8	25.3	19.4	22.8	20.9	18.0
AUC021	Waterbank Cres	671	67.2	27.0	18.0	18.7	27.1	23.0	22.0	21.6	15.3	24.5	NIL	17.4
AUC022	North Western Motorway / Niger St	670	35.3	34.1	32.9	29.0	45.7	39.2	39.2	43.2	42.5	39.4	30.4	26.9
AUC025	Hugh Watt Dr / Melrose Rd	671	25.8	26.3	21.8	20.7	23.2	27.1	26.0	27.3	32.1	21.1	19.9	18.6
AUC026	South Western Motorway / Hastie Ave	671	29.8	34.1	22.4	24.5	31.3	27.7	32.3	27.4	29.4	25.2	25.3	23.5
AUC027	South Western Motorway / Ashmore Pl	671	36.6	39.1	34.2	26.6	36.2	39.3	40.4	34.7	15.3	37.6	32.2	26.6
AUC039	Albany Highway / Ashby Pl	670	22.8	24.7	22.2	16.6	23.2	24.7	24.2	20.9	17.6			16.6
AUC040	Upper Harbour Dr / William Pitcher Pl	671	21.8	23.4	26.2	19.7	26.9	27.1	20.8	19.2	20.9			18.0
AUC041	Glenfield Rd / Sunset Rd	670	24.6	27.7	18.1	21.7	24.5	23.7	24.5	22.2	19.1			20.5
AUC042	Lake Rd / Service Ln	793	37.0	33.3	35.5	31.5	40.7	41.2	38.8	44.2	37.2			29.3
AUC043	Northern Motorway / Wairau Rd (AC Takapuna)	650	39.9	38.1	32.1	31.4	42.8	43.8	39.7	40.3	39.0			28.3
AUC044	Northern Motorway / Wairau Rd (AC Takapuna)	650	37.0	34.5	38.3	31.0	42.8	43.6	35.9	38.4	33.5			28.5
AUC045	Northern Motorway / Wairau Rd (AC Takapuna)	650	38.8	37.1	36.7	33.5	46.6	39.8	41.5	39.1	38.4			27.8
AUC046	Lake Rd / Esmonde Rd	793	39.7	36.8	39.2	33.0	49.5	44.2	38.1	41.7	40.9			29.5
AUC047	Woodside Dr	794	19.3	19.1	15.5	14.6	20.9	17.7	18.7	18.4	17.1			13.4
AUC049	Hobsonville Rd / Carnegie Cres	671	20.8	20.9	17.7	16.2	24.7	21.6	26.2	24.0				15.0
AUC050	SH16 / Kennedys Rd	793	30.3	NIL	15.4	20.9	22.3	20.3	16.1	18.9	17.8			23.6
AUC051	North Western Motorway / Taitapu St	671	27.8	25.1	24.9	21.6	30.9	25.8	NIL	28.8	21.0			20.1
AUC052	Henderson Valley Rd / Hickory Ave	793	26.6	23.8	19.6	22.0	25.6	27.7	22.2	28.2	30.8			20.1
AUC053	Te Atatu Rd / Edmonton Rd			30.4	32.0	35.4	52.6	47.2	42.8	41.9	43.6			23.2
AUC054	Lincoln Rd / Henderson Intermediate (AC Henderson)	675	22.1	18.8	15.9	20.8	23.7	22.0	27.4	22.6	27.4			17.4
AUC055	Lincoln Rd / Henderson Intermediate (AC Henderson)	675	24.2	21.8	15.7	21.2	24.6	22.8	25.1	20.4	26.4			17.9
AUC056	Lincoln Rd / Henderson Intermediate (AC Henderson)	675	20.7	22.0	15.6	21.5	23.5	20.2	23.6	23.8	25.3			17.1
AUC057	AC Glen Eden	677	13.4	13.8	10.0	12.4	14.7	13.6	13.7	13.3	16.8			9.7
AUC058	AC Glen Eden	677	13.4	12.9	9.4	12.8	14.2	12.7	14.5	13.6	14.4			10.0
AUC059	AC Glen Eden	677	13.9	13.5	9.6	12.6	14.1	13.8	14.0	13.2	15.8			10.1
AUC060	New North Rd / Mount Albert Rd	671	47.1	47.2	40.6	31.7	45.7	43.0	48.2	50.0	41.1			37.8
AUC061	Great South Rd / Green Ln East	669	37.2	44.9	38.2	30.5	42.7	40.1	38.8	44.1	33.8			27.8
AUC062	Ellerslie Panmure Highway / Mountain Rd	793	34.6	32.4	32.0	27.0	44.2	40.6	33.9	38.5	32.4			25.9
AUC063	Great North Rd / Para St	793	41.8	38.3	33.7	40.4	47.1	44.9	44.2	46.4	46.9			34.2
AUC064	Sandringham Rd / Kohimarama Rd (MIE Kingsland)	793	31.5	31.5	30.3	35.6	35.2	33.8	37.5	36.6	32.0			24.9

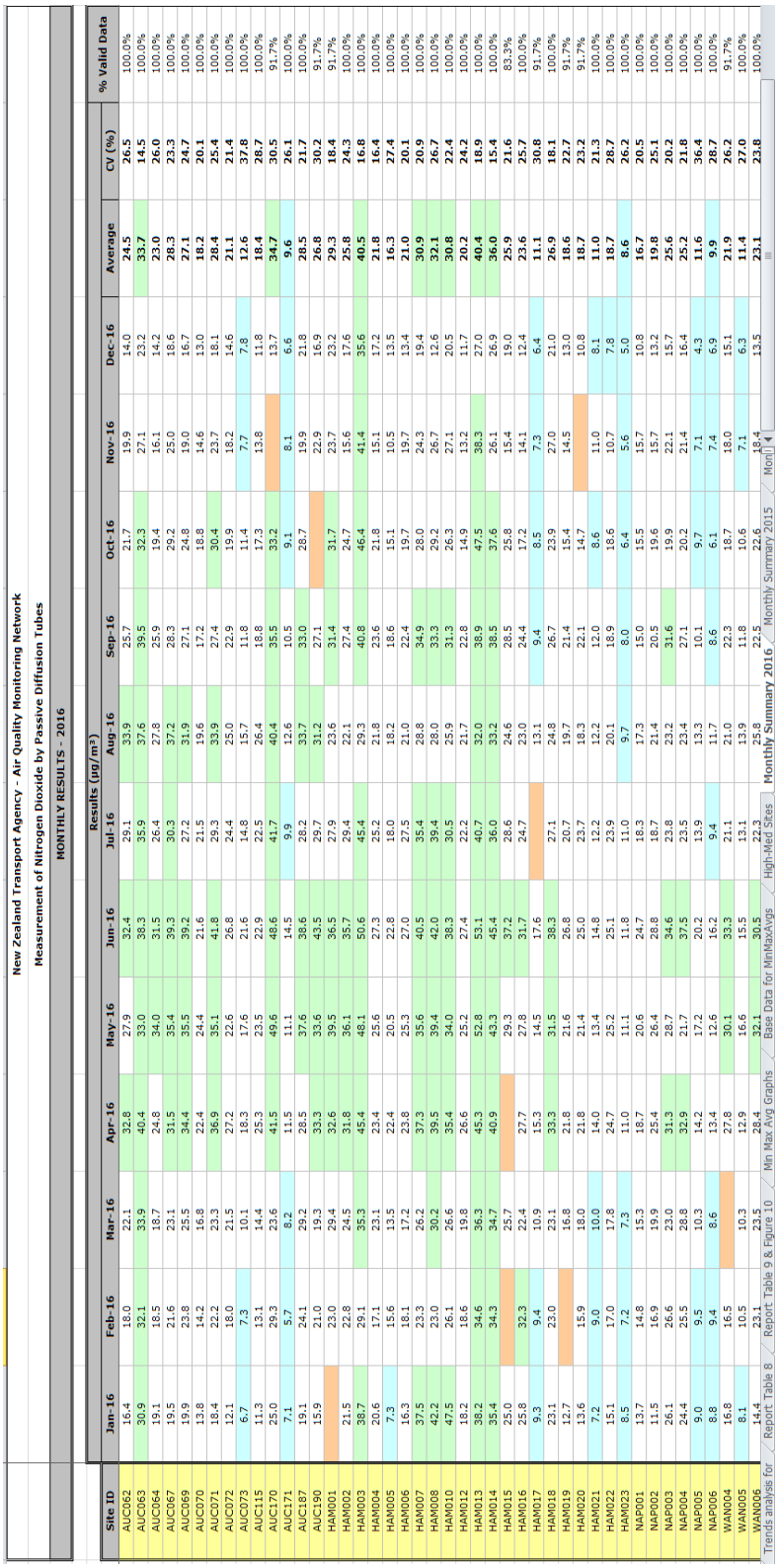
Jan17 | Feb17 | Mar17 | Apr17 | May17 | Jun17 | Monthly Summary 2017

Appendix D Example annual data spreadsheets

2007-2016 Metadata

	NZMG	NZMG	NZTM	NZTM														
Site Identification	Easting	Northing	Easting	Northing	Commissioned	Decommissioned	Monitoring Zone	Site Name	Area	Region	Site Type	Nearest Main Road	Nearest Main Road	Nearest SH (m)	SH	Nearest Local Road	Sensitive Receptor	Triplicate
HAM002	2708009	6378372	1797762	5816739	Jan-07		Hamilton	Avalon Dr / Grandview Rd	Nawton	Waikato	SH	3	SW	3	1		40	
HAM003	2710997	6374644	1800756	5813015	Jan-07		Hamilton	Lorne St / Ohaupo Rd	Melville	Waikato	SH	1	N	1	1		2	
HAM004	2727212	6364959	1816991	5803351	Jan-07		Cambridge	Victoria St / Queen St	Cambridge	Waikato	SH	1	S	1	1		15	
HAM005	2777082	6275859	1866997	5714268	Jan-07		Taupo	Tongariro St / Norman Smith St	Taupo	Waikato	SH	1.5	E	1.5	1		60	
HAM006	2793725	6335570	1883582	5774041	Jan-07		Rotorua	Old Taupo Rd / Pukuatua St	Rotorua	Bay of Plenty	SH	3	W	3	30A		40	
HAM007	2788264	6383905	1878044	5822402	Jan-07		Tauranga	Fifteenth Ave / Cameron Rd	Tauranga South	Bay of Plenty	SH	2.1	SW	2.1	2		45	
HAM008	2793133	6388054	1882910	5826562	Jan-07		Tauranga	Maunganui Rd / Golf Rd	Mt Maunganui	Bay of Plenty	SH	2	SW	2	29		30	
HAM010	2789493	6386894	1879269	5825395	Jan-07		Tauranga	Marsh St / Chapel St	Tauranga	Bay of Plenty	SH	2	NW	2	2A		60	
HAM012	2705979	6382998	1795724	5821363	Apr-10		Hamilton	Te Rapa Rd / Ann Michele St	Pukete	Waikato	SH	4	E	4	1		8	
HAM013	2709300	6376176	1799056	5814544	Apr-10		Hamilton	Greenwood St / Killarney Rd	Frankton	Waikato	SH	0.5	W	0.5	1		10	
HAM018	2794763	6385946	1884544	5824456	Apr-10		Tauranga	SH2 / Maunganui Rd	Te Maunga	Bay of Plenty	SH	1.8	W	1.8	2		50	
HAM022	2714699	6352469	1804490	5790839	May-10		Te Awamutu	Ohaupo Rd / Albert Park Dr	Te Awamutu	Waikato	SH	1	NE	1	3		5	
NAP001	2948813	6268592	2038946	5707152	Jan-07		Gisborne	Wainui Rd / Craig Rd	Kaiti	Gisborne	SH	1.6	NE	1.6	35		5	
NAP002	2841836	6177906	1931872	5616278	Jan-07		Napier	Napier Hastings Motorway / Meeanee Rd	Jervoistown	Hawke's Bay	SH	3	W	3	50		40	
NAP003	2845357	6182616	1935394	5620994	Jan-07		Napier	Hyderabad Rd / Georges Dr	Marewa	Hawke's Bay	SH	3	N	3	2		10	
NAP004	2837466	6169025	1927501	5607387	Jan-07		Hastings	Napier Hastings Motorway / Omahu Rd	Woolwich	Hawke's Bay	SH	20	NE	20	50A		180	
WAN001	2605648	6238606	1695561	5676854	Jan-07	Dec-14	New Plymouth	Northgate / Paynters Ave	Fitzroy	Taranaki	SH	1	N	1	3		50	
WAN002	2683714	6139847	1773681	5578142	Jan-07	Nov-09	Wanganui	London St / Grey St	Wanganui	Manawatu / Wanganui	SH	1	SE	1	3		50	
WAN004	2731352	6091837	1821340	5530133	Jan-07		Palmerston North	Rangitikei St / Featherston St	Palmerston North Central	Manawatu / Wanganui	SH	1	NE	1	3		20	
WAN005	2728877	6089599	1818864	5527893	Apr-10		Palmerston North	Pioneer Hwy / Maxwells Line	Awapuni	Manawatu / Wanganui	SH	1	S	1	56		30	
WAN006	2733238	6091975	1823226	5530270	Apr-10		Palmerston North	Main St / Ruahine St	Terrace End	Manawatu / Wanganui	SH	1	S	1	3		40	
WAN010	2683810	6139936	1773776	5578231	Nov-09		Wanganui	London St / Grey St	Wanganui	Manawatu / Wanganui	SH	1	NW	1	3		10	
WAN011	2605340	6238472	1695253	5676719	Aug-14		New Plymouth	Northgate / Paynters Ave	Strandon	Taranaki	SH	0	N	45	3	375	120	
WEL002	2675619	6003444	1765598	5441729	Jan-07	Mar-16	Lower Hutt	Western Hutt Rd / Manor Park Rd	Manor Park	Wellington	SH	1	NW	1	2		180	
WEL003	2667227	5996900	1757206	5435187	May-07		Lower Hutt	Western Hutt Rd / Riddlers Cres	Petone	Wellington	SH	40	N	40	2		8	
WEL004	2678624	6029713	1768605	5467998	Jan-07	Jan-09	Kapiti	Main Rd South / Ihakara St	Paraparaumu	Wellington	SH	3.2	SE	3.2	1		20	
WEL005	2664950	6005956	1754930	5444242	Mar-07		Porirua	Johnsonville Porirua Motorway / Titahi Bay Rd	Porirua	Wellington	SH	50	W	50	1		30	
WEL007	2658523	5990324	1748501	5428612	Mar-07		Wellington	Wellington Urban Motorway / Bolton St	Lambton Quay	Wellington	SH	30	E	30	1		15	
WEL008	2658939	5988040	1748917	5426328	Jan-07		Wellington	Rugby St / Sussex St	Mt Cook	Wellington	SH	1.5	E	1.5	1		15	
WEL009	2533238	5993244	1623243	5431540	Jan-07		Nelson	Haven Rd / Queen Elizabeth II Dr	Nelson	Nelson	SH	3	NE	3	6		40	
WEL010	2528631	5988954	1618638	5427252	Jun-07		Nelson	Whakatu Dr / Songer St	Stoke	Nelson	SH	10	NW	10	6		10	
WEL011	2526180	5985832	1616187	5424131	Jan-07		Nelson	Richmond Deviation / Melia Pl	Richmond	Tasman	SH	60	N	60	6		10	
WEL012	2588840	5966033	1678828	5404333	Jan-07		Blenheim	Nelson St / McLauchlan St	Blenheim	Marlborough	SH	3.1	N	3.1	6		20	
WEL027	2661775	5996790	1751754	5435077	Jan-09	Mar-10	Wellington	Johnsonville Porirua Motorway / Helston Rd	Johnsonville	Wellington	SH	100	W	100	1		5	
WEL028	2669902	5998674	1759881	5436960	Jan-09	Jan-10	Lower Hutt	Western Hutt Rd / Block Rd (GWRC Melling Station)	Boulcott	Wellington	SH	9.5	NW	9.5	2		4.5	T
WEL029	2669902	5998674	1759881	5436960	Jan-09	Jan-10	Lower Hutt	Western Hutt Rd / Block Rd (GWRC Melling Station)	Boulcott	Wellington	SH	9.5	NW	9.5	2		4.5	T
WEL030	2669902	5998674	1759881	5436960	Jan-09	Jan-10	Lower Hutt	Western Hutt Rd / Block Rd (GWRC Melling Station)	Boulcott	Wellington	SH	9.5	NW	9.5	2		4.5	T
WEL031	2658477	5988791	1748455	5427079	Jan-09	Nov-14	Wellington	Vivian St / Victoria St (GWRC Corner V)	Te Aro	Wellington	SH	6.5	SW	6.5	1		15	T
WEL032	2658477	5988791	1748455	5427079	Jan-09	Nov-14	Wellington	Vivian St / Victoria St (GWRC Corner V)	Te Aro	Wellington	SH	6.5	SW	6.5	1		15	T
WEL033	2658477	5988791	1748455	5427079	Jan-09	Nov-14	Wellington	Vivian St / Victoria St (GWRC Corner V)	Te Aro	Wellington	SH	6.5	SW	6.5	1		15	T
WEL050	2660124	5986752	1750102	5425039	Mar-10		Wellington	Wellington Rd / Hamilton Rd	Kilbirnie	Wellington	SH	4	N	4	1		2	

Appendix D Example annual data spreadsheets continued



New Zealand Transport Agency - Air Quality Monitoring Network

Measurement of Nitrogen Dioxide by Passive Diffusion Tubes

MONTHLY RESULTS - 2016

Results (µg/m³)

Site ID	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Average	CV (%)	% Valid Data
AUC062	16.4	18.0	22.1	32.8	27.9	32.4	29.1	33.9	25.7	21.7	19.9	14.0	**24.5**	**26.5**	100.0%
AUC063	30.9	32.1	33.9	40.4	33.0	38.3	35.9	37.6	39.5	32.3	27.1	23.2	**33.7**	**14.5**	100.0%
AUC064	19.1	18.5	18.7	24.8	34.0	31.5	26.4	27.8	25.9	19.4	16.1	14.2	**23.0**	**26.0**	100.0%
AUC067	19.5	21.6	23.1	31.5	35.4	39.3	30.3	37.2	28.3	29.2	25.0	18.6	**28.3**	**23.3**	100.0%
AUC069	19.9	23.8	25.5	34.4	35.5	39.2	27.2	31.9	27.1	24.8	19.0	16.7	**27.1**	**24.7**	100.0%
AUC070	13.8	14.2	16.8	22.4	24.4	21.6	21.5	19.6	17.2	18.8	14.6	13.0	**18.2**	**20.1**	100.0%
AUC071	18.4	22.2	23.3	36.9	35.1	41.8	29.3	33.9	27.4	30.4	23.7	18.1	**28.4**	**25.4**	100.0%
AUC072	12.1	18.0	21.5	27.2	22.6	26.8	24.4	25.0	22.9	19.9	18.2	14.6	**21.1**	**21.4**	100.0%
AUC073	6.7	7.3	10.1	18.3	17.6	21.6	14.8	15.7	11.8	11.4	7.7	7.8	**12.6**	**37.8**	100.0%
AUC115	11.3	13.1	14.4	25.3	23.5	22.9	22.5	26.4	18.8	17.3	13.8	11.8	**18.4**	**28.7**	100.0%
AUC170	25.0	29.3	23.6	41.5	49.6	48.6	41.7	40.4	35.5	33.2		13.7	**34.7**	**30.5**	91.7%
AUC171	7.1	5.7	8.2	11.5	11.1	14.5	9.9	12.6	10.5	9.1	8.1	6.6	**9.6**	**26.1**	100.0%
AUC187	19.1	24.1	29.2	28.5	37.6	38.6	28.2	33.7	33.0	28.7	19.9	21.8	**28.5**	**21.7**	100.0%
AUC190	15.9	21.0	19.3	33.3	33.6	43.5	29.7	31.2	27.1		22.9	16.9	**26.8**	**30.2**	91.7%
HAM001		23.0	29.4	32.6	39.5	36.5	27.9	23.6	31.4	31.7	23.7	23.2	**29.3**	**18.4**	91.7%
HAM002	21.5	22.8	24.5	31.8	36.1	35.7	29.4	22.1	27.4	24.7	15.6	17.6	**25.8**	**24.3**	100.0%
HAM003	38.7	29.1	35.3	45.4	48.1	50.6	45.4	29.3	40.8	46.4	41.4	35.6	**40.5**	**16.8**	100.0%
HAM004	20.6	17.1	23.1	23.4	25.6	27.3	25.2	21.8	23.6	21.8	15.1	17.2	**21.8**	**16.4**	100.0%
HAM005	7.3	15.6	13.5	22.4	20.5	22.8	18.0	18.2	18.6	15.1	10.5	13.5	**16.3**	**27.4**	100.0%
HAM006	16.3	18.1	17.2	23.8	25.3	27.0	27.5	21.0	22.4	19.7	19.7	13.4	**21.0**	**20.1**	100.0%
HAM007	37.5	23.3	26.2	37.3	35.6	40.5	35.4	28.8	34.9	28.0	24.3	19.4	**30.9**	**20.9**	100.0%
HAM008	42.2	23.0	30.2	39.5	39.4	42.0	39.4	28.0	33.3	29.2	26.7	12.6	**32.1**	**26.7**	100.0%
HAM010	47.5	26.1	26.6	35.4	34.0	38.3	30.5	25.9	31.3	26.3	27.1	20.5	**30.8**	**22.4**	100.0%
HAM012	18.2	18.6	19.8	26.6	25.2	27.4	22.2	21.7	22.8	14.9	13.2	11.7	**20.2**	**24.2**	100.0%
HAM013	38.2	34.6	36.3	45.3	52.8	53.1	40.7	32.0	38.9	47.5	38.3	27.0	**40.4**	**18.9**	100.0%
HAM014	35.4	34.3	34.7	40.9	43.3	45.4	36.0	33.2	38.5	37.6	26.1	26.9	**36.0**	**15.4**	100.0%
HAM015	25.0		25.7		29.3	37.2	28.6	24.6	28.5	25.8	15.4	19.0	**25.9**	**21.6**	83.3%
HAM016	25.8	32.3	22.4	27.7	27.8	31.7	24.7	23.0	24.4	17.2	14.1	12.4	**23.6**	**25.7**	100.0%
HAM017	9.3	9.4	10.9	15.3	14.5	17.6		13.1	9.4	8.5	7.3	6.4	**11.1**	**30.8**	91.7%
HAM018	23.1	23.0	23.1	33.3	31.5	38.3	27.1	24.8	26.7	23.9	27.0	21.0	**26.9**	**18.1**	100.0%
HAM019	12.7		16.8	21.8	21.6	26.8	20.7	19.7	21.4	15.4	14.5	13.0	**18.6**	**22.7**	91.7%
HAM020	13.6	15.9	18.0	21.8	21.4	25.0	23.7	18.3	22.1	14.7		10.8	**18.7**	**23.2**	91.7%
HAM021	7.2	9.0	10.0	14.0	13.4	14.8	12.2	12.2	12.0	8.6	11.0	8.1	**11.0**	**21.3**	100.0%
HAM022	15.1	17.0	17.8	24.7	25.2	25.1	23.9	20.1	18.9	18.6	10.7	7.8	**18.7**	**28.7**	100.0%
HAM023	8.5	7.2	7.3	11.0	11.1	11.8	11.0	9.7	8.0	6.4	5.6	5.0	**8.6**	**26.2**	100.0%
NAP001	13.7	14.8	15.3	18.7	20.6	24.7	18.3	17.3	15.0	15.5	15.7	10.8	**16.7**	**20.5**	100.0%
NAP002	11.5	16.9	19.9	25.4	26.4	28.8	18.7	21.4	20.5	19.6	15.7	13.2	**19.8**	**25.1**	100.0%
NAP003	26.1	26.6	23.0	31.3	28.7	34.6	23.8	23.2	31.6	19.9	22.1	15.7	**25.6**	**20.2**	100.0%
NAP004	24.4	25.5	28.8	32.9	21.7	37.5	23.5	23.4	27.1	20.2	21.4	16.4	**25.2**	**21.8**	100.0%
NAP005	9.0	9.5	10.3	14.2	17.2	20.2	13.9	13.3	10.1	9.7	7.1	4.3	**11.6**	**36.4**	100.0%
NAP006	8.8	9.4	8.6	13.4	12.6	16.2	9.4	11.7	8.6	6.1	7.4	6.9	**9.9**	**28.7**	100.0%
WAN004	16.8	16.5		27.8	30.1	33.3	21.1	21.0	22.3	18.7	18.0	15.1	**21.9**	**26.2**	91.7%
WAN005	8.1	10.5	10.3	12.9	16.6	15.5	13.1	13.9	11.8	10.6	7.1	6.3	**11.4**	**27.0**	100.0%
WAN006	14.4	23.1	23.5	28.4	32.1	30.5	22.3	25.8	22.5	22.6	18.4	13.5	**23.1**	**23.8**	100.0%

Trends analysis for / Report Table 8 / Report Table 9 & Figure 10 / Min Max Avg Graphs / Base Data for MinMaxAvgs / High-Med Sites / **Monthly Summary 2016** / Monthly Summary 2015 / Mon

Appendix E List of other subcontractors in 2017/18

Field subcontractor details

The field subcontractors responsible for sample exchange in different areas in 2017/18 are as follows:

Area	Field subcontractor
Whangarei	Fulton Hogan
Auckland	Watercare
Auckland	Beca
Hamilton	Opus
Te Awamutu	Broadspectrum
Taupo	Opus
Rotorua	Higgins
Tauranga	Westlink
Gisborne	Opus
Napier	Higgins
New Plymouth	Opus
Wanganui	Higgins
Wellington	Capital Journeys
Wellington RC	Greater Wellington RC
Nelson	Opus
Blenheim	Opus
Greymouth	Opus
Christchurch	Southern Link
ECan	Environment Canterbury
Dunedin	Downer
Queenstown	Aspiring Highways
Invercargill	Southroads

***Note**: The Transport Agency has a Network Outcomes Contract for the maintenance, operations and renewals of the state highway network in New Zealand. This contract includes requirements for field subcontractors to assist with the national network sampling programme.*

Appendix E List of other subcontractors in 2017/18 continued

Laboratory details

The following analytical laboratory is subcontracted in 2017/18 for the analysis of the exposed passive samplers:

Scientific Services Laboratory
Staffordshire County Council (SCC)
Stafford
United Kingdom