14 Air Quality

14.1 Introduction

Air quality is a description of the extent that the air contains contaminants usually from human activities. Air will contain many materials which vary on different days or times of the year. For example, on occasions after strong winds, Wellington's air is hazy because it contains fine sea-salt aerosol resulting from wind blowing over the sea. Even though the weather is fine, visibility of distant hills can be poor. In spring time the air contains pollen from plants, affecting people with allergies. However, air quality management is usually limited to a set of contaminants that arise from human activity and these contaminants are believed to affect human health or cause nuisance. These contaminants are either gases (or vapours) or fine particulate material that can be carried in the air for some time before settling out. In some cases these may be naturally occurring such as carbon monoxide, ozone, or nitrogen oxides but human activities cause these materials to be at much higher concentrations than would normally occur in the air. Air quality management has focused on establishing maximum levels for these contaminants which are usually set at a level that a vulnerable person could experience over their life without harm.

Two processes are important in air quality: the rate at which contaminants are emitted at a source and dispersion which is the process by which these contaminants spread through and dissipate into the air. Regional Councils in New Zealand have compiled inventories of emission sources divided into categories of domestic (primarily domestic fires), industrial, and motor vehicles. For Wellington, industrial emissions are low, motor vehicles are a major source of emissions all year round, and in winter domestic fires are also a major contributor.

Two factors promote dispersion, the wind which promotes both horizontal and vertical mixing especially where wind flows are turbulent, as they are in Wellington because of the topography and the sun which causes a vertical mixing by establishing convection currents. Cloud layers reduce the effect of the sun's heat and night time removes the sun's effect. In addition, wind speeds will often be less over the dusk to dawn period. This all means that the period from just before sunset to just after sunrise is often a period of fairly stable air and therefore poor dispersion. Pollutants generated in this period will therefore accumulate. In Wellington winter months, this period coincides with both the time that fires are being lit and with peak traffic. Therefore although it is often claimed that Wellington has good air quality because of its wind, there are numerous fine winter days where a smoke layer hangs over the Hutt Valley in the morning, and by day's end above Wellington City.

Geographic scale is also important in air quality management. Within an airshed, that is, a single body of air that can freely mix such as Wellington / Hutt Valley, or the Porirua region, it is the background level of air contaminants that is important. This background level is, in simplified terms, the level of contaminant if all the emissions in the area are mixed evenly though all the air of the area. At a much smaller scale, for example 50 to 200 metres, the dispersion from an emitting source is only partially complete and contaminants may be at harmful levels. This may occur, for example, near an industrial chimney (of which there are few in Wellington) or near a busy road. At the local level, air quality management will attempt to control the emission rate, or provide adequate separation of the population from the source for dispersion to occur.

Motor vehicles emit contaminants which affect the air quality near roadways. The project may alter the amount of pollutants emitted and the locations where they are emitted with potential to alter the air quality of the adjacent areas.

14.2 Vehicle emissions and ambient air quality

Motor vehicle emissions consist of the engine exhaust emissions, evaporation of fuel, brake dust, tyre wear and road surface dust. The amount of emitted contaminants depends on the type of vehicle and the type of driving mode. The highest emissions for some contaminants, such as carbon monoxide, occur under congested traffic conditions or at intersections, where emissions are typically much higher than when compared to free flowing traffic. For other contaminants, emission rates are highest at free flowing high speeds. The emissions from each vehicle are small so the air quality impact arises from the collective effect of the individual vehicles, both through the total number of vehicles and through how these vehicles interact to give congested or free flow conditions.

The recognised environmental indicators and air contaminants emitted by road transport include carbon monoxide (CO), oxides of nitrogen (NOx), fine particulates (PM_{10} and $PM_{2.5}$) and sulphur dioxide (SO2) (MfE 2005). Other contaminants that may have potential environmental impacts include volatile organic compounds (VOC), benzene and polycyclic aromatic hydrocarbons. In many air quality assessments, concentrations of carbon monoxide, oxides of nitrogen and PM_{10} have been often used as indicators of the air quality. It is taken that if each of these indicator species are within acceptable levels then all other contaminants should also be at acceptable levels. This is a standard approach as recognised in the Ministry for the Environment's Good Practice Guide for Assessing Emissions from Land Transport (MfE, 2008).

14.2.1 Dispersion of vehicle contaminants

Although dispersion will be affected by site-specific aspects, there is a general relationship between the distance from the road kerb and concentration of discharge contaminants in the ambient air, with the concentration dropping with distance. *Figure 14.1* shows typical concentrations for motor vehicle contaminants at different distances from the roadside for a flat area and under low wind speed or calm weather conditions. As is shown by *Figure 14.1*, the concentration falls off rapidly with distance from the road.

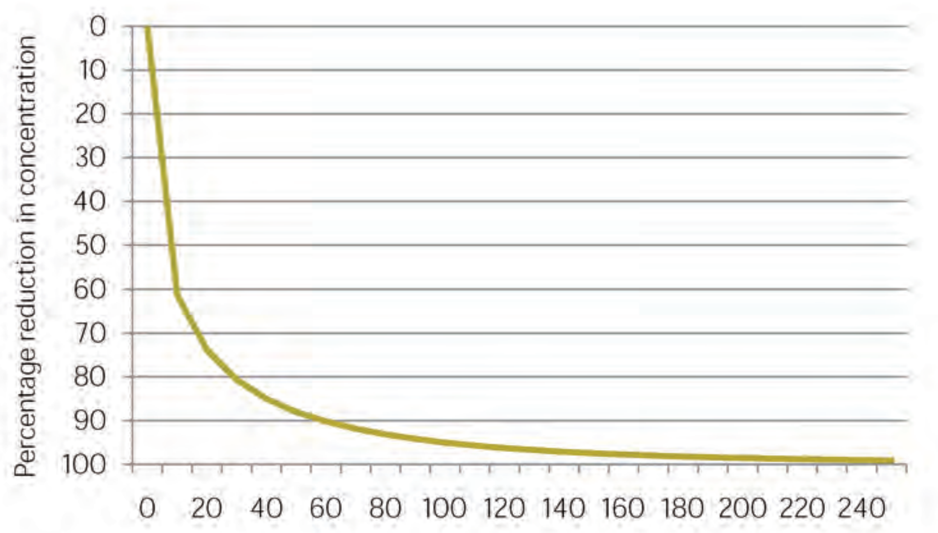

Figure 14.1: Typical concentrations of contaminants such as CO, NO_2, and PM_{10} at various distances from a carriageway edge[1]

1 Adapted from Figure A1.2 from the Ministry for the Environment's "Good Practice for Assessing Discharges to Air from Land Transport" (June 2008)

14.3 Air quality criteria

There are criteria for air quality which are the National Environmental Standards for Air Quality (NESAQ) introduced by the Ministry for the Environment in 2005. These air quality criteria supersede the previous Ambient Air Quality Guidelines (AAQG) that were produced in 2002. National Environmental Standards have a special status under the Resource Management Act. They are provided for by the Act and those agencies responsible for achievement are expected to adhere to them. The National Environmental Standards have a higher status than a New Zealand Standard developed by Standards New Zealand and have a higher status than departmental guidelines.

The purpose of NESAQ is to ensure that the air quality within a defined area is maintained at acceptable levels. "The ambient standards are the minimum requirements that outdoor air quality should meet in order to guarantee a set level of protection for human health and the environment" (MfE, 2005).

NESAQ covers five key air contaminants: carbon monoxide, oxides of nitrogen, sulphur dioxide, PM_{10}, and ozone. Carbon monoxide, oxides of nitrogen, and PM_{10} are the three of these contaminants relevant to this assessment as they are emitted by motor vehicles. The NESAQ criteria information for these contaminants is shown in *Table 14.1*.

Table 14.1: Ambient air quality standards from 1 September 2005

Contaminant	Standard threshold concentration	Time average	Allowable exceedances per year
Carbon monoxide, CO	10 mg/m^3	8 hours (running mean)	1
	30 mg/m^3	1 hour	1
Nitrogen dioxide, NO_2	200 µg/m^3	1 hour	9
Fine particles, PM_{10}	50 µ/m^3	24 hours	1

All three columns are relevant. The "standard threshold concentration" is the maximum concentration of a particular contaminant that is permitted. The averaging period gives effect to changing a concentration into a dose. The varying concentrations that occur within a particular time period are to be used to calculate an average level over the "time average" period. "Allowable exceedances per year" identifies the maximum number of times the "standard threshold concentration" could be exceeded within a year. This recognises that very occasionally freakish conditions may occur that cause pollution levels to be high. However, because of the various safety margins factored into developing the upper limits of the "standard threshold concentration", then the risk of harm from rare exceedances is very low.

The Greater Wellington Regional Council have ambient air quality guidelines which are specific for the Wellington region. The regional guidelines include criteria such as the Maximum Acceptable Level and the Maximum Desirable Level. *Table 14.2* shows the values from the regional guidelines applicable for the three assessed contaminants.

Table 14.2: Greater Wellington Regional Council ambient air quality guidelines

Contaminant	Maximum Acceptable Level	Maximum Desirable Level	Time average
Carbon monoxide, CO	30 mg/m^3	None	1 hour
Nitrogen dioxide, NO_2	200 µg/m^3	95 µg/m^3	1 hour
Fine particles, PM_{10}	50 µ/m^3	None	24 hours

The Greater Wellington Regional Council's Maximum Acceptable Levels are equal to the NESAQ standard threshold concentrations. Only one contaminant has a regional Maximum Desirable Level. This level is defined as the level which provides a maximum protection to the environment taking into account such factors as the existing air quality and community expectations. The Maximum Desirable Level is set to protect the more sensitive members of the population.

The air quality criteria for other species are less defined and where necessary the practice in other countries is used as a basis for establishing acceptable levels in New Zealand. Typically practice from Australia, the United Kingdom, and North America are often sourced as part of establishing recommended criteria for a New Zealand situation.

14.4 Topographical and meteorological conditions in the area of the Basin Reserve

The Basin Reserve is in the southeast corner of Wellington's Te Aro Flat and lies between the Mount Victoria and Mount Cook residential areas. Meteorological observations in Wellington show that northerly and southerly winds are frequent and are the dominant wind directions in this area. The distribution of wind speed and directions at the Basin Reserve are shown in *Figure 14.2*.

The rugged topography of the whole Wellington area gives rapid and strong wind fluctuations and there is a high frequency of strong wind. This windy weather is favourable for good dispersion of air contaminants and under these conditions air pollution levels remain well within the NESAQ threshold concentrations.

Compared with other New Zealand cities, in Wellington high air pollution events are uncommon, though they are more common in the Hutt Valley. However, during winter time in Wellington in periods of calm weather, concentrations of air contaminants can build up overnight and during early morning hours.

A temperature inversion is a thin layer of the atmosphere where temperature increases with height. Temperature inversions occur more frequently in the early morning hours under calm and cool weather conditions. Around the Basin Reserve, temperature inversions typically create a mixing height below 100 metres. A temperature inversion creates a "stable" air layer that prevents the upward dispersion of air contaminants by keeping contaminants circulating beneath the inversion layer. The contaminants that are prevented from penetrating through the inversion thus increase in concentration near the ground.

The lower lying areas of the Basin Reserve study area are about 5 to 6 metres above sea level. The residential areas around the Basin Reserve are located about 6 to 30 metres above sea level. At times during the winter, this area can be affected by increased concentrations of air contaminants when temperature inversions and light winds occur.

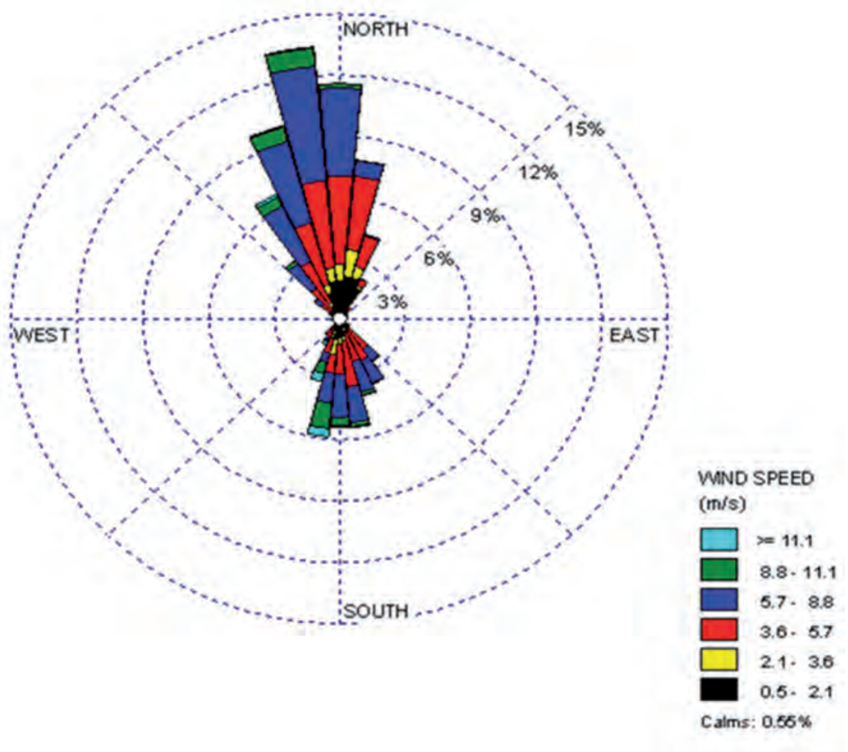

Figure 14.2: Wind rose example for central Wellington showing the predominance of northerlies and southerlies, and showing the almost complete absence of wind from westerly or easterly direction

14.5 Available air quality monitoring data

There are a number of available reports on air quality monitoring in Wellington. These reports include results of air quality monitoring programmes undertaken by the Greater Wellington Regional Council and reports produced by NIWA containing results from other investigation programmes. The air quality monitoring data used in this assessment were obtained from the reports covering the period from 1999 to 2009.

Figure 14.3: The permanent and continuous air quality monitoring station at the corner of Victoria Street and Vivian Street in Wellington City

A summary of the air quality monitoring results from the above reports is shown in *Table 14.3*. The table includes measured maximum values and median concentrations. Direct comparison of these results should take into account all the factors that could affect the measurements at each site and monitoring period. A major influence is the location the instruments and the position of the sampling intakes. Monitoring results shown in *Table 14.3* use a 1 hour time average for carbon monoxide and nitrogen dioxide, and use a 24 hour time average for PM_{10}.

Table 14.3: Reported air quality monitoring data for the Wellington urban area[2]

References	Distance to roadside	Concentration of air contaminants					
		CO mg/m³		NO_2 µg/m³		PM_{10} µg/m³	
		max	median	max	median	max	median
Perry Davy, 1999	13 metres	14.8	1.3	n/a	n/a	n/a	n/a
GWRC 2007 report	8 metres	3.7	0.6	99	33	37	14
GWRC 2008 report	8 metres	3.6	0.3	103	30	27	13
Talbot et.al, June 2008	50 metres	3.5	*0.1	32.4	*6.5	31.9	*14.6

2 These are average values for the period of monitoring from 17 October 2007 to 21 April 2008

The "Distance to roadside" in *Table 14.3* is the distance between the road kerb and the location of the air quality monitoring station or point where the concentration of air contaminants was measured. The inner city Greater Wellington Regional Council permanent air quality monitoring station is located at the corner of Victoria Street and Vivian Street (*Figure 14.3*), and the "Distance to roadside" is measured to the kerb of Victoria Street. However, the station is also only 12 metres from the kerb of Vivian Street which carries traffic volumes approximately double the traffic volumes on Victoria Street.

In 2007 NZTA commenced a programme of monitoring air quality near the State Highway network using passive monitoring tubes detecting nitrogen dioxide as an indicator of air quality. A further part of the programme matches passive tube sampling to continuous monitoring and the field results are then adjusted to provide a reliable result that can be referenced to calibrated readings. Originally only one monitoring site was located in the Basin Reserve area and now there are four in the area. For sampling, passive tubes are installed at monitoring sites for a period of one month. Concentrations of nitrogen dioxide at the Basin Reserve are measured then adjusted using real time measurements at monitoring stations to give the one month average concentrations of nitrogen dioxide shown in *Table 14.4*.

Table 14.4: One month average concentrations of nitrogen dioxide (µg/m³) at Basin Reserve

Month	Rugby Street / Sussex Street	Paterson Street	Wellington East Girls' College	Ellice Street / Dufferin Street
Jan 2008	28.3	10.2		
Feb 2008	27.3	14.5		
Mar 2008	34.9	10.4		
Apr 2008	38.7	16.9		
May 2008	37.2	n/a		
Jun 2008	26.0	19.4		
Jul 2008	47.6	21.0	13.1	
Aug 2008	27.8	16.7	8.0	
Sep 2008	26.3	12.9	9.2	
Oct 2008	37.1	13.0	9.4	
Nov 2008	22.7	11.6	7.7	
Dec 2008	21.3	8.8	5.8	
Jan 2009	22.0	10.3	7.1	22.1
Feb 2009*	32.5	11.3	8.0	22.3
Mar 2009	36.2	15.2	8.3	23.8
Apr 2009	35.6	15.9	11.6	33.8
May 2009	29.0	23.0	10.4	28.6
Jun 2009	33.4	27.2	11.9	38.0
Jul 2009	49.8	23.4	13.3	37.9
Aug 2009	54.7	21.7	n/a	31.9

* Note: The data for 2009 has not yet been adjusted so reported concentrations are indicative only.

14.5.1 Seasonal variations

The seasonal variation of air pollution is well documented for various urban locations throughout New Zealand. For example, the air quality monitoring data from Christchurch, Dunedin, Taupo or Hamilton show well established fluctuations of air contaminants in the urban ambient air. Changes depend on seasons, with air pollution levels in winter time (June through August) higher than for the rest of the year. It was observed that similar trends are present in Wellington, however due to the relative windiness of Wellington's weather these fluctuations are less pronounced. This is evident from *Table 14.4*. While there is a general trend for the summer monthly average reading to be less than the average from winter months, there is considerable variation from month to month, as shown by the data for May, June, July 2008 for instance.

This data has not been quality assured therefore should be used only as indicative[3].

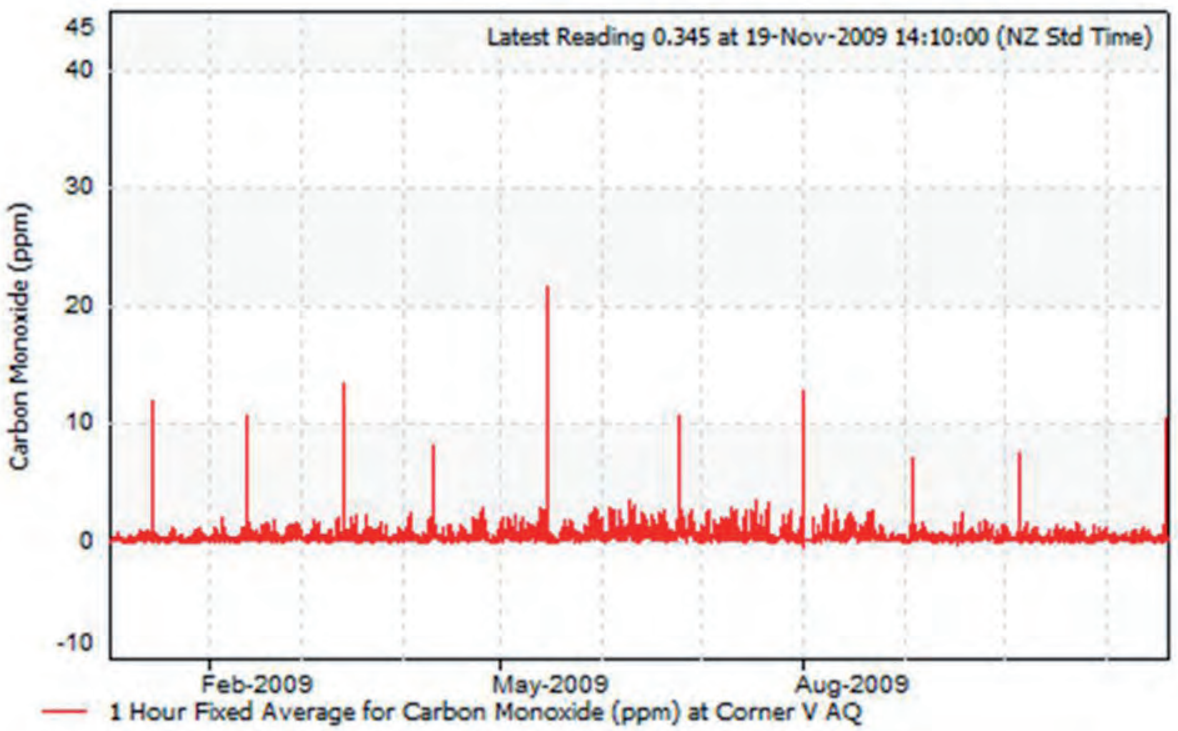

Figure 14.4: Carbon monoxide concentrations (1 hour time average) measured in Wellington City from January 2009 to November 2009

In records such as these, the short term peaks can also be due to very localised events, such as an idling truck or bus parked near to the monitoring site. These extreme events therefore cannot be taken unquestionably as a representation of background values.

14.5.2 The Mount Victoria road tunnel

The Mount Victoria road tunnel is located on the eastern end of the study area. The intended project is likely to finish 100 to 200 metres away from the western (Mount Victoria) portal (that is shown in *Figure 14.5*). There is no intention for the project to alter the tunnel.

The Mount Victoria road tunnel is 600 metres long and contaminants emitted by the 38,000 vehicles per day that use this tunnel accumulate in the air. The tunnel is ventilated by two processes. The first and main process is the natural airflow that occurs through the tunnel when there is wind. In a north-westerly wind, the airflow is from the Mount Victoria portal to the Hataitai portal. In a southerly or south-easterly wind, the airflow is from the Hataitai portal to the Mount Victoria portal.

The second Mount Victoria road tunnel ventilation process is mechanical ventilation. Fresh air is pumped into the tunnel, emerging within the tunnel along its length from ventilation holes under the pedestrian walkway that runs through the tunnel parallel to the road. Two vertical shafts extract air from the tunnel. Each shaft is positioned approximately 150 metres in from either of the tunnel's portals. The shafts discharge into the tree covered areas of Wellington's town belt, which occupies the land between the two portals.

The concentration of contaminants in the air discharged from the portals depends on the weather conditions and the mechanical ventilation system. Measurements made in 1998 showed that contaminants increased to about two or three times the normal roadside levels at the point of discharge from the portal; however these measurements were made when the mechanical ventilation was not operating. While the air discharged from the portals will tend to increase contaminant levels, the tunnel operates counter to the outside conditions. That is, light northerly conditions tend to cause contaminants to accumulate near the Basin Reserve but light northerly conditions cause the air to flow towards Hataitai through the Mount Victoria road tunnel, so that the tunnel has no additional effect to contaminants at the Mount Victoria portal. Conversely, south-easterly conditions which cause the tunnel air to be discharged from the Mount Victoria portal are winds that also tend to reduce the contaminant levels in the Basin Reserve area.

At present, an upgrade of the fire protection systems in the Mount Victoria road tunnel is being carried out. It is understood that this work will also upgrade the ventilation system.

Figure 14.5: The Mount Victoria portal of the Mount Victoria road tunnel

3 Figure 14.4 shows concentrations of carbon monoxide measured at the corner of Vivian and Victoria Street, in Wellington City. It can be seen that air pollution increased to higher concentrations around the period from June through August. Other monitoring not shown here but otherwise inspected shows similar patterns in concentrations of nitrogen dioxide and concentrations of PM_{10}.

Figure 14.4 is typical of air quality data throughout New Zealand. Occasional very high readings are obtained against a background of fluctuating but consistently much lower readings. The events of high concentrations are often associated with temperature inversions. Temperature inversion (For CO 1 ppm = 1.25 mg m-3 @0ºC) may occur in an area during relatively calm, cool and clear conditions and are more common in winter. Air quality monitoring shows that during such conditions dispersion of air contaminants is limited and there is a strong correlation between temperature inversions and high air pollution levels. The highest concentrations of contaminants are therefore more likely to occur during winter months from June to August, when calm weather conditions prevail and concentrations of air contaminants can build up when high traffic volumes and burning of domestic fires coincide with these atmospheric conditions.

14.6 Modelled concentrations

The maximum ambient air concentrations were assessed at regular intervals using grid receptors and the predicted concentrations are shown in *Table 14.5*. Concentration plots for PM_{10}, nitrogen dioxide and carbon monoxide are shown in *Appendix C*. The model shows highest concentrations above or in close proximity of the roadway (carriageway).

Table 14.5: Modelled maximum concentrations of air contaminants (project effect plus estimated background)

Contaminant	Model results	Ambient air quality guideline limits	Averaging interval
CO	5.3 mg/m³	10 mg/m³	1 hour
NO_2	130.0 μg/m³	200 μg/m³	1 hour
PM_{10}	35.5 μg/m³	50 μg/m³	24 hour

Highest concentrations of PM_{10} and nitrogen dioxide will occur along Dufferin Street and between Dufferin Street and the entrance to the Mount Victoria road tunnel. Elevated roadside concentrations around the tunnel's entrance are due to the highest traffic volume being on this road. Note that the PM_{10} levels are dominated by the chosen background value of 15μg/m³. Additional PM_{10} generated by roads in the study area is 2 to 20 μg/m³ over this background level with 2 to 7 μg/m³ the norm for most receptor sites.

Another area where high concentrations can occur is Sussex Street and the corner of Sussex Street and Buckle Street (refer *Table 14.7*). Concentrations can be high during peak hours because Sussex Street and Buckle Street are the main route for both the east-west flows and from southern Wellington residential areas and Newtown moving towards the central business district. Peak hour traffic on these streets is congested and vehicle emissions are at their maximum because of the density of vehicles on the street.

Predicted concentrations of air contaminants at receptor sites are shown in *Table 14.6*.

Table 14.6: Predicted total maximum concentrations of air contaminants at receptor sites

Site locations	Concentration		
	CO mg/m³	NO_2 μg/m³	PM_{10} μg/m³*
1 Basin Reserve, centre of play area	2.4	56.5	17.8
2 Basin Reserve embankment	2.6	56.5	18.5
3 Corner Adelaide Road and Rugby Street	3.6	75.3	19.5
4 Wellington College	2.2	37.6	16.7
5 St Mark's Church (Dufferin Street)	3.2	75.3	21.0
6 9A Dufferin St	4.5	94.1	31.6
7 St Mark's School	2.9	75.3	21.7
8 Wellington College cricket ground	2.9	75.3	21.8
9 Wellington East Girls' College	2.5	56.5	17.9
10 St Joseph's Catholic Church	3.0	56.5	21.8
11 28 Ellice Street (backyard)	2.6	56.5	18.4
12 33 Ellice Street	2.5	56.5	17.7
13 21 Ellice Street	3.1	75.3	18.9
14 5 Moir Street	2.1	56.5	17.1
15 Corner Kent Terrace and Ellice Street	3.3	75.3	21.2
16 Marksman Motor Inn	3.9	75.3	19.9
17 22 Sussex Street (Te Awhina apartment complex)	4.1	75.3	21.3
18 Corner Sussex Street and Buckle Street	4.0	75.3	20.7
19 Tasman Garden Apartments	2.5	37.6	17.5
20 Massey Design Department	2.1	18.8	16.0
21 National War Memorial	2.2	37.6	16.6
22 176 Tory Street	2.5	37.6	16.5
23 Mount Cook School	2.3	37.6	16.2

* Note: PM_{10} concentrations calculated using 15 ×g/m³ as the background concentration

The modelling results show that the air quality guidelines and standards will not be exceeded at any of the key receptors as a result of this project.

14.7 Comparison with monitoring

An appropriate site to compare predicted concentrations and air quality monitoring results is the site established at Buckle Street for the period from October 2007 to April 2008. The key parameters are shown in *Table 14.7*.

Comparison of the modelled nitrogen dioxide levels to the passive dose tube monitoring is assisted by information from the United Kingdom where an average annual level of 40 μg/m³ is said to be associated with occasional periods when the 200 μg/m³ limit with a 1 hour averaging period is exceeded.

The measurement site and the modelling receptor point are both 50 metres away from the road kerb of Buckle Street.

Table 14.7: Comparison of modelled and measured concentrations for Buckle Street

Pollutant	Modelled Maximum Concentrations	Measured Maximum Concentrations	Measured Average Concentrations
1 hour CO	2.3 mg/m³	3.5 mg/m³	0.1 mg/m³
1 hour NO_2	37.6 μg/m³	32.4 μg/m³	6.5 μg/m³
24 hour PM_{10}	16.2 μg/m³	31.9 μg/m³	14.6 μg/m³

The comparison shows that the modelling results are in a relatively good agreement with the air quality monitoring data for carbon monoxide, and nitrogen dioxide; particulates were underestimated, the modelled maximum concentration was closer to the measured average for particulate matter. The difference between measured and predicted concentrations depends on the distance from the road edge. For the distances beyond 50 metres the underestimation becomes more pronounced.

These factors will be examined more closely in the final assessment, using more detailed modelling methods.

14.8 Discussion and Summary

In many circumstances, such detailed roadway dispersion modelling is not carried out for an issues, opportunities and constraints report. It has been done in this case, since all of the input data were available, and the results are more quantified. Thus a good indication is given for the potential effects, their extent and location.

The future more detailed work will need to take account of additional factors and data that are not fully available at this time. These include:

- Defined options for the proposed roadway alterations;
- A better idea of the existing concentrations (the estimates used here will be updated following some proposed new site specific monitoring.); and
- Assessing the effects of airflows out of the Mount Victoria tunnel portal (which has not been included here, and presents a challenge in terms of modelling its effects). A more refined treatment of the NO to NO_2 conversion rate.

Each of these refinements should improve the accuracy of the assessment, and see a better agreement between the on-site monitoring and the modelling results.

However these preliminary modelling results do indicate that the air quality guidelines and standards will not be exceeded at any of the key receptors as a result of this project.

It is expected that proposed works will reduce congestion and smooth traffic flow on the road network in the Basin Research area and this may have some influence on air quality as driving mode influences the rate at which various contaminants are emitted. Emission rates of some contaminants such as carbon monoxide are highest in congested flows, and conversely emission rates of other species such as the oxides of nitrogen are highest for fast uninterrupted driving. However as the speed limits will be 50 kilometres per hour, reducing congestion should provide a higher reduction of carbon monoxide than the offsetting increase in other species such as nitric oxides. A further aspect is that congestion causes a high density of vehicles in the roadway so that the number of emitting vehicles in the space is increased thereby increasing total quantity of emissions.

Reduced congestion and smoother flow reduces this high density of vehicle emission sources.

14.9 Impacts and Opportunities for Adjacent Land Uses

The project area has a number of potentially impacted land uses. These include two primary schools, two secondary schools, a university, several churches, a number of residences and businesses, plus nationally important facilities such as Government House and the National war Memorial, and outdoor spaces notably including the Basin Reserve but also school grounds. The area also has modestly high pedestrian counts, particularly children pedestrians accessing schools, people attending events at the Basin Reserve grounds, and commuters walking between Newtown and the central city.

The major change with this project will be the shift of the east-west stream of traffic from the south of the Basin Reserve to the northern side thereby concentrating higher volumes of traffic along the northern side.

This project is unlikely to have an impact on air quality other than at localised positions within a few metres of the roadway in the immediate project area. Beyond the project area there will be approximately the same amount of traffic generating much the same contaminants with some small changes in the relative ratios. Some reduction in overall contaminant generation should occur because of the more direct route for east-west traffic thus reducing the distance travelled and also the level of congestion.

Air quality effects are predominantly confined close to the roadway so adjacent new sections of roadway there could be changes in contaminant concentrations. Therefore when evaluating the road alteration options, it will be important to assess the extent of change at the sensitive locations and to assess the changed levels relative to the NESAQ guidelines. Air quality effects of traffic will rise at some adjacent properties if the road is shifted to new positions. There will be some reductions of contaminants towards the southern sections because the east-west traffic is moved to the north. There will also be changes in rates of the types of contaminants emitted because of changes in vehicle flow types as congestion will be relieved with the removal of some traffic signals.

Some descriptors have been developed to aid the discussion around air quality rather than confine it to discussion as to whether it is above or below a stated guideline level. Below the guideline level the four classifications of air quality commonly used are "excellent", "good", "acceptable", and "alert". These classifications are related to the level of impact. Worsening of the classification would be a "minor" to "significant" impact, but causing the guideline to be exceeded would be a "very significant" impact. The reverse also holds true. Improving the classification at sensitive locations could be considered as a "minor" to "significant" benefit.

At present within the area around the Basin Reserve it appears that air quality is within guideline levels and is most likely within the two middle classifications of "good" (being 10 to 33 percent of the NESAQ levels) and "acceptable" (being 33 to 66 percent of the NESAQ levels).

Elevated structures, especially those five to seven metres above the ground are beneficial to air quality because they facilitate the rapid dispersal of air contaminants so that contaminant levels around ground level will be low.

The NESAQ guidelines have a focus on health and the requirements for some species are to ensure that an average level per hour is not exceeded. Consequently air quality needs to be considered anywhere people are for any significant period of time.

14.9.1 Adjacent land uses

Basin Reserve

Central to the area is the Basin Reserve, shown in *Figure 14.6*. The ground is used mainly for summer sports and some entertainment events. Much of the project is directed at preserving the character of this ground. The land use here is for activities that range from one or two hours to seven or eight hour periods of time.

Figure 14.6: The Basin Reserve

The Basin Reserve presents both opportunities and challenges. A significant reduction in air quality within the Basin Reserve could be a negative impact of the project. Retaining an environment close to the status quo, or the potential of even improving the air quality, could help to increase benefits of the project. Options are likely to be quite favourable for the Basin Reserve as they will reduce traffic at the south-eastern, southern, and western sides. Elevated routes that are close to the Basin Reserve or routes that are more distant from the Basin Reserve will also be favourable.

The northeast corner including Mount Victoria residential area

A major area that may be impacted by many of the road alteration options is the area between Kent Terrace and Paterson Street, the street leading into the Mount Victoria tunnel. The nature of the area is indicated in *Figure 14.7*.

Figure 14.7: The nature of the Mount Victoria residential area near the project area

The buildings adjacent to Kent Terrace are commercial. Hania Street has a mix of cultural and commercial uses with the cultural uses located in the northern half of the street. There is one residential building midway on Hania Street (37 Hania Street) and one high rise apartment fronting Kent Terrace that under possible options would be adjacent new road links through the area.

The commercial buildings of Hania Street back onto a residential part of the Mount Victoria suburb: Moir Street, Ellice Street, and Brougham Street. Any new road links in this area would remove some of the commercial buildings and put increased traffic closer to these residences so that air quality will likely be reduced to some degree. What would make such a change readily acceptable is first if it can be shown to be within NESAQ guidelines but additionally is any worsening of air quality is only a "minor" change from current levels.

The area between Ellice Street and Paterson Street includes St. Joseph's Church and its associated buildings. The project may move the roadways much closer to this property. Previously it was shown that air quality was worst at roadside and close to roadside, so it will be important to evaluate the air quality for this area when the road alteration options are assessed for their air quality impacts.

East and south of the Basin Reserve

South of Paterson Street linking to the Mount Victoria tunnel and east of Dufferin Street are two secondary schools: Wellington East Girls' College and Wellington College. The area also contains St. Mark's School, St. Mark's Church, and several residences. The secondary school buildings are at a distance from the road but the schools' grounds are adjacent to the road. The likely effect of the project is that the roadway will either move further away from these land uses or the roadway will be unchanged in position, albeit with reduced traffic flows. This is an area of high pedestrian activity, with pupils accessing these schools and using the outdoor spaces of the schools. Expectations are either some small improvements in air quality or little change from present levels. Part of this area is also influenced by discharges of contaminated air via the Mount Victoria tunnel portal when winds blow from the south and east.

West of the Basin Reserve and Buckle Street

North of Buckle Street, between Taranaki Street and Cambridge Terrace, there is a band of approximately 40 metres of empty land for the proposed Memorial Park. The development of road alteration options will be compatible with this intended new land use. Between Taranaki Street and Tory Street there are industrial buildings. Tory Street has some residential buildings on it and the educational facility of Mount Cook School, which is 80 metres north of the current road alignment. Detailed measurements have shown that the existing road system does not cause NESAQ levels to be exceeded at Mount Cook school, and in fact the contaminant concentration levels are generally well within NESAQ limits.

A very significant land use in this area is the National War Memorial (shown in *Figure 14.8*), including Carillion and Tomb of the Unknown Warrior on Buckle Street. This is intended to be both a place of sombre reflection and a place for public ceremony and speeches. Crowds or guards of honour on site can be in place for up to several hours at a time.

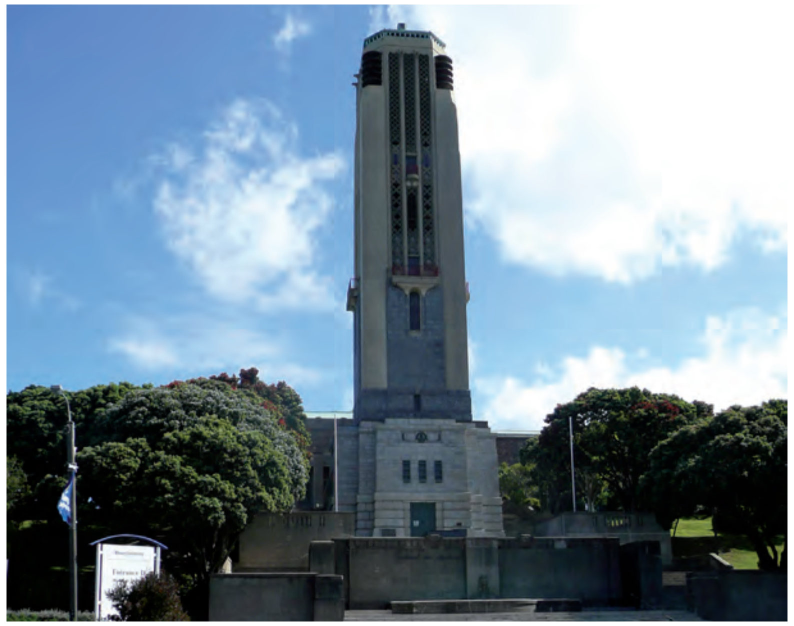

Figure 14.8: The National War Memorial site

In Sussex Street, west of the Basin Reserve and partly shown in *Figure 14.9*, several apartment blocks and a motel are very close to the existing road. The shift of traffic that would occur under all road alteration options will reduce the traffic volumes in this area by about 60 percent. This means that 60 percent of the emission source is removed from the immediate area and an almost comparable improvement in air quality should occur. This means that the improvement of the Adelaide Road environment that is intended as part of the development of that area could be extended down past the Basin Reserve as far as Buckle Street.

Figure 14.9: Views of Sussex Street/ Buckle Street residential area

14.10 Conclusion

Air quality is an important environment impact to be considered in assessing the options for altering State Highway 1 around the Basin Reserve area.

The Basin Reserve area has a wide range of land uses, many of which are potentially sensitive receivers with respect to air quality. These land uses include residences, schools, churches, cultural centres, sports grounds, as well as some iconic national facilities such as the National War Memorial including the Tomb of the Unknown Warrior, the Basin Reserve sports ground, and Government House.

Air quality data from monitoring in the area and modelling shows that the air quality is poorest closest to the roadways (and a number of land uses are street-side) but thereafter levels of contaminants drop off quickly. Air quality meets the NESAQ, the Ambient Guidelines, the Regional Council plan criteria and can generally be described as "good" to "acceptable".

The options proposed for the modifications are not expected to have any significant effect on air quality outside the main study area. Within the study area there are expected to be some localised changes from existing air quality that correspond to shifts in the location of traffic flows. Improvements are expected in air quality south and west of the Basin Reserve. Some minor increases are expected on the northern side of the Basin Reserve. Conversely, there are several areas that will experience a significant improvement in air quality, such as the dense residential areas along Sussex Street, and much of the section either side through to Buckle Street and Adelaide Road.

At no location more than a few metres from the roadside are there any exceedances of standards or guidelines. Sensitive receptors and residences along the route will not experience any significantly worse air quality.

The long term trend is also for the rate at which New Zealand vehicles emit contaminants to decrease. Starting in the mid-1990's the Ministry of Transport has been effecting policies to ensure that the emission improvements achieved in the countries from which New Zealand sources vehicles also apply to vehicles entering New Zealand. The New Zealand vehicle fleet has a replacement period of approximately twenty years, so that over time the fleet will have a progressively lowering rate of contaminant emission. This progressively lowering rate is allowed for in the air quality modelling. The Auckland Regional Council vehicle emissions model contains projections out to 2030 of the fleet composition and the model factors into these projections the current emission rates for new vehicles.

Other vehicle fleet changes, such as vehicles with biofuels or hybrid petrol / electric vehicles, will also reduce vehicle emissions but these changes are not yet included in the model.