Windsor Bridge replacement project

AIR QUALITY WORKING PAPER – WORKING PAPER 11

NOVEMBER 2012

(blank page)

Roads and Maritime Services

Windsor Bridge replacement project

Air quality working paper – working paper 11

November 2012

Prepared by Sinclair Knight Merz (SKM) for Roads and Maritime Services NSW

Contents

Glossary of terms and abbreviations

Term	Meaning
AHD	Australian Height Datum
AWS	Automatic Weather Station
EIS	Environmental Impact Statement
EPA	Environment Protection Authority
HMA	Hazardous materials audit
NATA	National Association of Testing Authorities
OEH	Office of Environment and Heritage
PIARC	Permanent International Association of Road Congress
RAAF	Royal Australian Air Force
RMS	Roads and Maritime Services
SKM	Sinclair Knight Merz
TRAQ	Tool for Roadside Air Quality

Executive Summary

Roads and Maritime Service NSW (RMS) is proposing to construct a new bridge across the Hawkesbury River at Windsor to replace the existing bridge that has reached the end of its economic life (the project). To support the design and approval of the project, RMS is preparing an Environmental Impact Statement (EIS) under Part 5.1 of the *Environmental Planning and Assessment Act 1979*. This air quality assessment has been prepared as a specialist component of the EIS to identify and assess the impacts of the project on construction and operational air quality and advise mitigation actions to avoid or minimise impacts.

Air quality impacts are identified as a key issue for the EIS and require assessment of the potential for adverse air quality impacts during both construction and operational phases of the project. The main objective of the air quality assessment is to determine the potential for the project to cause adverse air quality impacts and to identify appropriate mitigation measures to avoid or minimise impacts. This was assessed by examining the proposed activities to be undertaken, and identifying the relevant Environment Protection Authority (EPA) air quality criteria.

A qualitative air quality assessment was undertaken for the construction works. The assessment identified the potential for dust emissions to cause nuisance impacts if activities are located close to sensitive receivers, such as residential dwellings, and local businesses. The magnitude of dust impacts would depend on the amount of earthworks involved at a particular location, the duration of activities, and the local meteorology at the time, particularly wind speed and direction.

The annual pattern of winds highlights the potential for adverse dust impacts at sensitive receivers to the northeast and southwest of the site. Some rural properties lay to the northeast but most sensitive receivers are primarily to the southwest and comprise of mainly commercial properties within the town centre. Construction activities conducted over spring and summer would have the highest potential for adverse impacts to sensitive receivers within the town centre due to increased frequency of winds from the northeast. These impacts can be managed and mitigated with suitable dust control measures and practices.

A hazardous materials audit has been undertaken for the structure of the existing Windsor Bridge to identify hazardous substances of concern within the existing bridge structure including asbestos and lead based paints. No asbestos was detected, however the iron piers and cross bracings of the bridge structure contain lead based paints. These painted surfaces will need to be managed during demolition of the existing bridge structure. A detailed plan of management which outlines the design and operation of lead based paint containment systems will be required by the project.

For the assessment of operational impacts, the Tool for Roadside Air Quality (TRAQ) developed by RMS was used to estimate potential air quality impacts associated with the project. Average daily traffic volumes from Windsor Road for 2016 and 2026 were forecasted including hourly volumes and the proportion of heavy vehicles.

Dispersion modelling of CO, NO_2 and PM_{10} vehicle emissions was undertaken for both the existing road sections based on 2011 traffic data, and traffic flow on the project in the opening year of 2016 and in 2026. The dispersion modelling was based on worst case meteorological conditions and results for the proposed bridge replacement indicate:

- Predicted concentrations along the proposed alignment in 2016 and 2026 are lower than the existing case for CO, NO_2 and PM_{10} concentrations across all pollutant averaging periods. This is likely to be attributed to assumed reductions in the proportion of older vehicles in the fleet simulating improved vehicle emissions in future years.
- With the exception to predicted maximum 24-hour PM_{10} concentrations predicted pollutant concentrations along Bridge Street and Windsor Road are within the EPA criterion when added to existing background concentrations.
- For Bridge Street and Windsor Road the predicted 2016 and 2026 concentrations of maximum 24-hour PM_{10}, when added to the background concentration indicated exceedences of the maximum 24-hour PM_{10} concentration at the curb, dissipating to concentrations within the 50µg/m^3 criterion within 10 metres of the highway. Given the existing background concentration were inclusive of vehicle emission concentrations and traffic volumes are predicted to increase irrespective of the project, the predicted maximum 24-hour PM_{10} concentrations are likely to be over estimated. However, the maximum 24-hour PM_{10} at nearby sensitive receivers would be within the EPA criteria.
- All predicted pollutant concentrations along Freemans Reach Road are within the EPA criterion when added to existing background concentrations.

In summary, temporary dust impacts associated with construction and demolition works would be minor provided adequate dust control measures are implemented. No adverse air quality impacts are predicted during operation as it is assumed that older vehicles will begin to be replaced with new vehicles with higher emission standard. As such air quality impacts would be similar to existing conditions.

1 Introduction

This chapter introduces the project, providing a brief outline of its need, scope, and location. It also outlines the structure of this working paper.

1.1 Overview

Roads and Maritime Services NSW (RMS) is proposing to construct a new bridge across the Hawkesbury River at Windsor to replace the existing bridge that has reached the end of its economic life. To support the design and approval of the Windsor Bridge replacement, RMS is preparing an Environmental Impact Statement (EIS) under Part 5.1 of the *Environmental Planning and Assessment Act 1979*. This air quality assessment has been prepared as a specialist component of the EIS to identify and assess the impacts of the proposal on construction and operational air quality and advise mitigation actions to avoid or minimise impacts.

1.2 Project description

1.2.1 Overview

The project would comprise:

- Construction of a new bridge over the Hawkesbury River at Windsor, around 35 metres downstream of the existing Windsor bridge.
- Reconstruction and upgrading of existing intersections and bridge approach roads to accommodate the new bridge, including:
    - Removal of the existing roundabout and installation of traffic signals at the intersection of George and Bridge Streets.
    - Construction of a new dual lane roundabout at the intersection of Freemans Reach Road, Wilberforce Road, northern bridge approach road and the access road to Macquarie Park. All roads serviced by the new roundabout would require minor realignments.
    - Realignment of the southern and northern bridge approach roads. The new southern bridge approach road would generally follow the alignment of Old Bridge Street along the eastern side of Thompson Square. The northern bridge approach road would be a new road connecting the bridge to the new dual lane roundabout.
    - Construction of a shared pedestrian/cycle pathway for access to and across the new bridge.
    - Removal of the existing bridge approach roads and then backfilling, rehabilitating and landscaping these areas.
    - Demolition of the existing Windsor bridge including piers and abutments.
    - Landscaping works within Thompson Square parkland and adjacent to the northern intersection of Bridge Street, Wilberforce Road, Freemans Reach Road and the access road to Macquarie Park.
    - Redevelopment of part of The Terrace to provide continuous access along the southern bank of the river and under the replacement bridge to Windsor Wharf.
    - Construction of scour protection works on the southern and northern banks and around three bridge piers.
    - Construction of a permanent water quality basin to capture and treat stormwater runoff from the bridge and northern intersection prior to stormwater being discharged to the Hawkesbury River.

- Architectural treatments for noise mitigation, as required, where feasible and reasonable and in agreement with affected property owners.
- Flood mitigation works at individual properties.
- Ancillary works including:
    - Adjustment, relocation and/or protection of utilities and services, as required.
    - Construction and operation of temporary construction, stockpiling and compound sites.

In **Figure 1-1** the main elements of the project are shown including the construction zone and project boundary.

In addition to the above-listed work elements, early works for further identification, salvage, recording and protection of Aboriginal and historic heritage, would be carried out as part of impact mitigation for the project. These early works would include:

- Salvage excavation at identified Aboriginal heritage sites on the southern bank of the river in accordance with the procedures identified in the Aboriginal heritage chapter of the Environmental Impact Statement for the project.
- Excavation, recording and protection of historic heritage in accordance with the procedures identified in the historic heritage chapter of the Environmental Impact Statement for the project.

1.2.2 The replacement bridge and intersections

The replacement bridge would be located around 35 metres downstream of the existing Windsor bridge. The southern bridge approach road would be via a new realigned section of Bridge Street, which would start at the existing intersection of George Street and Bridge Street and head generally north-west along the alignment of Old Bridge Street on the eastern side of the Thompson Square parkland. The existing roundabout at the George Street and Bridge Street intersection would be replaced by traffic signals. The replacement bridge would connect with the junction of Wilberforce Road, Freemans Reach Road and the Macquarie Park access road at a new dual lane roundabout intersection.

The replacement bridge would be an incrementally launched bridge constructed of reinforced concrete and comprising five spans. The bridge deck would be about 15.5 metres wide and be supported on up to four piers in the river. It would have an overall length of about 160 metres, spanning both the river and The Terrace. This would enable The Terrace to be reconnected to provide vehicular, pedestrian and cyclist access to Windsor Wharf. The clearance under the bridge where it spans The Terrace would be about 3.6 metres, which would allow a range of service and emergency vehicles to pass under the bridge and access Windsor Wharf.

The replacement bridge would initially comprise two traffic lanes (one in each direction), each about 3.5 metres wide and with an adjacent two metre wide shoulder. There would also be a three metre wide shared pedestrian/cycle path on the western side of the bridge. The two metre wide road shoulders of the replacement bridge would allow the bridge to be re-configured to a three lane bridge in the future, when required. The introduction of the three lane configuration would occur when additional traffic capacity is required. The three traffic lanes would consist of two southbound lanes and one northbound lane.

The low point of the replacement bridge would be around 9.8 metres Australian Height Datum (AHD), making it around 2.8 metres higher than the lowest point of the existing bridge. The height of the replacement bridge may change slightly during the detailed design phase. This would give the replacement bridge a slightly higher level of flood immunity than the existing bridge. While the existing bridge is overtopped in a one in two year flood event, the replacement bridge is predicted to remain above water for the one in two year flood event but be overtopped in an event just smaller than the one in three year flood. This level of flood immunity is consistent with that of the northern approach roads (Wilberforce Road and Freemans Reach Road), which have a flood immunity that lies about midway between the one in two year and one in three year flood levels.

1.2.3 Demolition of the existing bridge

The existing Windsor bridge would be removed following commissioning of the replacement bridge and associated bridge approach roads. The existing bridge superstructure and substructure would be removed in sections, with temporary bracing installed, as required, to maintain the stability of remaining sections during the demolition process. Where possible the process of demolition would involve cutting or dismantling the superstructure and substructure into sections, with each section transported off-site for further demolition at an appropriately approved and licensed facility. Where possible the dismantled bridge elements would be reused or recycled, however some components of the bridge would require disposal at a landfill. Lead based paint has also been found on the bridge, so demolition activities would need to comply with relevant standards for managing lead based paint. Disruption of waterway traffic would be limited to the greatest extent practicable, with alternative navigation channels provided while the existing navigation span is closed for the demolition works.

1.2.4 Pedestrian and cycling facilities

The project would incorporate facilities for pedestrians and cyclists and include a shared pedestrian/cycle pathway that would be constructed from Wilberforce Road and Macquarie Park, across the western side of the replacement bridge and southern approach road to the corner of George and Bridge Streets. Pedestrian and cyclist access along the southern bank of the river would also be improved with the connection and redevelopment of The Terrace. In addition, the following general works would be undertaken to improve pedestrian safety and access:

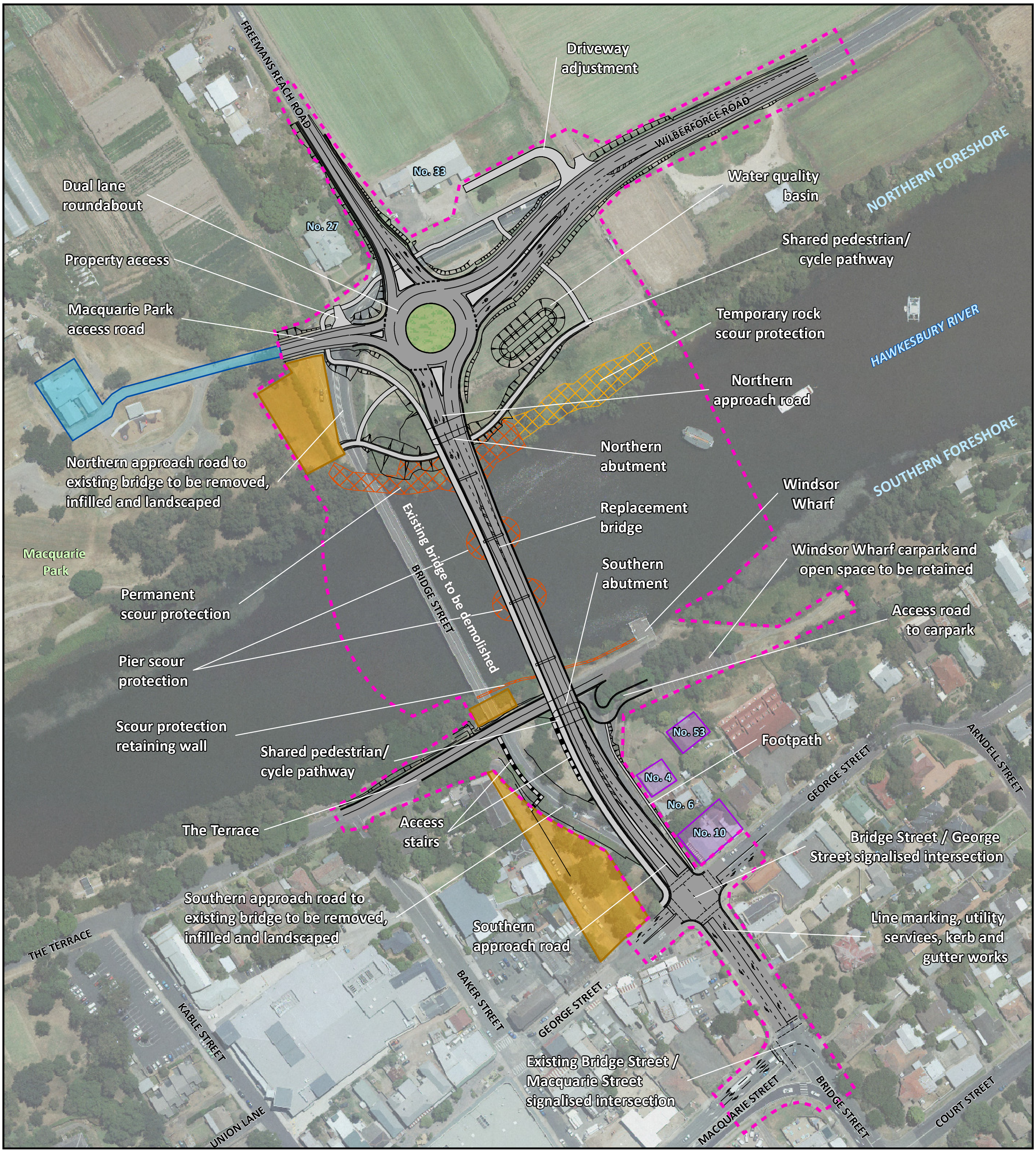
- Provision of a new 1.2 metre wide footpath adjacent to properties fronting Old Bridge Street.
- Provision of a new signalised pedestrian crossing on all four approaches to the intersection of Bridge Street and George Street.
- Provision of new pedestrian footpaths for safe access around and across the proposed dual lane roundabout at the junction of Freemans Reach Road, Wilberforce Road and the Macquarie Park access road including a path under the northern bridge abutment.

1.2.5 Water quality basin

The project would include construction of a permanent water quality basin to capture and treat stormwater runoff from the bridge and northern intersection prior to stormwater being discharged to the Hawkesbury River. The water quality basin would be located on the eastern side of the proposed roundabout at the junction of Freemans Reach Road, Wilberforce Road and the Macquarie Park access road.

For the southern approach road a trash net to collect litter and a shut-off-valve to contain any spills in the stormwater system would be installed at the discharge point of the drainage system near Windsor Wharf.

Figure 1-1 | Key project elements



Indicative only – subject to detailed design

LEGEND
- Concept design
- Construction work zone
- Permanent rock scour protection (if required)
- Temporary rock scour protection (if required)
- Properties requiring flood mitigation works. Works subject to further consultation with and agreement from affected property owners.
- Properties requiring noise mitigation works. Works that are feasible and reasonable would be subject to further consultation with and agreement from affected property owners.
- Works subject to further council and stakeholder consultation

Sinclair Knight Merz does not warrant that this document is definitive nor free of error and does not accept liability for any loss caused or arising from reliance upon information provided herein.

GDA 1994 | MGA Zone 56
A4 1:3,000

0 100
Metres

AUSIMAGE SKM

26/10/2012 | I:\NBIF\Projects\NB11459\Technical\GIS\GIS_Directory\ArcMap\Specialist_Reports\Project_Description\NB11459_EIS_001_KeyElements_r2v1.mxd
Sydney Spatial Team - Prepared by : DD
Checked by : JC

1.2.6 Scour protection

Scour protection would be provided to protect the bridge abutments and piers from the erosive impacts of high river flows. On the southern bank, the scour protection would consist of a concrete panel retaining wall between Windsor Wharf and the existing bridge. Large diameter rocks (900 millimeters) and/or sandstone blocks would also be used to provide scour protection in some locations on the southern bank.

On the northern bank extensive rock and sandstone block scour protection would be required extending up the bank to about five meters above the usual water level. Other forms of scour protection such as a concrete grid planted with grass would be installed in areas above this where scour protection is required.

Scour protection using large rocks would be provided around three of the four bridge piers. Scour protection for each pier would cover an eight metre radius and would be to a depth of 4.5 metres. Dredging around the piers would be required to place the rocks below the river bed level. For the southernmost pier little or no scour protection would be required as bedrock is close to the surface in this location.

During the detailed design phase further work would be undertaken to minimise the visual impact of all visible scour protection.

1.2.7 Public utility works

The existing bridge supports a number of public utilities which would be replicated on the replacement bridge including:

- A 450 millimetre water main (cement lined steel pipe).
- A 50 millimetre sewer rising main (galvanised iron pipe).
- A 100 millimetre electrical conduit.
- Telecommunications conduits (3 x 80 millimetre galvanised iron conduits).

Other public utilities that may need to be adjusted as part of the project include:

- High voltage overhead power lines from Macquarie Street to Wilberforce Road which cross the river on a similar alignment to the replacement bridge. These power lines would need to be relocated prior to bridge construction.
- Power lines near the corner of Wilberforce Road and Freemans Reach Road.
- Local stormwater drainage infrastructure.
- A rising main from Windsor Wharf to the local sewer system, which is used to pump out boat sewage holding tanks.
- A gravity sewer main, which runs beneath Old Bridge and Bridge Streets.
- A number of water mains on both the northern and southern river banks.
- Street lighting on both the northern and southern river banks.
- Telstra assets located on both sides of the river. In particular, Telstra assets located near the proposed southern bridge abutment would need to be relocated prior to construction of the bridge abutment.
- A new recycled water main for future use if required.
- Traffic signal cables along Bridge Street between George Street and Macquarie Street.

1.2.8 Urban and landscape concept design

The urban design and landscape concept design associated with the project was developed by applying project specific urban design principles and treatments. Works associated with the current concept design are described below.

Southern bank and Thompson Square area

At this stage of project development, the scope of works in Thompson Square parkland has yet to be fully defined and would be subject to further consultation with the community, government stakeholders and most importantly Hawkesbury City Council – who would be responsible for managing Thompson Square parkland in the longer term. For the purposes of assessment in the EIS, preliminary urban design and landscaping works for Thompson Square have been identified. These works have been developed with the objectives of providing pedestrian and cyclist access from the replacement bridge to various areas in Thompson Square and providing a base for additional urban design and landscaping works arising from the consultation process. The consultation process for the additional urban design and landscaping works for Thompson Square is ongoing and if possible the full scope of works would be presented and assessed in the Submissions Report. However, it is recognised that the full scope of works may not have been agreed before the completion of the Submissions Report and a post-approval Urban Design and Landscaping Plan for Thompson Square parkland maybe be required.

The scope of works assessed in the EIS include:

- Infilling the southern approach road to the existing bridge.
- Removal of some trees which are either in poor condition or would be impacted by the project.
- Minor earthworks in the Thompson Square lower parkland area to improve the connection of the parkland to the river.
- Construction of stairs from the bridge pedestrian/cyclist path to The Terrace and from Thompson Square road to The Terrace to provide pedestrian access.
- Reinstatement of the section of The Terrace and river bank currently bisected by the existing bridge and approach roads.
- Planting of trees and other vegetation in Thompson Square parkland.
- Landscaping in the road reserve between the three properties on Old Bridge Street and the southern approach road.

Bridge

The project specific urban design principles have been used to refine the visual appearance of the replacement bridge. This includes refinements to the pier shape, bridge superstructure and abutments to minimise its visual impact and provide context to the heritage values of Windsor.

Northern bank

- Infilling the northern approach road to the existing bridge.
- Minor earthworks to improve the visual appearance of the bank.
- Construction of pedestrian/cyclist paths to Wilberforce Road and Macquarie Park.
- Planting of trees and other vegetation.

1.2.9 Construction works

Temporary construction and compound sites

There would be two main construction and compound sites required for the duration of the project (about 18 months, excluding pre-construction and early works). One of these sites would be located within the turf farm between the Hawkesbury River and Wilberforce Road (Lot 2 DP 1096472 and Lot 2 DP65136); while the other would be sited on land between Old Bridge Street and Windsor Wharf (refer to Figure 1-1). The lower Thompson Square parkland would also be closed to public access and used to provide access for the construction of the southern abutment and approach road. The majority of the construction activity would be concentrated on the northern bank as this would be the location of casting yard for the incrementally launched bridge and would be the location where access to the river would predominately occur.

The construction compound on the southern bank would be located in the car parks and grassed areas and would support the construction of the southern approach road and other minor works.

Offices may be leased near Thompson Square for construction personnel.

Order of Construction Works

The order of construction works would be implemented to minimise environmental and traffic impacts as far as practical. The likely order of construction works would consist of the following:

- Pre-construction activities and early works – including construction compound and casting bed establishment, installation of environmental controls, public utility relocations or adjustments and additional investigations and heritage salvage.
- Construction of the bridge - including construction of the piers in the river, two bridge abutments and construction and launching of the bridge superstructure.
- Installation of scour protection on the banks and in the river.
- Construction of the northern roundabout and approach road and most of the southern approach road.
- Construction of temporary pavement both at Wilberforce Road and near the corner of George and Bridge Streets to provide additional road width to enable construction of the subsequent stages.
- Construction of the remainder of the southern approach road and the new sections of Freemans Reach Road, Wilberforce Road and Macquarie Park access road.
- Commissioning and opening of the replacement bridge to traffic.
- Demolition of the existing bridge and urban design works in Thompson Square, on the southern bank, northern bank and other adjacent areas.
- Removal of temporary structures and demobilisation of the construction facilities.

This proposed order of construction works is indicative and may change once detailed construction planning is completed. It is likely that some aspects of construction may overlap.

Construction period

It is anticipated that a construction period of around 18 months (excluding pre-construction and early works) would be required to complete the proposed works including demolition of the existing bridge.

Work hours

The majority of the construction works would be carried out during standard working hours, as detailed in **Table 1-1**. Some construction activities, in particular those requiring road closures, would need to be undertaken outside of standard working hours to prevent major disruptions to traffic and access. Other construction activities such as service relocations and cutovers may also need to be undertaken outside normal working hours. Low noise activities may also be undertaken outside of normal working hours to optimise construction efficiency.

Table 1-1 Standard working hours

Day	Start time	Finish time
Monday to Friday	7am	6pm
Saturday	8am	1pm
Sunday and public holidays	No work	

Construction equipment

The types of construction equipment likely to be used for the project would include (but would not necessarily be limited to) the following:

- Excavation plant, such as excavators, back hoes and front end loaders for pavement cutting, removal and general earthworks.
- Bobcats and sweepers.
- Compaction plant, including rollers, vibrating rollers, concrete vibrators and trench plate compactors.
- Pneumatic jack hammers.
- Profiling, milling and road paving plant.
- Jet-blasting and shot-blasting machines.
- Miscellaneous vehicles, including utilities, trucks, bogies and semi-trailers.
- Miscellaneous hand tools and equipment.
- Generators, lighting towers, signage and variable message boards.
- Various barges, workboats and pontoons.
- Piling rigs and various mobile and fixed cranes.
- Concrete and grouting pumps and transport vehicles.
- Support trusses, stress jacks and scaffold systems.

1.3 Objectives and scope

1.3.1 Objectives

Air quality impacts are identified as a key issue for the EIS and require assessment of potential for adverse air quality impacts during both construction and operational phases. The assessment in this report aims to establish the significance of any potential impacts on air quality during construction and operation of the project. The assessment also provides details of measures to mitigate potential impacts in accordance with relevant guidelines so that the project’s impact on air quality would be minimised.

1.3.2 Scope of works

Specifically, the tasks for air quality assessment were to:

- Review the relevant regulatory air quality criteria and provide a discussion on the health effects of the key air pollutants.
- Review local air quality and meteorological conditions in the project region.
- Assess the potential for adverse air quality impacts during construction activities at sensitive receivers (based on level of activity and meteorology) and proposing suitable mitigation measures as required.
- Where lead based paint and/or asbestos are identified and require remediation prior to demolition of the existing bridge, develop general control measures to ensure these hazardous substances do not enter the environment.
- Develop basic dispersion models for the route, based on worst-case meteorology and hourly traffic information.
- Predict roadside air pollutant concentrations for opening year (2016) and 10 years after opening (2026) and compare predictions against air quality criteria.
- Outline how potential impacts to air quality would be managed, mitigated and monitored.

1.3.3 Study requirements

In accordance with the Director General's Environmental Assessment Requirements (DGRs), RMS must prepare an EIS. The DGRs lists air quality as a key issue which must be addressed in the report.

Table 1-2 Director General's Environmental Assessment Requirements

Reference	Requirements	Where addressed in report?
DGRs key issues: Air Quality	Air quality - including but not limited to activities that have the potential to impact on local and regional air quality and details of the proposed mitigation measures to prevent the generation and emission of dust.	Potential air quality impacts are discussed in **Section 4**. Mitigation measures are discussed in **Section 5**

1.3.4 Study area

The study area is located in the town of Windsor, NSW within the City of Hawkesbury Local Government Area. The existing bridge spans the Hawkesbury River. Within the study area land use south of the river is comprised mainly of commercial and residential premises while to the north the primary land use is rural residential and agricultural. On the southern side of the river there are a number of recreational areas including Thompson Square park and The Terrace. Macquarie Park is located on the northern side of the river west of northern approach road to the existing bridge. The location of the study area is provided in **Figure 1-1**.

Nearby sensitive receivers include low density residential properties, and commercial properties including motels which are located to the east of Bridge Street. To the west of Bridge Street sensitive receivers are largely local businesses including hotels and eateries. Sensitive receivers on Freemans Reach Road and Wilberforce Road include rural residential properties and a turf farm. Properties on the northbound side of Freemans Reach Road are elevated and generally screened by thick vegetation.

(blank page)

2 Assessment methodology

2.1 Assessment approach

2.1.1 Construction Assessment Methodology

A qualitative air quality assessment was undertaken for the construction works. The assessment identified proposed activities at the construction site, local meteorology, and includes recommendation of suitable mitigation measures to minimise and avoid air quality impacts at sensitive receivers. Tasks for assessment of the construction works were:

- Identification of the location and intensity of key construction activities.
- Identification of the location of nearest sensitive receivers to construction activities.
- Characterisation of the existing air quality environment at these localities.
- Assessment of the prevailing meteorological conditions in the project region.
- Identify and outline how potential impacts to air quality would be managed and mitigated.
- Where lead based paint and/or asbestos were identified and require remediation prior to demolition of the existing bridge, general control measures to ensure these hazardous substances do not enter the environment were described.

2.1.2 Operation Assessment Methodology

Review of Air Quality and Meteorological Data

A review of local air quality and metrological data collected by the NSW Office of Environment and Heritage and Bureau of Meteorology (BoM) was undertaken. Relevant regulatory air quality data enforced by the Environmental Protection Authority (EPA) were identified and a discussion on environmental and health effects of key air pollutants is provided.

Traffic Forecasts

This section discusses the methodology for vehicle emission estimation and how dispersion modelling was used to quantify potential air quality impacts of the project. Average daily traffic volumes from Windsor Road for 2016 and 2026 were forecasted including hourly volumes and the proportion of heavy vehicles (SKM 2012a).

The forecast traffic data was then used to estimate vehicle emissions for average daily traffic, taking into account the traffic volume, traffic mix, speed, number of lanes and road grade. Peak hour traffic speed has been set to 38 km/h modelled on arterial roads. **Table 2-1** summarises the traffic data used for this assessment.

Table 2-1 Summary of Existing and Forecast Traffic for 2016 and 2026

Road		Existing (2011)		Opening Year (2016)		10yrs After Opening (2026)	
		No. Vehicles	% Heavy Vehicles	No. Vehicles	% Heavy Vehicles	No. Vehicles	% Heavy Vehicles
Bridge Street	Northbound	9,767	7.0	10,623	7.0	12,297	7.0
	Southbound	9,366	7.0	10,103	7.0	11,685	7.0
Wilberforce Road	Eastbound	6,459	7.2	6,961	7.2	7,996	7.2
	Westbound	6,784	7.0	7,253	7.0	8,278	7.0
Freemans Reach Road	Northbound	3,776	6.6	4,166	6.6	4,881	6.6
	Southbound	3,104	7.0	3,396	7.0	4,012	7.0

Dispersion Modelling

For the purpose of this assessment, the Tool for Roadside Air Quality (TRAQ) developed by RMS was used to estimate potential air quality impacts associated with the Project.

Total emissions for the key roads that would experience changes in traffic with the project have been generated using the total traffic volume with percentages of vehicles in each age bracket and type category. Road grade and speed information was also included in the calculations.

Vehicle emission factors from the World Road Association, referred to as PIARC (formerly the Permanent International Association of Road Congress) are used by TRAQ to estimate emissions from relevant roads in the vicinity of Windsor Road. In 2004, PIARC (2004) published a document with comprehensive vehicle emissions factors for different road gradients, vehicle speeds and for vehicles conforming to different European emission standards. The emission data in TRAQ have been modified to take into account the age, vehicle mix and emission control technology of the Australian vehicle fleet.

To assess air quality impacts it is necessary to have information on existing pollutant levels in the area in which the proposal would be likely to contribute to these levels. Local air quality data has been identified and discussed in **Section3.4**. This data has been added to the TRAQ background air quality database and incorporated into the dispersion model.

2.2 Legislation and guidelines

Air quality criteria are used to assess the potential for ambient air quality to give rise to adverse health or nuisance effects. The most significant emissions produced from motor vehicles are oxides of nitrogen (NOx), carbon monoxide (CO) and particulate matter (that is, particulate matter with equivalent aerodynamic diameters equal or less than 10 microns; PM_{10}).

The EPA has set air quality assessment criteria as part of their ‘Approved Methods for the Modelling and Assessment of Air Pollutants in NSW’ (DEC, 2005). **Table 2-2** summarises the EPA air quality assessment criteria that are relevant to this assessment. In general, these criteria relate to the total concentration of air pollutant in the air and not just the contribution from project-specific sources. Therefore, some consideration of background levels needs to be made when using these criteria to assess impacts. Further discussion of background levels in the study area is provided in **Section 3.4**.

Table 2-2 EPA assessment criteria for relevant air pollutants for road air quality assessments

Pollutant	Averaging time	Criterion
Carbon monoxide (CO)	Maximum 1-hour average	30,000 µg/m^3
	Maximum 8-hour average	10,000 µg/m^3
Nitrogen dioxide (NO_2)	Maximum 1-hour average	246 µg/m^3
	Annual average	62 µg/m^3
Particulate matter (as PM_{10})	Maximum 24-hour average	50 µg/m^3
	Annual average	30 µg/m^3

µg/m^3 = micrograms per cubic metre.

While the EPA also set criteria for other pollutants from motor vehicles, such as air toxics, the pollutants listed in **Table 2-2** typically consume the greatest fraction of the respective criteria near roadways. The focus on CO, NO_2 and PM_{10} is therefore considered adequate for quantifying the air quality impacts of the project.

Appendix A provides some background on the health effects of CO, NO_x and PM_{10}.

(blank page)

3 Existing environment

3.1 Overview

This section provides a description of the dispersion meteorology, local climatic conditions and existing air pollutant in the area.

3.2 Climatic Conditions

The BoM collects regional climatic information at Richmond Royal Australian Air Force (RAAF), around three kilometres west of the study area. A range of climatic data collected from this station is presented in **Table 3-1** (BoM, 2012). Temperature and humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean monthly rainfall and the average number of rain days per month.

Table 3-1 Climatic information from Richmond RAAF

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean maximum temperature (C)	30	29	27	24	21	18	17	20	23	25	27	28
Mean minimum temperature (C)	18	18	16	11	8	5	4	4	8	11	14	16
Mean rainfall (mm)	74	125	74	44	55	47	32	32	51	55	86	63
Mean number of days of rain	8	8	8	6	6	5	4	4	5	6	8	7
Mean 9am temperature (C)	22	21	19	17	13	10	9	11	15	18	19	21
Mean 9am relative humidity (%)	72	78	80	76	82	83	80	69	63	58	68	68
Mean 9am wind speed (km/h)	9	8	7	7	6	6	6	8	10	10	10	9
Mean 3pm temperature (C)	29	27	26	23	20	17	17	19	22	24	25	28
Mean 3pm relative humidity (%)	47	52	52	49	53	53	48	39	39	40	46	44
Mean 3pm wind speed (km/h)	17	16	15	14	13	14	14	18	19	19	19	18

Monthly climate statistics for Richmond RAAF, station number 067105*. Commenced: 1993; Last record: April 2012; Latitude (deg S):* -33.60*; Longitude (deg E):* 150.78*; Elevation: 19 m; State: NSW. Source: Bureau of Meteorology, 2012.*

The data from **Table 3-1** show that the region is characterised by mild to warm summers and cold winters. January is typically the warmest month with a mean daily maximum temperature of 30°C. July and August are the coolest months with a mean daily minimum temperature of 4°C.

Rainfall data collected at Richmond RAAF show that February is usually the wettest month with mean rainfall of 125 millimetres, falling over an average of eight days in the month. The lowest monthly rainfall on average is in July and August, both with a mean monthly rainfall of 32 millimetres over 4 rain days. The mean annual rainfall is 738 millimetres with an average of 74 rain days each year.

3.3 Local Meteorology

Meteorological conditions, as opposed to climatic conditions, are those which are focussed on smaller geographical and time scales.

Local meteorology and, in particular, wind patterns are important for the transportation and dispersion of air pollutants. On a relatively small scale, winds are largely affected by the local topography, but at larger scales, there are synoptic scale influences, such as sea breeze circulations and regional drainage flows that can drive the meteorological conditions for a particular location. It is important to understand the local meteorological conditions in air quality assessments, especially for the early works activities where there could be substantial dust generation. This section therefore provides a review of local meteorological conditions in various parts of the project region.

Meteorological data, including temperature, wind speed and wind direction, have been obtained from the BoM Automatic Weather Station (AWS) at Richmond RAAF from 2009 to 2011. Wind speed and wind direction records for 2011 were found to be the most complete (99.9% data completion) and thus have been presented in this report. Wind roses prepared from the 2011 data which show the frequency of wind speeds and wind directions, based on one year of hourly records are presented in **Figure 3-1**. While wind patterns vary from day to day, most regions experience similar wind patterns from year to year, and the general pattern of winds for 2011 would be similar to other years for the four regions.

It can be seen from **Figure 3-1** that on an annual basis, the most common wind directions are from the south southwest to southwest; however northeast to east north-easterly winds are also prevalent. The site experiences generally light winds with an average annual wind speed of 2.4 metres per second (m/s). The highest seasonal average wind speeds occur during spring; averaging 2.6 metres per second; here a similar trend to the annual wind direction is observed with winds frequently from the northeast to east northeast and from the south southwest to southwest. During the summer the wind direction is highly variable with winds from the northeast to southwest, with wind speeds averaging 2.5 metres per second. Autumn has the lowest seasonal average wind speed at 2.2 metres per second with winds frequently from the south southwest to southwest. Like autumn, in winter winds commonly come from the southwest. The average wind speed in winter is the same as the annual wind speed.

To use the wind data to assess dispersion, it is also necessary to have available data on atmospheric stability. Atmospheric stability describes the rate at which a plume will disperse, represented by typically six classes; A to F (that is, unstable through to very stable conditions).

For Richmond RAAF, stability classes are calculated for each hour in the 2011 calendar year. **Table 3-2** shows the frequency of occurrence of the stability categories expected in the area. The most common stability class is D class. This suggests that the dispersion conditions are such that dust emissions will disperse rapidly for a significant proportion of the time.

The meteorological conditions are also discussed in terms of dust transport, in **Section 4.1.1** of this report.

Figure 3-1 Annual and seasonal wind-roses (Richmond RAAF AWS, 2011)

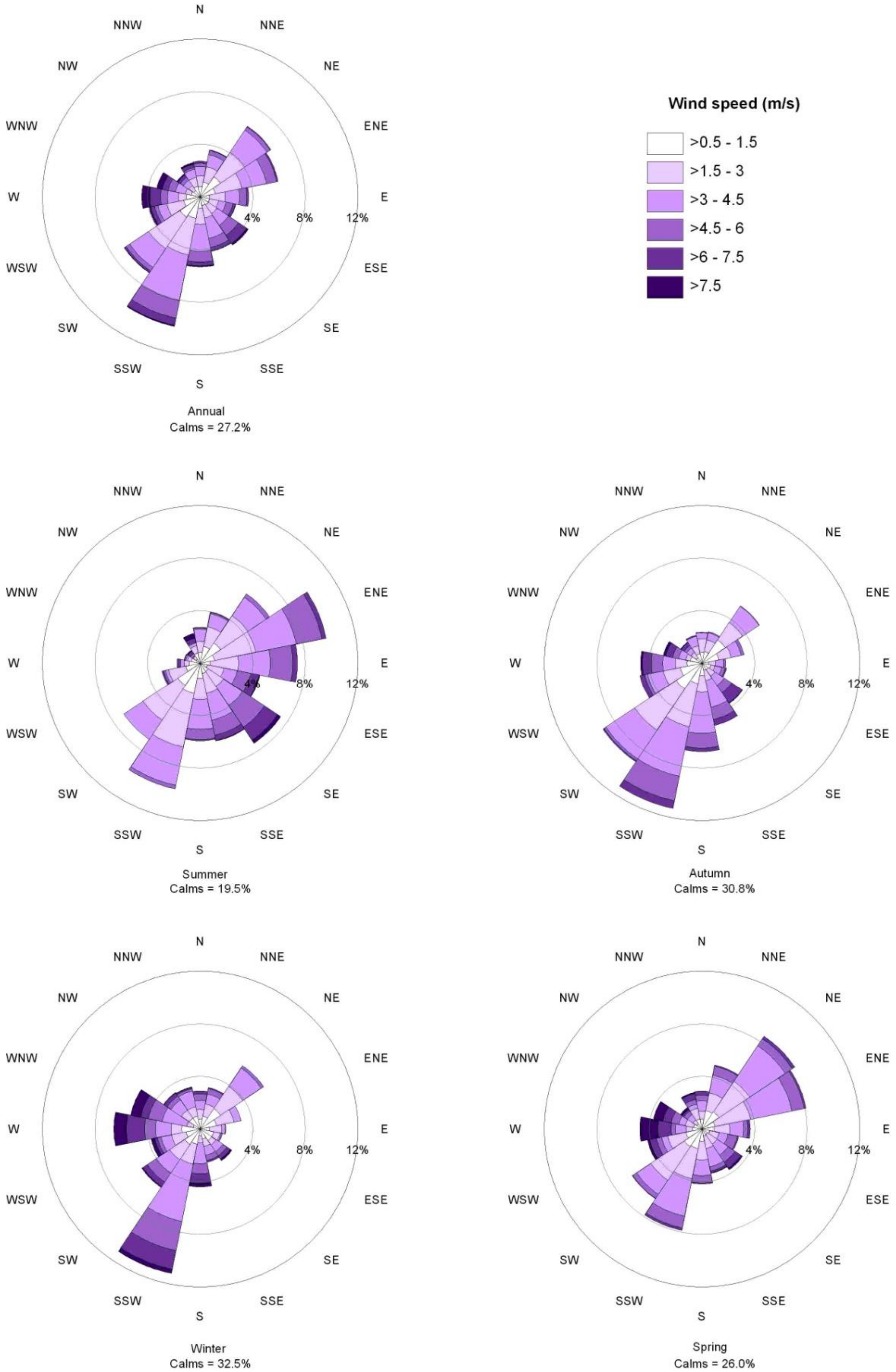


Table 3-2 Frequency of occurrence of stability categories in the area

Stability class	Frequency of occurrence (Richmond RAAF AWS, 2011) (%)
A	16
B	5
C	8
D	38
E	13
F	20
Total	**100**

3.4 Existing Air Quality

The EPA air quality assessment criteria (see **Table 2-2**) refer to pollutant levels which are intended to include the contribution from existing pollutant sources (that is, cumulative). To assess impacts it is therefore necessary to have information on existing pollutant levels in the area in which the proposal would be likely to contribute to these levels.

Air quality monitoring can be used to characterise the existing air quality and to establish “background” levels. No air quality monitoring has been carried out specifically for this project however OEH operate an air quality monitoring station at Richmond located inside the campus of the University of Western Sydney, Hawkesbury. The station measures both PM_{10} (using a tapered element oscillating microbalance) and NO_2 concentrations and is situated in a residential/semi-rural area and air quality data sourced from this location is thought to be representative of the study area. While the Richmond air quality monitoring station does not monitor CO concentrations, 8-hour CO concentrations are recorded at the Prospect OEH Station also located within the northwest Sydney region. Regional air quality data for 2011 is presented in **Table 3-3**. No hourly CO concentration records were available.

The OEH data showed that there were no exceedances of the recorded CO 8-hour average concentration of 10 mg/m^3 with an 8-hour maximum of 1.9 mg/m^3 observed in 2011 (OEH 2011). It has been assumed that the maximum 1-hour concentration is equal to the maximum 8-hour concentration.

Both the maximum 1-hour average and annual average NO2 concentration recorded at Richmond are well below the EPA criteria of 62 µg/m^3 and 246 µg/m^3 respectively (OEH 2011).

The recorded maximum 24-hour PM_{10} concentration was 46 µg/m^3 which is below the EPA criterion of 50 µg/m^3 (OEH 2011). This value was recorded on 22 October 2011 when a series of hazard reduction burns were undertaken across the region resulting in an elevated PM_{10} concentration (NSWRFS 2011). As such the second highest 24-hour PM_{10} concentration recorded in 2011 on 15 March has been adopted at 40 µg/m^3(OEH 2011). The annual average PM_{10} concentration for 2011 is well below the EPA criteria of 30 µg/m^3 (DEC 2005). Additional sources of air pollution emissions may include traffic emissions and agricultural emissions.

Table 3-3 EPA assessment criteria for relevant air pollutants

Pollutant	Averaging time	Recorded concentration	EPA Criteria
CO	Maximum 1-hour average	1.9 mg/m^3	30 mg/m^3
	Maximum 8-hour average	1.9 mg/m^3	10 mg/m^3
NO_2	Maximum 1-hour average	54 µg/m^3	246 µg/m^3
	Annual average	9 µg/m^3	62 µg/m^3
PM_{10}	Maximum 24-hour average	40 µg/m^3	50 µg/m^3
	Annual average	13 µg/m^3	30 µg/m^3

(blank page)

4 Impact assessment

4.1 Construction and demolition

4.1.1 Particulate Matter

Air quality impacts during construction would largely result from dust generated during earthworks and other activities associated with road construction. The total amount of dust generated would depend on the silt and moisture content of the soil, local meteorological conditions, the types of operations being carried out, the size of exposed areas, and the frequency of water spraying and the speed of machinery. Particulate emissions from construction have the potential to affect amenity and, in extreme cases, health.

It is anticipated that construction activities would include:

- Site establishment and preliminary works, including installation of erosion and sediment controls and other pre-construction environmental management measures.
- Archaeological investigations and surveys.
- Removal of vegetation and relocation of utilities, where required.
- Earthworks, and drainage works.
- Haulage of materials, cut and fill.
- Bridge construction including pile driving,
- Construction of road pavement and kerbing.
- Signposting and line marking.
- Landscaping and rehabilitation.
- Demolition of the existing bridge, and other structures within the construction corridor.
- Removal of structures and ancillary facilities.

A range of construction plant and equipment would be required for the above activities. These would typically include excavators, cranes, graders, vibratory rollers, haul trucks, backhoes, bitumen and asphalt spraying plants, line-marking equipment, water carts and bulldozers.

Primary sources of emissions of airborne particulate matter associated with the project may include:

- Clearing of vegetation and topsoil by bulldozers and/or backhoes.
- Excavation and levelling of soil by bulldozers, backhoes and/or excavators.
- Movement of soil and fill by dump trucks and scrapers.
- Wind erosion from unsealed surfaces and stockpiles.
- Wheel generated dust by construction vehicles travelling along unsealed areas.

A total of 12,300 cubic metres of fill material would be required for the construction works. Local fill from the project construction site in the order of 1,500 cubic metres would be reused where possible, although additional imported fill of around 10,800 cubic metres would be required.

There is potential for dust emissions to cause nuisance impacts if activities are located close to sensitive receivers, such as residential dwellings, and local businesses. The magnitude of dust impacts would depend on the amount of earthworks involved at a particular location, the duration of activities, and the local meteorology at the time, particularly wind speed and direction. **Section 3.3** provides a description of local wind patterns. The following paragraph provides the qualitative assessment of potential dust impacts, taking into consideration the local wind patterns and the proximity of work sites to nearby sensitive receivers.

Annually, winds within the study area most commonly occur from the south southwest to southwest and the northeast to east northeast. The annual pattern of winds highlights the potential for adverse dust impacts at sensitive receivers to the northeast and southwest of the site. Some rural properties lay to the northeast but most sensitive receivers are primarily to the southwest and are comprised of mainly commercial properties within the town centre. Construction activities conducted over spring and summer would have the highest potential for observed impacts and sensitive receivers within the town centre due to increased frequency of winds from the northeast. These impacts can be managed and mitigated with suitable dust control measures and practices. These measures are discussed further in **Section 5**.

4.1.2 Hazardous substances

A hazardous materials audit (HMA) has been undertaken on the structure of the existing Windsor Bridge to identify hazardous substances of concern within the existing bridge structure including asbestos and lead based paints. The audit took the form of a visual inspection of the bridge structure and bridge supported services and sampling of suspect building materials. Samples of material suspected of containing asbestos or lead based paint were collected and tested by Envirolab Services Pty Ltd (SKM 2012b).

A representative sample of material suspected of containing asbestos was collected from the gasket/seal from the water main on the underside of the eastern side of the bridge platform (southern end). Asbestos Synthetic Mineral Fibres identification was undertaken by Envirolab Services Pty Ltd using the National Association of Testing Authorities (NATA) accredited Polarised Light Microscopy method (SKM 2012b).

Samples of paint from painted surfaces were collected from metal components of the bridge structure and supported services including the piers, cross bracing, tubular crash rail, a water main, joist girders and kerb anchor strap. All samples were submitted to Envirolab Services Pty Ltd for NATA accredited analysis for lead in paint.

No Asbestos was identified; however lead based paints were detected on the iron piers and cross bracings of the bridge structure. These painted surfaces would need to be managed during demolition of the existing bridge structure. This poses a potential risk of inhalation of fine particles containing lead based paint during demolition.

4.2 Operation

The model predictions of CO, NO_2 and PM_{10} concentrations for the project have been provided as tables in **Section 4.2.1** to **Section 0**. The tables provide the highest contribution of pollutants from motor vehicle emissions and the cumulative impacts when added to the background concentration (refer to **Section 4.2**). Detailed information on the concentration of atmospheric pollutants for each scenario up to a distance of 200 metres from the kerb is presented in **Appendix B**.

Operational impacts discussed in this section relate to traffic volumes, both on the existing road sections based on 2012 traffic data, and traffic flow on the replacement bridge and approach roads in the opening year of 2016 and in 2026. Three sections of road are accounted for including; Bridge Street, Wilberforce Road, Freemans Reach Road.

Operation of the project would not result in increased traffic, and as such no project scenarios for 2012 and 2016 have been assessed. While the project has the potential to improve traffic flow, differences in the dispersion of vehicle emissions between the base case and proposed scenario are considered negligible.

The following points should be noted when reading the operational air quality assessment below:

- Predicted existing pollutant concentration contributions from the highway when added to background concentrations recorded at Richmond are likely to be an over estimation as existing measurements would be inclusive of vehicle emission concentrations.
- For all pollutants assessed, the highest concentrations would be near the kerb and concentrations would decrease with distance from the kerb, due to dispersion.
- Predicted decreases in pollutant concentrations between the existing case and projected scenarios for 2016 and 2026 are likely attributed to assumed reductions in the proportion of older vehicles in the fleet simulating improved vehicle emissions in future years.
- Operational impacts are based on worst case metrological conditions and as such model predictions of CO, NO_2 and PM_{10} are likely to be lower than predicted.

4.2.1 Carbon monoxide (CO)

The predicted maximum 1-hour and 8-hour CO concentrations under each scenario inclusive of background concentrations are included in **Table 4-1**. Maximum 1-hour and 8-hour CO concentrations out to 200 metre from the highway are presented in **Appendix B**.

The dispersion modelling results for the predicted maximum 1-hour CO concentration indicated:

- Existing concentrations at the kerb attributed to roadway emissions were predicted to be 0.8, 0.5 and 0.3 mg/m3 for Bridge Street, Wilberforce Road and Freemans Reach Road respectively.
- Predicted concentrations along the proposed alignment in 2016 and 2026 for all modelled roads were lower than the existing case and when added to the background concentration, were well below the EPA criteria.

The dispersion modelling results for the predicted maximum 8-hour CO concentration indicated:

- Existing concentrations at the kerb attributed to roadway emissions were predicted to be 0.5, 0.4 and 0.2 mg/m3 for Bridge Street, Wilberforce Road and Freemans Reach Road respectively.
- Predicted concentrations along the proposed alignment in 2016 and 2026 for all modelled roads were lower than the existing case and when added to the background concentration were well below the EPA criteria.

Table 4-1 Maximum 1-hour and 8-hour CO concentrations

Year	Averaging Period	Distance from kerb (m)	CO concentration (mg/m^3)			EPA Criteria (mg/m^3)	Assessment
			Due to Roadway	Background	Cumulative		
Bridge Street							
2011	Maximum 1-hour	0	0.8	1.9	2.7	30	Below criterion
	Maximum 8-hour	0	0.5	1.9	2.4	10	Below criterion
2016	Maximum 1-hour	0	0.5	1.9	2.4	30	Below criterion
	Maximum 8-hour	0	0.3	1.9	2.2	10	Below criterion
2026	Maximum 1-hour	0	0.2	1.9	2.1	30	Below criterion
	Maximum 8-hour	0	0.1	1.9	2.0	10	Below criterion
Wilberforce Road Street							
2011	Maximum 1-hour	0	0.5	1.9	2.4	30	Below criterion
	Maximum 8-hour	0	0.4	1.9	2.3	10	Below criterion
2016	Maximum 1-hour	0	0.3	1.9	2.2	30	Below criterion
	Maximum 8-hour	0	0.2	1.9	2.1	10	Below criterion
2026	Maximum 1-hour	0	0.1	1.9	2.0	30	Below criterion
	Maximum 8-hour	0	0.1	1.9	2.0	10	Below criterion
Freemans Reach Road							
2011	Maximum 1-hour	0	0.3	1.9	2.2	30	Below criterion
	Maximum 8-hour	0	0.2	1.9	2.1	10	Below criterion
2016	Maximum 1-hour	0	0.2	1.9	2.1	30	Below criterion
	Maximum 8-hour	0-10	0.1	1.9	2.0	10	Below criterion
2026	Maximum 1-hour	0	0.1	1.9	2.0	30	Below criterion
	Maximum 8-hour	0	0.1	1.9	2.0	10	Below criterion

4.2.2 Nitrogen Dioxide (NO_2)

The predicted maximum 1-hour and annual average NO_2 concentrations under each scenario inclusive of background concentrations are included in **Table 4-2**. Maximum 1-hour and annual average NO_2 concentrations out to 200 metres from the highway are presented in **Appendix B**.

The dispersion modelling results for the predicted maximum 1-hour NO_2 concentration indicated:

- Existing concentrations at the kerb attributed to roadway emissions were predicted to be 44.8, 32.4 and 16.9 $\mu g/m^3$ for Bridge Street, Wilberforce Road and Freemans Reach Road respectively.
- Predicted concentrations along the proposed alignment in 2016 and 2026 for all modelled roads were lower than the existing case and when added to the background concentration, were well below the EPA criteria.

The dispersion modelling results for the predicted annual average NO_2 concentration indicated:

- Existing concentrations at the kerb attributed to roadway emissions were predicted to be 0.5, 0.4 and 0.2 $\mu g/m^3$ for Bridge Street, Wilberforce Road and Freemans Reach Road respectively.

- Predicted concentrations along the proposed alignment in 2016 and 2026 were lower than the existing case and when added to the background concentration, were well below the EPA criteria.

Table 4-2 Maximum 1-hour and annual average NO_2 concentrations

Year	Averaging Period	Distance from kerb (m)	NO_2 concentration (μg/m^3)			EPA Criteria (μg/m^3)	Assessment
			Due to Roadway	Background	Cumulative		
Bride Street							
2011	Maximum 1-hour	0	44.8	54.0	98.8	246	Below criterion
	Annual Average	0	9	9.0	18.0	62	Below criterion
2016	Maximum 1-hour	0	30.9	54.0	84.9	246	Below criterion
	Annual Average	0	6.2	9.0	15.2	62	Below criterion
2026	Maximum 1-hour	0	21.2	54.0	75.2	246	Below criterion
	Annual Average	0	4.2	9.0	13.2	62	Below criterion
Wilberforce Road							
2011	Maximum 1-hour	0	32.4	54.0	86.4	246	Below criterion
	Annual Average	0	6.5	9.0	15.5	62	Below criterion
2016	Maximum 1-hour	0	22.1	54.0	76.1	246	Below criterion
	Annual Average	0	4.4	9.0	13.4	62	Below criterion
2026	Maximum 1-hour	0	15.1	54.0	69.1	246	Below criterion
	Annual Average	0	3	9.0	12.0	62	Below criterion
Freemans Reach Road							
2011	Maximum 1-hour	0	19.6	54.0	73.6	246	Below criterion
	Annual Average	0	3.9	9.0	12.9	62	Below criterion
2016	Maximum 1-hour	0	13.7	54.0	67.7	246	Below criterion
	Annual Average	0	2.7	9.0	11.7	62	Below criterion
2026	Maximum 1-hour	0	9.5	54.0	63.5	246	Below criterion
	Annual Average	0	1.9	9.0	10.9	62	Below criterion

4.2.3 Particulate Matter (PM_{10})

The predicted maximum 24-hour and annual average PM_{10} concentrations under each scenario inclusive of background concentrations are included in **Table 4-3**. Maximum 24-hour and annual average PM_{10} concentrations out to 200 metres from the highway are presented in **Appendix B**.

The dispersion modelling results for the predicted maximum 24-hour PM_{10} concentration indicated:

- Existing concentrations at the kerb attributed to roadway emissions were 16.0, 11.6 and 7.1 μg/m^3 for Bridge Street, Wilberforce Road and Freemans Reach Road respectively.
- Predicted concentrations along the proposed alignment in 2016 and 2026 for all modelled roads are lower than the existing case for PM10 concentrations across both pollutant averaging periods. This is likely to be attributed to assumed reductions in the proportion of older vehicles in the fleet simulating improved vehicle emissions in future years.

- Modelled results for Bridge Street and Wilberforce Road when added to the background concentration of 40 µg/m^3 were found to be in exceedance of the 50 µg/m^3 EPA criterion at the kerb for all scenarios, but fell beneath the air quality goal within 10 metres from the kerb (see **Appendix B**). Considering existing background concentration are inclusive of vehicle emission and traffic volumes are predicted to increase irrespective of project, maximum 24-hour PM_{10} concentrations are expected to comply with the EPA criterion at nearby sensitive receivers.
- Modelled results for Freemans Reach Road predicted no exceedance of the EPA criterion when added to the background concentration for the existing and proposed alignment.

The dispersion modelling results for the predicted annual average PM_{10} concentration indicated:

- For the existing alignment concentration at the kerb attributed to roadway emissions were found to be 6.4, 4.6 and 2.8 µg/m^3 for Bridge Street, Wilberforce Road and Freemans Reach Road respectively.
- Predicted concentrations along the proposed alignment in 2016 and 2026 for all modelled roads were lower than the existing case and when added to the annual average background concentration is below EPA criterion.

Table 4-3 Maximum 24-hour and annual average PM_{10} concentrations

Year	Averaging Period	Distance from kerb (m)	PM_{10} concentration (µg/m^3)			EPA Criteria (µg/m^3)	Assessment
			Due to Roadway	Background	Cumulative		
Bridge Street							
2011	Maximum 24-hour	0	16	40.0	56.0	50	Above criterion
	Annual Average	0	6.4	13.0	19.4	30	Below criterion
2016	Maximum 24-hour	0	14.5	40.0	54.5	50	Above criterion
	Annual Average	0	5.8	13.0	18.8	30	Below criterion
2026	Maximum 24-hour	0	14.9	40.0	54.9	50	Above criterion
	Annual Average	0	5.9	13.0	18.9	30	Below criterion
Wilberforce Road							
2011	Maximum 24-hour	0	11.6	40.0	51.6	50	Above criterion
	Annual Average	0	4.6	13.0	17.6	30	Below criterion
2016	Maximum 24-hour	0	10.3	40.0	50.3	50	Above criterion
	Annual Average	0	4.1	13.0	17.1	30	Below criterion
2026	Maximum 24-hour	0	10.5	40.0	50.5	50	Above criterion
	Annual Average	0	4.2	13.0	17.2	30	Below criterion
Freemans Reach Road							
2011	Maximum 24-hour	0	7.1	40.0	47.1	50	Below criterion
	Annual Average	0	2.8	13.0	15.8	30	Below criterion
2016	Maximum 24-hour	0	6.5	40.0	46.5	50	Below criterion
	Annual Average	0	2.6	13.0	15.6	30	Below criterion
2026	Maximum 24-hour	0	6.8	40.0	46.8	50	Below criterion
	Annual Average	0	2.7	13.0	15.7	30	Below criterion

4.2.4 Regional air quality

The project would provide a new river crossing and intersections that have been designed to achieve a high level of service for road users and to operate efficiently. This would result in less congestion, improved travel times and reduced fuel usage. Overall, there would be a minor reduction in the amount of air pollutants emitted into the regional airshed by vehicles using the project.

(blank page)

5 Environmental management measures

5.1 Construction and demolition measures

5.1.1 Safeguards for particulate matter

Control measures would be included in the construction environmental management plan to ensure that dust emissions are suitably managed such that air quality impacts at nearby sensitive receivers are minimised. Typical dust mitigation measures include:

- Covering of all materials transported to and from the construction site.
- Covering or spraying water on stockpiles of soil or other materials, particularly during dry or windy conditions.
- Suppressing dust on unsealed surfaces, temporary roadways, stockpiles and other exposed areas using water trucks, hand held hoses, temporary vegetation and other practices.
- Imposing speed limits for equipment on unsealed surfaces.
- Locating stockpiles as far away from residences as practically possible.
- Minimising the extent of disturbed areas as far as practicable. This may be achieved by staging the works to minimise the number of disturbed areas at any one time.
- Rehabilitating disturbed areas as quickly as possible.
- Modifying or stopping dust generating activities during very windy conditions.
- Operating and maintaining vehicles and equipment in accordance with manufacturer's specifications.
- Visual monitoring of air quality, near sensitive receivers to verify the effectiveness of controls.
- Installing wheel wash facilities to reduce tracking of mud and soil off-site.
- An environmental complaints register should be established to record any air quality concerns made by the public during demolition and construction works.

5.1.2 Safeguards for hazardous substances

Any demolition of bridge structures containing lead based paints shall be undertaken in accordance with the following (SKM 2012b):

- Australian Standard AS 4361.1 – 1995, Guide to lead paint management, Part 1: Industrial applications
- Australian Standard AS 4361.2 – 1998, Guide to lead paint management, Part 2: Residential and commercial buildings
- Australian Standard AS 2601 – 2001, The demolition of structures.

Specifically the management of lead based paints would require containment of the work area. Containment includes all procedures and systems that prevent dust and debris spreading beyond the immediate work area. Containment includes physical barriers to prevent travel of dust, the exclusion of occupants or the public from the work area, security of the work area and regular cleaning up and disposal of debris. Regardless of which option is chosen to manage the paint, an appropriate degree of containment would need to be installed prior to carrying out the work.

Options for the management of lead based paints during the demolition of the existing bridge structure (based on the respective Australian standards) are as follows SKM (2012b):

- Containment- This option would involve the implementation of a high level of containment to prevent dust and debris spreading beyond the immediate works site during demolition.
- Paint stabilisation – Paint stabilisation would require the existing surfaces to be stabilised with another non-hazardous covering. During both stabilisation and structure removal, a moderate level of containment would be required.
- Paint removal – Paint removal would require the existing painted surfaces to be removed prior to demolition. During paint removal, a high level of containment would be required. Little to no containment would be required to manage the demolition of the structure following removal of the lead based paints.

No asbestos was observed or identified during the site inspection and laboratory analysis (SKM 2012b), however in the event asbestos is discovered, any asbestos work must be carried out in accordance with the 'Guide to the Control of Asbestos Hazards in Buildings and Structure' (NOHSC 1988) and 'Code of Practice for the Safe Removal of Asbestos' (NOHSC 2002). Air quality monitoring would be required if asbestos is discovered in the existing bridge or other areas.

5.2 Operational measures

No air quality control measures are required for operation.

6 Conclusion

6.1 Key findings of the assessment

6.1.1 Construction

There is potential for dust emissions to cause nuisance impacts if activities are located close to sensitive receivers, such as residential dwellings, and local businesses. The magnitude of dust impacts would depend on the amount of earthworks involved at a particular location, the duration of activities, and the local meteorology at the time, particularly wind speed and direction.

The annual pattern of winds highlights the potential for adverse dust impacts at sensitive receivers to the northeast and southwest of the site. Some rural properties lay to the northeast but most sensitive receivers are primarily to the southwest and are comprised of mainly commercial properties within the town centre. Construction activities conducted over spring and summer would have the highest potential for observed impacts and sensitive receivers within the town centre due to increased frequency of winds from the northeast. These impacts can be managed and mitigated with suitable dust control measures and practices.

A hazardous materials audit was undertaken for the structure of the existing Windsor bridge to identify hazardous substances of concern within the existing bridge structure including asbestos and lead based paints. No asbestos was detected, however the iron piers and cross bracings of the bridge structure contain lead based paints. These painted surfaces would need to be managed during demolition of the existing bridge structure. A detailed plan of management which outlines the design and operation of lead based paint containment systems would be required by the project.

6.1.2 Operation

Dispersion modelling of CO, NO_2 and PM_{10} vehicle emissions was undertaken for both the existing road sections based on 2011 traffic data, and traffic flow for the project in 2016 and in 2026. The dispersion modelling was based on worst case meteorological conditions and results for the proposed highway upgrade indicate:

- Predicted concentrations along the proposed alignment in 2016 and 2026 are lower than the existing case for CO, NO_2 and PM_{10} concentrations across all pollutant averaging periods. This is likely to be attributed to assumed reductions in the proportion of older vehicles in the fleet simulating improved vehicle emissions in future years.

- With the exception to predicted maximum 24-hour PM_{10} concentrations predicted pollutant concentrations along Bridge Street and Windsor Road are within the EPA criterion when added to existing background concentrations.

- For Bridge Street and Windsor Road the predicted 2016 and 2026 concentrations of maximum 24-hour PM_{10}, when added to the background concentration indicated exceedences of the maximum 24-hour PM_{10} concentration at the kerb, dissipating to concentrations within the 50µg/m^3 criterion within 10 metres of the highway. Given the conservative nature of this assessment with existing background concentration and inclusive of vehicle emission concentrations and given traffic volumes are predicted to increase irrespective of the project the predicted maximum 24-hour PM_{10} concentrations are likely to be over estimated. As the sensitive receivers about 10 metres from the alignment, the maximum 24-hour PM_{10} would be within the EPA goal.

- All predicted pollutant concentrations along Freemans Reach Road are within the EPA criterion when added to existing background concentrations.

In conclusion temporary dust impacts associated with construction and demolition works are considered minor provided adequate control measures to ensure that dust emissions are suitably managed such that air quality impacts at nearby sensitive receivers are minimised.

No adverse potential air quality impacts are predicted during operation as reductions in the proportion of older vehicles and their replacement with newer vehicles with improved emission standards would result in improved roadside air quality despite increased traffic flows.

7 References

BoM (2012) Climate Data Online, Bureau of Meteorology, Accessed 12 April 2012: http://www.bom.gov.au/climate/averages/maps.shtml

BoM (2011) Meteorological Data for Richmond Automatic Weather Station, Bureau of Meteorology, Sydney, NSW, Australia

DEC (2005) Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in New South Wales. Department of Environment and Conservation: Sydney.

NSWRFS (2011) Hazard Reduction Advisory for 20 October to 28 October, NSW Rural Fire Service, Lidcome, NSW, Australia

OEH (2011) Office of Environment and Heritage Air Quality Data Base, Office of Environment and Heritage, Sydney, NSW, Australia. Accessed 12th April 2012: http://www.environment.nsw.gov.au/AQMS/search.htm

SKM (2012a) Traffic profile calculations for Windsor Bridge, Sinclair Knight Merz, St Leonards, NSW, Australia.

SKM (2012b) Hazardous Materials Audit, Windsor Bridge Replacement, Draft Report, Sinclair Knight Merz, St Leonards, NSW, Australia.

(blank page)

Appendix A – Health effects of air pollutants

A.1 Carbon monoxide (CO)

Carbon monoxide can be harmful to humans because it can reduce the capacity of the blood to transport oxygen. This process is reversible. Symptoms of carbon monoxide intoxication are lethargy and headaches, although these are generally not reported until concentrations in the blood exceed 10% of saturation. There is evidence of risk to individuals with cardiovascular disease at lower concentrations (4% saturation).

A.2 Oxides of nitrogen (NOx)

Oxides of nitrogen emitted by motor vehicles are comprised mainly of nitric oxide (approximately 95%) and nitrogen dioxide (approximately 5%) at the point of emission. Nitric oxide is not generally considered to be harmful to health at the concentrations typically found in urban environments, but can contribute to the formation of photochemical smog. Exposure to high concentrations of nitrogen dioxide can increase the likelihood of respiratory problems, particularly in children with asthma or older people with heart disease.

A.3 Particulate matter (PM)

Airborne particulate matter can be naturally occurring, such as pollen or smoke and soot generated from bushfires, or be the result of human activity, such as motor vehicle or industrial emissions. Particulate matter affects environmental conditions by enhancing chemical reactions in the atmosphere; reducing visibility; increasing the possibility of precipitation, fog and clouds; and reducing solar radiation.

The health effects of particles are largely related to the extent to which they can penetrate the respiratory tract. Larger particles (those greater than 10 μg/m3) generally adhere to the mucus in the noise, mouth, pharynx and larger bronchi and are generally removed by swallowing or expectorating. Particles below 2.5 μm can reach the deepest parts of the respiratory system, where they can only be removed by the body's cellular defence system. Respirable particles have been associated with cardiovascular disease and a wide range of respiratory illnesses (such as asthma and bronchitis)

.

Appendix B – Detailed Results

B.1 Carbon Monoxide (CO)

Table B-1 Maximum 1-hour and 8-hour CO concentrations

Year	Averaging Period	Distance from kerb (m)	CO concentration (mg/m^3) Due to Roadway	Background	Cumulative	EPA Criteria (mg/m^3)	Assessment
Bridge Street							
2011	Maximum 1-hour	0	0.8	1.9	2.7	30	Below criterion
		10	0.3	1.9	2.2	30	Below criterion
		20	0.2	1.9	2.1	30	Below criterion
		30	0.2	1.9	2.1	30	Below criterion
		40	0.1	1.9	2.0	30	Below criterion
		50	0.1	1.9	2.0	30	Below criterion
		75	0.1	1.9	2.0	30	Below criterion
		100	0.1	1.9	2.0	30	Below criterion
		150	0.1	1.9	2.0	30	Below criterion
		200	0.1	1.9	2.0	30	Below criterion
	Maximum 8-hour	0	0.5	1.9	2.4	10	Below criterion
		10	0.2	1.9	2.1	10	Below criterion
		20	0.1	1.9	2.0	10	Below criterion
		30	0.1	1.9	2.0	10	Below criterion
		40	0.1	1.9	2.0	10	Below criterion
		50	0.1	1.9	2.0	10	Below criterion
		75	0.1	1.9	2.0	10	Below criterion
		100	0.1	1.9	2.0	10	Below criterion
		150	0	1.9	1.9	10	Below criterion
		200	0	1.9	1.9	10	Below criterion
2016	Maximum 1-hour	0	0.5	1.9	2.4	30	Below criterion
		10	0.2	1.9	2.1	30	Below criterion
		20	0.1	1.9	2.0	30	Below criterion
		30	0.1	1.9	2.0	30	Below criterion
		40	0.1	1.9	2.0	30	Below criterion
		50	0.1	1.9	2.0	30	Below criterion
		75	0.1	1.9	2.0	30	Below criterion
		100	0.1	1.9	2.0	30	Below criterion
		150	0	1.9	1.9	30	Below criterion
		200	0	1.9	1.9	30	Below criterion
	Maximum 8-hour	0	0.3	1.9	2.2	10	Below criterion
		10	0.1	1.9	2.0	10	Below criterion
		20	0.1	1.9	2.0	10	Below criterion
		30	0.1	1.9	2.0	10	Below criterion
		40	0.1	1.9	2.0	10	Below criterion
		50	0.1	1.9	2.0	10	Below criterion
		75	0	1.9	1.9	10	Below criterion
		100	0	1.9	1.9	10	Below criterion
		150	0	1.9	1.9	10	Below criterion
		200	0	1.9	1.9	10	Below criterion
2026	Maximum 1-hour	0	0.2	1.9	2.1	30	Below criterion
		10	0.1	1.9	2.0	30	Below criterion
		20	0	1.9	1.9	30	Below criterion
		30	0	1.9	1.9	30	Below criterion
		40	0	1.9	1.9	30	Below criterion
		50	0	1.9	1.9	30	Below criterion
		75	0	1.9	1.9	30	Below criterion
		100	0	1.9	1.9	30	Below criterion
		150	0	1.9	1.9	30	Below criterion
		200	0	1.9	1.9	30	Below criterion
	Maximum 8-hour	0	0.1	1.9	2.0	10	Below criterion
		10	0	1.9	1.9	10	Below criterion
		20	0	1.9	1.9	10	Below criterion
		30	0	1.9	1.9	10	Below criterion
		40	0	1.9	1.9	10	Below criterion
		50	0	1.9	1.9	10	Below criterion
		75	0	1.9	1.9	10	Below criterion

Year	Averaging Period	Distance from kerb (m)	CO concentration (mg/m^3) Due to Roadway	Background	Cumulative	EPA Criteria (mg/m^3)	Assessment
		100	0	1.9	1.9	10	Below criterion
		150	0	1.9	1.9	10	Below criterion
		200	0	1.9	1.9	10	Below criterion
Wilberforce Road Street							
2011	Maximum 1-hour	0	0.5	1.9	2.4	30	Below criterion
		10	0.2	1.9	2.1	30	Below criterion
		20	0.2	1.9	2.1	30	Below criterion
		30	0.1	1.9	2.0	30	Below criterion
		40	0.1	1.9	2.0	30	Below criterion
		50	0.1	1.9	2.0	30	Below criterion
		75	0.1	1.9	2.0	30	Below criterion
		100	0.1	1.9	2.0	30	Below criterion
		150	0.1	1.9	2.0	30	Below criterion
		200	0	1.9	1.9	30	Below criterion
	Maximum 8-hour	0	0.4	1.9	2.3	10	Below criterion
		10	0.1	1.9	2.0	10	Below criterion
		20	0.1	1.9	2.0	10	Below criterion
		30	0.1	1.9	2.0	10	Below criterion
		40	0.1	1.9	2.0	10	Below criterion
		50	0.1	1.9	2.0	10	Below criterion
		75	0.1	1.9	2.0	10	Below criterion
		100	0	1.9	1.9	10	Below criterion
		150	0	1.9	1.9	10	Below criterion
		200	0	1.9	1.9	10	Below criterion
2016	Maximum 1-hour	0	0.3	1.9	2.2	30	Below criterion
		10	0.1	1.9	2.0	30	Below criterion
		20	0.1	1.9	2.0	30	Below criterion
		30	0.1	1.9	2.0	30	Below criterion
		40	0.1	1.9	2.0	30	Below criterion
		50	0.1	1.9	2.0	30	Below criterion
		75	0	1.9	1.9	30	Below criterion
		100	0	1.9	1.9	30	Below criterion
		150	0	1.9	1.9	30	Below criterion
		200	0	1.9	1.9	30	Below criterion
	Maximum 8-hour	0	0.2	1.9	2.1	10	Below criterion
		10	0.1	1.9	2.0	10	Below criterion
		20	0.1	1.9	2.0	10	Below criterion
		30	0.1	1.9	2.0	10	Below criterion
		40	0	1.9	1.9	10	Below criterion
		50	0	1.9	1.9	10	Below criterion
		75	0	1.9	1.9	10	Below criterion
		100	0	1.9	1.9	10	Below criterion
		150	0	1.9	1.9	10	Below criterion
		200	0	1.9	1.9	10	Below criterion
2026	Maximum 1-hour	0	0.1	1.9	2.0	30	Below criterion
		10	0	1.9	1.9	30	Below criterion
		20	0	1.9	1.9	30	Below criterion
		30	0	1.9	1.9	30	Below criterion
		40	0	1.9	1.9	30	Below criterion
		50	0	1.9	1.9	30	Below criterion
		75	0	1.9	1.9	30	Below criterion
		100	0	1.9	1.9	30	Below criterion
		150	0	1.9	1.9	30	Below criterion
		200	0	1.9	1.9	30	Below criterion
	Maximum 8-hour	0	0.1	1.9	2.0	10	Below criterion
		10	0.1	1.9	2.0	10	Below criterion
		20	0	1.9	1.9	10	Below criterion
		30	0	1.9	1.9	10	Below criterion
		40	0	1.9	1.9	10	Below criterion
		50	0	1.9	1.9	10	Below criterion
		75	0	1.9	1.9	10	Below criterion
		100	0	1.9	1.9	10	Below criterion
		150	0	1.9	1.9	10	Below criterion
		200	0	1.9	1.9	10	Below criterion

Year	Averaging Period	Distance from kerb (m)	CO concentration (mg/m³)			EPA Criteria (mg/m³)	Assessment
			Due to Roadway	Background	Cumulative		
Freemans Reach Road							
2011	Maximum 1-hour	0	0.3	1.9	2.2	30	Below criterion
		10	0.1	1.9	2.0	30	Below criterion
		20	0.1	1.9	2.0	30	Below criterion
		30	0.1	1.9	2.0	30	Below criterion
		40	0.1	1.9	2.0	30	Below criterion
		50	0.1	1.9	2.0	30	Below criterion
		75	0	1.9	1.9	30	Below criterion
		100	0	1.9	1.9	30	Below criterion
		150	0	1.9	1.9	30	Below criterion
		200	0	1.9	1.9	30	Below criterion
	Maximum 8-hour	0	0.2	1.9	2.1	10	Below criterion
		10	0.1	1.9	2.0	10	Below criterion
		20	0.1	1.9	2.0	10	Below criterion
		30	0.1	1.9	2.0	10	Below criterion
		40	0	1.9	1.9	10	Below criterion
		50	0	1.9	1.9	10	Below criterion
		75	0	1.9	1.9	10	Below criterion
		100	0	1.9	1.9	10	Below criterion
		150	0	1.9	1.9	10	Below criterion
		200	0	1.9	1.9	10	Below criterion
2016	Maximum 1-hour	0	0.2	1.9	2.1	30	Below criterion
		10	0.1	1.9	2.0	30	Below criterion
		20	0.1	1.9	2.0	30	Below criterion
		30	0	1.9	1.9	30	Below criterion
		40	0	1.9	1.9	30	Below criterion
		50	0	1.9	1.9	30	Below criterion
		75	0	1.9	1.9	30	Below criterion
		100	0	1.9	1.9	30	Below criterion
		150	0	1.9	1.9	30	Below criterion
		200	0	1.9	1.9	30	Below criterion
	Maximum 8-hour	0	0.1	1.9	2.0	10	Below criterion
		10	0.1	1.9	2.0	10	Below criterion
		20	0	1.9	1.9	10	Below criterion
		30	0	1.9	1.9	10	Below criterion
		40	0	1.9	1.9	10	Below criterion
		50	0	1.9	1.9	10	Below criterion
		75	0	1.9	1.9	10	Below criterion
		100	0	1.9	1.9	10	Below criterion
		150	0	1.9	1.9	10	Below criterion
		200	0	1.9	1.9	10	Below criterion
2026	Maximum 1-hour	0	0.1	1.9	2.0	30	Below criterion
		10	0	1.9	1.9	30	Below criterion
		20	0	1.9	1.9	30	Below criterion
		30	0	1.9	1.9	30	Below criterion
		40	0	1.9	1.9	30	Below criterion
		50	0	1.9	1.9	30	Below criterion
		75	0	1.9	1.9	30	Below criterion
		100	0	1.9	1.9	30	Below criterion
		150	0	1.9	1.9	30	Below criterion
		200	0	1.9	1.9	30	Below criterion
	Maximum 8-hour	0	0.1	1.9	2.0	10	Below criterion
		10	0	1.9	1.9	10	Below criterion
		20	0	1.9	1.9	10	Below criterion
		30	0	1.9	1.9	10	Below criterion
		40	0	1.9	1.9	10	Below criterion
		50	0	1.9	1.9	10	Below criterion
		75	0	1.9	1.9	10	Below criterion
		100	0	1.9	1.9	10	Below criterion
		150	0	1.9	1.9	10	Below criterion
		200	0	1.9	1.9	10	Below criterion

B.2 Nitrogen Dioxide (NO2)

Table B-2 Maximum 1-hour and annual average NO2 concentrations

Year	Averaging Period	Distance from kerb (m)	NO_2 concentration (µg/m^3)			EPA Criteria (µg/m^3)	Assessment
			Due to Roadway	Background	Cumulative		
Bride Street							
2011	Maximum 1-hour	0	44.8	54.0	98.8	246	Below criterion
		10	26.1	54.0	80.1	246	Below criterion
		20	24.6	54.0	78.6	246	Below criterion
		30	20.1	54.0	74.1	246	Below criterion
		40	17.3	54.0	71.3	246	Below criterion
		50	15.4	54.0	69.4	246	Below criterion
		75	12.4	54.0	66.4	246	Below criterion
		100	10.5	54.0	64.5	246	Below criterion
		150	8.3	54.0	62.3	246	Below criterion
		200	6.8	54.0	60.8	246	Below criterion
	Annual Average	0	9	9.0	18.0	62	Below criterion
		10	5.2	9.0	14.2	62	Below criterion
		20	4.9	9.0	13.9	62	Below criterion
		30	4	9.0	13.0	62	Below criterion
		40	3.5	9.0	12.5	62	Below criterion
		50	3.1	9.0	12.1	62	Below criterion
		75	2.5	9.0	11.5	62	Below criterion
		100	2.1	9.0	11.1	62	Below criterion
		150	1.7	9.0	10.7	62	Below criterion
		200	1.4	9.0	10.4	62	Below criterion
2016	Maximum 1-hour	0	30.9	54.0	84.9	246	Below criterion
		10	17.9	54.0	71.9	246	Below criterion
		20	16.8	54.0	70.8	246	Below criterion
		30	13.7	54.0	67.7	246	Below criterion
		40	11.9	54.0	65.9	246	Below criterion
		50	10.5	54.0	64.5	246	Below criterion
		75	8.5	54.0	62.5	246	Below criterion
		100	7.2	54.0	61.2	246	Below criterion
		150	5.7	54.0	59.7	246	Below criterion
		200	4.7	54.0	58.7	246	Below criterion
	Annual Average	0	6.2	9.0	15.2	62	Below criterion
		10	3.6	9.0	12.6	62	Below criterion
		20	3.4	9.0	12.4	62	Below criterion
		30	2.7	9.0	11.7	62	Below criterion
		40	2.4	9.0	11.4	62	Below criterion
		50	2.1	9.0	11.1	62	Below criterion
		75	1.7	9.0	10.7	62	Below criterion
		100	1.4	9.0	10.4	62	Below criterion
		150	1.1	9.0	10.1	62	Below criterion
		200	0.9	9.0	9.9	62	Below criterion
2026	Maximum 1-hour	0	21.2	54.0	75.2	246	Below criterion
		10	12.1	54.0	66.1	246	Below criterion
		20	11.4	54.0	65.4	246	Below criterion
		30	9.3	54.0	63.3	246	Below criterion
		40	8	54.0	62.0	246	Below criterion
		50	7.2	54.0	61.2	246	Below criterion
		75	5.8	54.0	59.8	246	Below criterion
		100	4.9	54.0	58.9	246	Below criterion
		150	3.9	54.0	57.9	246	Below criterion
		200	3.2	54.0	57.2	246	Below criterion
	Annual Average	0	4.2	9.0	13.2	62	Below criterion
		10	2.4	9.0	11.4	62	Below criterion
		20	2.3	9.0	11.3	62	Below criterion
		30	1.9	9.0	10.9	62	Below criterion
		40	1.6	9.0	10.6	62	Below criterion
		50	1.4	9.0	10.4	62	Below criterion
		75	1.2	9.0	10.2	62	Below criterion
		100	1	9.0	10.0	62	Below criterion
		150	0.8	9.0	9.8	62	Below criterion
		200	0.6	9.0	9.6	62	Below criterion

Year	Averaging Period	Distance from kerb (m)	NO$_2$ concentration (µg/m^3)			EPA Criteria (µg/m^3)	Assessment
			Due to Roadway	Background	Cumulative		
Wilberforce Road							
2011	Maximum 1-hour	0	32.4	54.0	86.4	246	Below criterion
		10	19.2	54.0	73.2	246	Below criterion
		20	18.2	54.0	72.2	246	Below criterion
		30	14.8	54.0	68.8	246	Below criterion
		40	12.8	54.0	66.8	246	Below criterion
		50	11.3	54.0	65.3	246	Below criterion
		75	9.1	54.0	63.1	246	Below criterion
		100	7.7	54.0	61.7	246	Below criterion
		150	6.1	54.0	60.1	246	Below criterion
		200	5	54.0	59.0	246	Below criterion
	Annual Average	0	6.5	9.0	15.5	62	Below criterion
		10	3.8	9.0	12.8	62	Below criterion
		20	3.6	9.0	12.6	62	Below criterion
		30	3	9.0	12.0	62	Below criterion
		40	2.6	9.0	11.6	62	Below criterion
		50	2.3	9.0	11.3	62	Below criterion
		75	1.8	9.0	10.8	62	Below criterion
		100	1.5	9.0	10.5	62	Below criterion
		150	1.2	9.0	10.2	62	Below criterion
		200	1	9.0	10.0	62	Below criterion
2016	Maximum 1-hour	0	22.1	54.0	76.1	246	Below criterion
		10	13.1	54.0	67.1	246	Below criterion
		20	12.3	54.0	66.3	246	Below criterion
		30	10.1	54.0	64.1	246	Below criterion
		40	8.7	54.0	62.7	246	Below criterion
		50	7.7	54.0	61.7	246	Below criterion
		75	6.2	54.0	60.2	246	Below criterion
		100	5.3	54.0	59.3	246	Below criterion
		150	4.1	54.0	58.1	246	Below criterion
		200	3.4	54.0	57.4	246	Below criterion
	Annual Average	0	4.4	9.0	13.4	62	Below criterion
		10	2.6	9.0	11.6	62	Below criterion
		20	2.5	9.0	11.5	62	Below criterion
		30	2	9.0	11.0	62	Below criterion
		40	1.7	9.0	10.7	62	Below criterion
		50	1.5	9.0	10.5	62	Below criterion
		75	1.2	9.0	10.2	62	Below criterion
		100	1.1	9.0	10.1	62	Below criterion
		150	0.8	9.0	9.8	62	Below criterion
		200	0.7	9.0	9.7	62	Below criterion
2026	Maximum 1-hour	0	15.1	54.0	69.1	246	Below criterion
		10	8.9	54.0	62.9	246	Below criterion
		20	8.4	54.0	62.4	246	Below criterion
		30	6.8	54.0	60.8	246	Below criterion
		40	5.9	54.0	59.9	246	Below criterion
		50	5.2	54.0	59.2	246	Below criterion
		75	4.2	54.0	58.2	246	Below criterion
		100	3.6	54.0	57.6	246	Below criterion
		150	2.8	54.0	56.8	246	Below criterion
		200	2.3	54.0	56.3	246	Below criterion
	Annual Average	0	3	9.0	12.0	62	Below criterion
		10	1.8	9.0	10.8	62	Below criterion
		20	1.7	9.0	10.7	62	Below criterion
		30	1.4	9.0	10.4	62	Below criterion
		40	1.2	9.0	10.2	62	Below criterion
		50	1	9.0	10.0	62	Below criterion
		75	0.8	9.0	9.8	62	Below criterion
		100	0.7	9.0	9.7	62	Below criterion
		150	0.6	9.0	9.6	62	Below criterion
		200	0.5	9.0	9.5	62	Below criterion
Freemans Reach Road							
2011	Maximum 1-hour	0	19.6	54.0	73.6	246	Below criterion
		10	12	54.0	66.0	246	Below criterion
		20	11.4	54.0	65.4	246	Below criterion
		30	9.3	54.0	63.3	246	Below criterion

Year	Averaging Period	Distance from kerb (m)	NO_2 concentration (µg/m^3) Due to Roadway	Background	Cumulative	EPA Criteria (µg/m^3)	Assessment
		40	8	54.0	62.0	246	Below criterion
		50	7.1	54.0	61.1	246	Below criterion
		75	5.7	54.0	59.7	246	Below criterion
		100	4.8	54.0	58.8	246	Below criterion
		150	3.7	54.0	57.7	246	Below criterion
		200	3.1	54.0	57.1	246	Below criterion
	Annual Average	0	3.9	9.0	12.9	62	Below criterion
		10	2.4	9.0	11.4	62	Below criterion
		20	2.3	9.0	11.3	62	Below criterion
		30	1.9	9.0	10.9	62	Below criterion
		40	1.6	9.0	10.6	62	Below criterion
		50	1.4	9.0	10.4	62	Below criterion
		75	1.1	9.0	10.1	62	Below criterion
		100	1	9.0	10.0	62	Below criterion
		150	0.7	9.0	9.7	62	Below criterion
		200	0.6	9.0	9.6	62	Below criterion
2016	Maximum 1-hour	0	13.7	54.0	67.7	246	Below criterion
		10	8.3	54.0	62.3	246	Below criterion
		20	7.9	54.0	61.9	246	Below criterion
		30	6.4	54.0	60.4	246	Below criterion
		40	5.5	54.0	59.5	246	Below criterion
		50	4.9	54.0	58.9	246	Below criterion
		75	3.9	54.0	57.9	246	Below criterion
		100	3.3	54.0	57.3	246	Below criterion
		150	2.6	54.0	56.6	246	Below criterion
		200	2.1	54.0	56.1	246	Below criterion
	Annual Average	0	2.7	9.0	11.7	62	Below criterion
		10	1.7	9.0	10.7	62	Below criterion
		20	1.6	9.0	10.6	62	Below criterion
		30	1.3	9.0	10.3	62	Below criterion
		40	1.1	9.0	10.1	62	Below criterion
		50	1	9.0	10.0	62	Below criterion
		75	0.8	9.0	9.8	62	Below criterion
		100	0.7	9.0	9.7	62	Below criterion
		150	0.5	9.0	9.5	62	Below criterion
		200	0.4	9.0	9.4	62	Below criterion
2026	Maximum 1-hour	0	9.5	54.0	63.5	246	Below criterion
		10	5.7	54.0	59.7	246	Below criterion
		20	5.4	54.0	59.4	246	Below criterion
		30	4.4	54.0	58.4	246	Below criterion
		40	3.8	54.0	57.8	246	Below criterion
		50	3.4	54.0	57.4	246	Below criterion
		75	2.7	54.0	56.7	246	Below criterion
		100	2.3	54.0	56.3	246	Below criterion
		150	1.8	54.0	55.8	246	Below criterion
		200	1.5	54.0	55.5	246	Below criterion
	Annual Average	0	1.9	9.0	10.9	62	Below criterion
		10	1.1	9.0	10.1	62	Below criterion
		20	1.1	9.0	10.1	62	Below criterion
		30	0.9	9.0	9.9	62	Below criterion
		40	0.8	9.0	9.8	62	Below criterion
		50	0.7	9.0	9.7	62	Below criterion
		75	0.5	9.0	9.5	62	Below criterion
		100	0.5	9.0	9.5	62	Below criterion
		150	0.4	9.0	9.4	62	Below criterion
		200	0.3	9.0	9.3	62	Below criterion

B.3 Particulate Matter (PM_{10})

Table B-3 Maximum 24-hour and annual average PM10 concentrations

Year	Averaging Period	Distance from kerb (m)	PM_{10} concentration (µg/m³)			EPA Criteria (µg/m³)	Assessment
			Due to Roadway	Background	Cumulative		
Bridge Street							
2011	Maximum 24-hour	0	16	40.0	56.0	50	Non-Below criterion
		10	6.2	40.0	46.2	50	Below criterion
		20	4.4	40.0	44.4	50	Below criterion
		30	3.6	40.0	43.6	50	Below criterion
		40	3.1	40.0	43.1	50	Below criterion
		50	2.8	40.0	42.8	50	Below criterion
		75	2.2	40.0	42.2	50	Below criterion
		100	1.9	40.0	41.9	50	Below criterion
		150	1.5	40.0	41.5	50	Below criterion
		200	1.2	40.0	41.2	50	Below criterion
	Annual Average	0	6.4	13.0	19.4	30	Below criterion
		10	2.5	13.0	15.5	30	Below criterion
		20	1.8	13.0	14.8	30	Below criterion
		30	1.4	13.0	14.4	30	Below criterion
		40	1.2	13.0	14.2	30	Below criterion
		50	1.1	13.0	14.1	30	Below criterion
		75	0.9	13.0	13.9	30	Below criterion
		100	0.8	13.0	13.8	30	Below criterion
		150	0.6	13.0	13.6	30	Below criterion
		200	0.5	13.0	13.5	30	Below criterion
2016	Maximum 24-hour	0	14.5	40.0	54.5	50	Non-Below criterion
		10	5.6	40.0	45.6	50	Below criterion
		20	3.9	40.0	43.9	50	Below criterion
		30	3.2	40.0	43.2	50	Below criterion
		40	2.8	40.0	42.8	50	Below criterion
		50	2.5	40.0	42.5	50	Below criterion
		75	2	40.0	42.0	50	Below criterion
		100	1.7	40.0	41.7	50	Below criterion
		150	1.3	40.0	41.3	50	Below criterion
		200	14.5	40.0	54.5	50	Non-Below criterion
	Annual Average	0	5.8	13.0	18.8	30	Below criterion
		10	2.2	13.0	15.2	30	Below criterion
		20	1.6	13.0	14.6	30	Below criterion
		30	1.3	13.0	14.3	30	Below criterion
		40	1.1	13.0	14.1	30	Below criterion
		50	1	13.0	14.0	30	Below criterion
		75	0.8	13.0	13.8	30	Below criterion
		100	0.7	13.0	13.7	30	Below criterion
		150	0.5	13.0	13.5	30	Below criterion
		200	1.1	40.0	41.1	50	Below criterion
2026	Maximum 24-hour	0	14.9	40.0	54.9	50	Non-Below criterion
		10	5.7	40.0	45.7	50	Below criterion
		20	4	40.0	44.0	50	Below criterion
		30	3.3	40.0	43.3	50	Below criterion
		40	2.8	40.0	42.8	50	Below criterion
		50	2.5	40.0	42.5	50	Below criterion
		75	2	40.0	42.0	50	Below criterion
		100	1.7	40.0	41.7	50	Below criterion
		150	1.4	40.0	41.4	50	Below criterion
		200	1.1	40.0	41.1	50	Below criterion
	Annual Average	0	5.9	13.0	18.9	30	Below criterion
		10	2.3	13.0	15.3	30	Below criterion
		20	1.6	13.0	14.6	30	Below criterion
		30	1.3	13.0	14.3	30	Below criterion
		40	1.1	13.0	14.1	30	Below criterion
		50	1	13.0	14.0	30	Below criterion
		75	0.8	13.0	13.8	30	Below criterion
		100	0.7	13.0	13.7	30	Below criterion
		150	0.5	13.0	13.5	30	Below criterion
		200	0.4	13.0	13.4	30	Below criterion

Year	Averaging Period	Distance from kerb (m)	PM10 concentration (µg/m³) Due to Roadway	Background	Cumulative	EPA Criteria (µg/m³)	Assessment
Wilberforce Road							
2011	Maximum 24-hour	0	11.6	40.0	51.6	50	Above criterion
		10	4.6	40.0	44.6	50	Below criterion
		20	3.2	40.0	43.2	50	Below criterion
		30	2.6	40.0	42.6	50	Below criterion
		40	2.3	40.0	42.3	50	Below criterion
		50	2	40.0	42.0	50	Below criterion
		75	1.6	40.0	41.6	50	Below criterion
		100	1.4	40.0	41.4	50	Below criterion
		150	1.1	40.0	41.1	50	Below criterion
		200	0.9	40.0	40.9	50	Below criterion
	Annual Average	0	4.6	13.0	17.6	30	Below criterion
		10	1.8	13.0	14.8	30	Below criterion
		20	1.3	13.0	14.3	30	Below criterion
		30	1.1	13.0	14.1	30	Below criterion
		40	0.9	13.0	13.9	30	Below criterion
		50	0.8	13.0	13.8	30	Below criterion
		75	0.6	13.0	13.6	30	Below criterion
		100	0.6	13.0	13.6	30	Below criterion
		150	0.4	13.0	13.4	30	Below criterion
		200	0.4	13.0	13.4	30	Below criterion
2016	Maximum 24-hour	0	10.3	40.0	50.3	50	Above criterion
		10	4.1	40.0	44.1	50	Below criterion
		20	2.9	40.0	42.9	50	Below criterion
		30	2.4	40.0	42.4	50	Below criterion
		40	2	40.0	42.0	50	Below criterion
		50	1.8	40.0	41.8	50	Below criterion
		75	1.4	40.0	41.4	50	Below criterion
		100	1.2	40.0	41.2	50	Below criterion
		150	1	40.0	41.0	50	Below criterion
		200	0.8	40.0	40.8	50	Below criterion
	Annual Average	0	4.1	13.0	17.1	30	Below criterion
		10	1.6	13.0	14.6	30	Below criterion
		20	1.2	13.0	14.2	30	Below criterion
		30	0.9	13.0	13.9	30	Below criterion
		40	0.8	13.0	13.8	30	Below criterion
		50	0.7	13.0	13.7	30	Below criterion
		75	0.6	13.0	13.6	30	Below criterion
		100	0.5	13.0	13.5	30	Below criterion
		150	0.4	13.0	13.4	30	Below criterion
		200	0.3	13.0	13.3	30	Below criterion
2026	Maximum 24-hour	0	10.5	40.0	50.5	50	Above criterion
		10	4.1	40.0	44.1	50	Below criterion
		20	2.9	40.0	42.9	50	Below criterion
		30	2.4	40.0	42.4	50	Below criterion
		40	2.1	40.0	42.1	50	Below criterion
		50	1.8	40.0	41.8	50	Below criterion
		75	1.5	40.0	41.5	50	Below criterion
		100	1.2	40.0	41.2	50	Below criterion
		150	1	40.0	41.0	50	Below criterion
		200	0.8	40.0	40.8	50	Below criterion
	Annual Average	0	4.2	13.0	17.2	30	Below criterion
		10	1.7	13.0	14.7	30	Below criterion
		20	1.2	13.0	14.2	30	Below criterion
		30	1	13.0	14.0	30	Below criterion
		40	0.8	13.0	13.8	30	Below criterion
		50	0.7	13.0	13.7	30	Below criterion
		75	0.6	13.0	13.6	30	Below criterion
		100	0.5	13.0	13.5	30	Below criterion
		150	0.4	13.0	13.4	30	Below criterion
		200	0.3	13.0	13.3	30	Below criterion

Year	Averaging Period	Distance from kerb (m)	PM10 concentration (µg/m³) Due to Roadway	Background	Cumulative	EPA Criteria (µg/m³)	Assessment
			Freemans Reach Road				
2011	Maximum 24-hour	0	7.1	40.0	47.1	50	Below criterion
		10	2.9	40.0	42.9	50	Below criterion
		20	2	40.0	42.0	50	Below criterion
		30	1.7	40.0	41.7	50	Below criterion
		40	1.4	40.0	41.4	50	Below criterion
		50	1.3	40.0	41.3	50	Below criterion
		75	1	40.0	41.0	50	Below criterion
		100	0.9	40.0	40.9	50	Below criterion
		150	0.7	40.0	40.7	50	Below criterion
		200	0.5	40.0	40.5	50	Below criterion
	Annual Average	0	2.8	13.0	15.8	30	Below criterion
		10	1.2	13.0	14.2	30	Below criterion
		20	0.8	13.0	13.8	30	Below criterion
		30	0.7	13.0	13.7	30	Below criterion
		40	0.6	13.0	13.6	30	Below criterion
		50	0.5	13.0	13.5	30	Below criterion
		75	0.4	13.0	13.4	30	Below criterion
		100	0.3	13.0	13.3	30	Below criterion
		150	0.3	13.0	13.3	30	Below criterion
		200	0.2	13.0	13.2	30	Below criterion
2016	Maximum 24-hour	0	6.5	40.0	46.5	50	Below criterion
		10	2.6	40.0	42.6	50	Below criterion
		20	1.9	40.0	41.9	50	Below criterion
		30	1.5	40.0	41.5	50	Below criterion
		40	1.3	40.0	41.3	50	Below criterion
		50	1.2	40.0	41.2	50	Below criterion
		75	0.9	40.0	40.9	50	Below criterion
		100	0.8	40.0	40.8	50	Below criterion
		150	0.6	40.0	40.6	50	Below criterion
		200	0.5	40.0	40.5	50	Below criterion
	Annual Average	0	2.6	13.0	15.6	30	Below criterion
		10	1	13.0	14.0	30	Below criterion
		20	0.7	13.0	13.7	30	Below criterion
		30	0.6	13.0	13.6	30	Below criterion
		40	0.5	13.0	13.5	30	Below criterion
		50	0.5	13.0	13.5	30	Below criterion
		75	0.4	13.0	13.4	30	Below criterion
		100	0.3	13.0	13.3	30	Below criterion
		150	0.2	13.0	13.2	30	Below criterion
		200	0.2	13.0	13.2	30	Below criterion
2026	Maximum 24-hour	0	6.8	40.0	46.8	50	Below criterion
		10	2.7	40.0	42.7	50	Below criterion
		20	1.9	40.0	41.9	50	Below criterion
		30	1.6	40.0	41.6	50	Below criterion
		40	1.4	40.0	41.4	50	Below criterion
		50	1.2	40.0	41.2	50	Below criterion
		75	1	40.0	41.0	50	Below criterion
		100	0.8	40.0	40.8	50	Below criterion
		150	0.6	40.0	40.6	50	Below criterion
		200	0.5	40.0	40.5	50	Below criterion
	Annual Average	0	2.7	13.0	15.7	30	Below criterion
		10	1.1	13.0	14.1	30	Below criterion
		20	0.8	13.0	13.8	30	Below criterion
		30	0.6	13.0	13.6	30	Below criterion
		40	0.5	13.0	13.5	30	Below criterion
		50	0.5	13.0	13.5	30	Below criterion
		75	0.4	13.0	13.4	30	Below criterion
		100	0.3	13.0	13.3	30	Below criterion
		150	0.3	13.0	13.3	30	Below criterion
		200	0.2	13.0	13.2	30	Below criterion