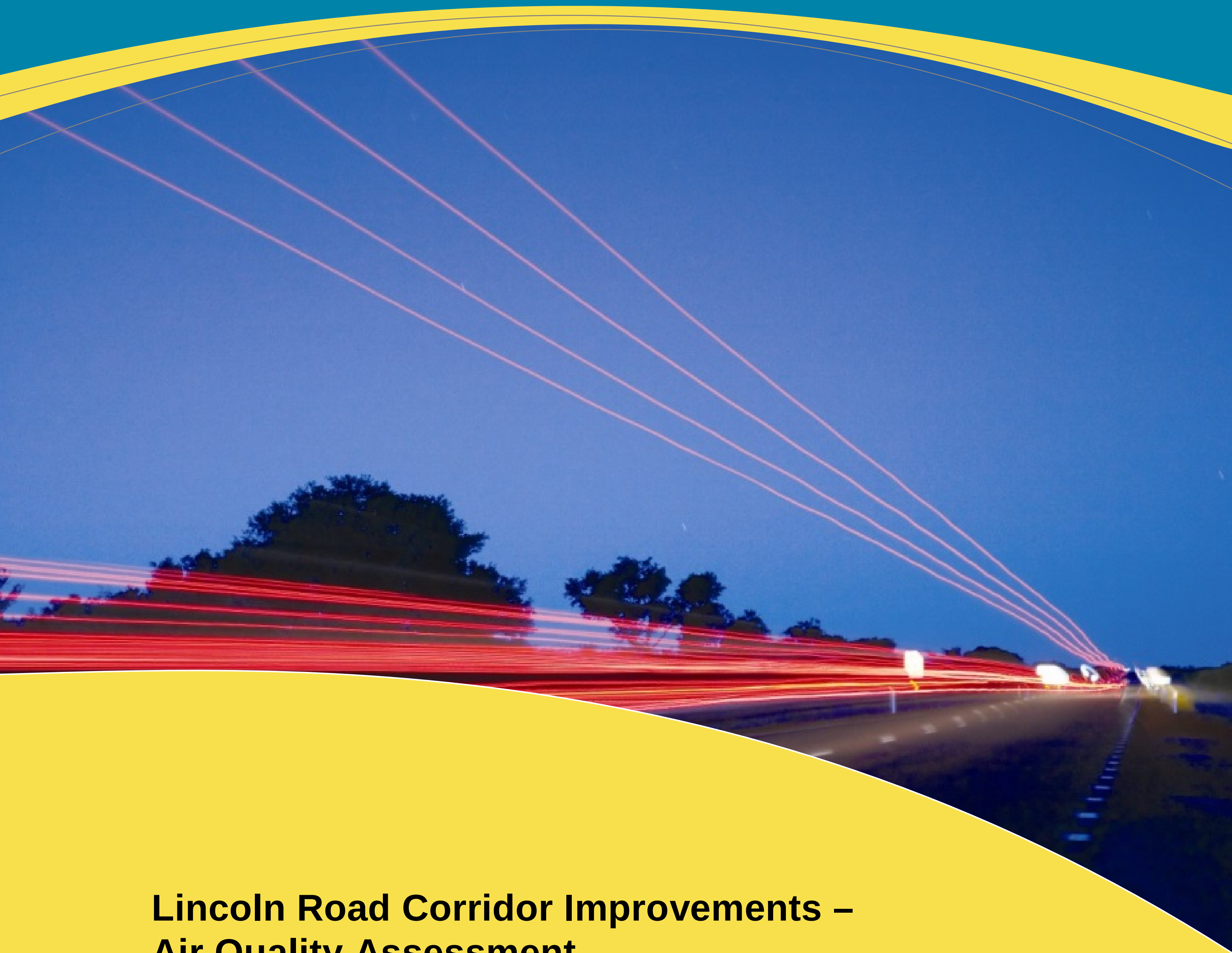

Lincoln Road Corridor Improvements – Air Quality Assessment

Prepared for Auckland Transport

31/05/2016

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REVISION SCHEDULE

Rev No	Date	Description	Signature or Typed Name (documentation on file).			
			Prepared by	Checked by	Reviewed by	Approved by
R001a	15/12/2015	Comments on report	DB	PH	GS	GS
R001b	10/03/2016	Comments on report	DB	PH	GS	GS
R001c	31/05/2016	Final report	DB	PH	GS	GS

Executive Summary

Auckland Transport (AT) commissioned MWH New Zealand Limited (MWH) to undertake a screening-level assessment of the potential construction-phase and operational-phase air quality effects that may arise as a result of the Lincoln Road Corridor Improvements (LRCI) project located in Henderson, Auckland.

In this report, the potential construction phase dust impacts have been assessed on a qualitative basis. It is considered that in the absence of appropriate mitigation, there is the potential for *slight* to *negligible* dust nuisance effects to occur at sensitive receptors located in close proximity to the construction compounds and construction works. However, with the implementation of a Dust Management Plan (or wider Environmental/Construction Management Plan), potential construction phase dust emissions (including odour and/or hazardous air pollutants) are likely to be effectively controlled and the potential for dust nuisance effects will be greatly reduced. It is recommended that a condition be imposed requiring a Dust Management Plan that includes the mitigation measures identified in this report. It is also recommended that a programme of dust monitoring is carried out before, during and after the construction phase in order to quantitatively assess the ambient concentrations of particulate matter in the vicinity of the construction compounds and construction works. This monitoring requirement would be appropriate to include as a condition of the designation.

Providing that the mitigation measures are adopted into a site Dust Management Plan and are adhered to at all times during the construction phase, the Auckland Council's permitted activity standards for dust in the operative Auckland Council Regional Plan: Air, Land and Water and the equivalent controls in the Proposed Auckland Unitary Plan (PAUP) are likely to be met.

The operational phase road traffic emissions that will be generated along the Lincoln Road corridor have been assessed on a quantitative basis using a screening modelling assessment. Based on incremental analysis of the predicted opening year concentrations minus the base year predicted concentrations, the results indicate that the potential air quality effects following the opening of the scheme are likely to be *slight, beneficial* for particulate matter (as PM_{10}) and *slight, adverse* for nitrogen dioxide (NO_2) as the ambient air quality criteria are likely to be met at all sensitive receptor locations and the project road contributions are relatively low (i.e. the potential air quality effects are unlikely to be significant at any sensitive receptor location).

The results indicate that there are unlikely to be any adverse health effects to members of the public located within the Lincoln Road corridor study area as a result of the scheme, as the total predicted annual mean NO_2 concentration was predicted to be 63% of the health-based NO_2 assessment criterion (set by the World Health Organisation), while the 24-hour mean PM_{10} concentration was predicted to be 76% of the assessment criterion (National Environmental Standard for PM_{10}).

Auckland Transport

Lincoln Road Corridor Improvements – Air Quality Assessment

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APPENDICES

1 Introduction

This report forms part of Auckland Transport's (AT) Notice of Requirement for the Lincoln Road Corridor Improvements (LCRI) project. The LRCI project aims to improve the efficiency of Lincoln Road, improve public transport reliability in this area, and improve safety for all road users.

The LRCI project applies to a 1.3 kilometre (km) length of Lincoln Road, between its intersection with Te Pai Place / Pomaria Road to the south and State Highway 16 (SH16) on-ramp to the north. The project will upgrade Lincoln Road through the provision of additional transit lanes, dedicated cycle lanes and footpaths in each direction whilst maintaining two lanes for general traffic in each direction. Additional or longer turning lanes will be constructed at controlled intersections to improve capacity and a raised median will be installed along the centre of the road, with right turning and U-turns provided for at controlled intersections. The improvements will be integrated with the New Zealand Transport Agency's upgrades at SH16 at the Lincoln Road Interchange.

The LRCI project also involves the collection and treatment of stormwater generated from the road at 312 Lincoln Road and discharge to a new coastal outfall at Daytona Strand (the resource consents necessary to undertake this part of the project will be applied for at a later date). There will be a new public road formed to the rear of 300-312 Lincoln Road, which will provide access to Daytona Reserve and existing properties that will be unable to access directly from Lincoln Road.

This report is a screening-level assessment of the potential construction-phase and operational-phase air quality effects that may arise as a result of the LRCI project.

2 Background

2.1 Project Site Location

The location of the project site is shown in **Figure 2–1**. The figure was produced for a 2 km by 2 km basemap centred on the Lincoln Road / Universal Drive intersection using OpenStreetMap (OSM) under the open Database License. OSM has been used throughout this report and MWH has acknowledged OSM and its contributors where relevant. The Open Database License can be read in full on the OSM website (http://opendatacommons.org/licenses/odb1/1.0/).

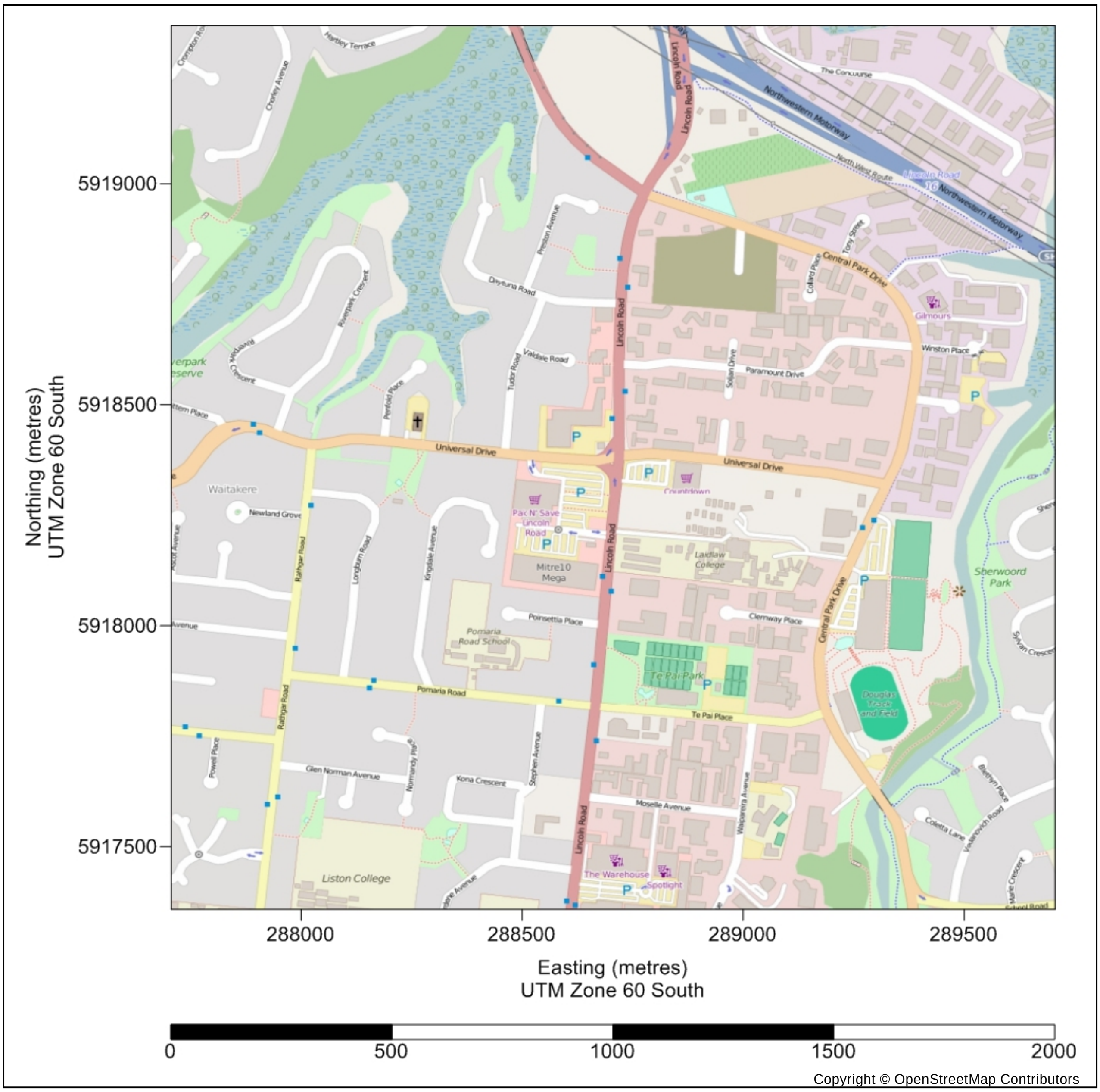

Figure 2-1: Project Site Location Showing OSM Basemap

Figure 2–2 shows the same area as **Figure 2–1** but for an Environmental Systems Research Institute (ESRI) basemap.

Figure 2-2: Project Site Location Showing ESRI Basemap

2.2 Sensitive Receptor Locations

In the context of this air quality assessment, the term 'sensitive receptor' includes any persons, locations or systems that may be susceptible to changes in abiotic factors as a consequence of discharges to air associated with the project, both during the construction phase and the operational phase of the scheme.

In accordance with Ministry for the Environment's *'Good Practice Guide for Assessing Discharges to Air from Land Transport'* (MfE, 2008),[1] typical locations for sensitive receptors include:

- Residential properties;
- Retirement villages;
- Hospitals or medical centres;
- Schools;
- Marae;
- Libraries;
- Public outdoor locations (e.g. parks, reserves, sports fields).

Sensitive receptors do not include locations that are indoors (e.g. within residences), inside vehicles, within indoor workplace environments, or within outdoor workplace environments where members of the public are not typically exposed to airborne contaminants. It is beyond the scope of this study to determine the potential air quality impacts at every discrete sensitive receptor located along the project corridor.

Figure 2–3 shows a Google Earth aerial basemap for the same 2 km by 2 km area with the addition of a 350 m buffer line (shown in yellow) from the proposed Lincoln Road route alignment (shown in blue). The UK Institute of Air Quality Management's (IAQM) *'Guidance on the Assessment of Dust from Demolition and Construction'* considers any receptor within 350 m of a boundary of a construction site to be potentially affected by that operation[2].

[1] Good Practice Guide for Assessing Discharges to Air from Land Transport, Ministry for the Environment, June 2008.

[2] IAQM, 2014. Guidance on the Assessment of Dust from Demolition and Construction, February 2014.

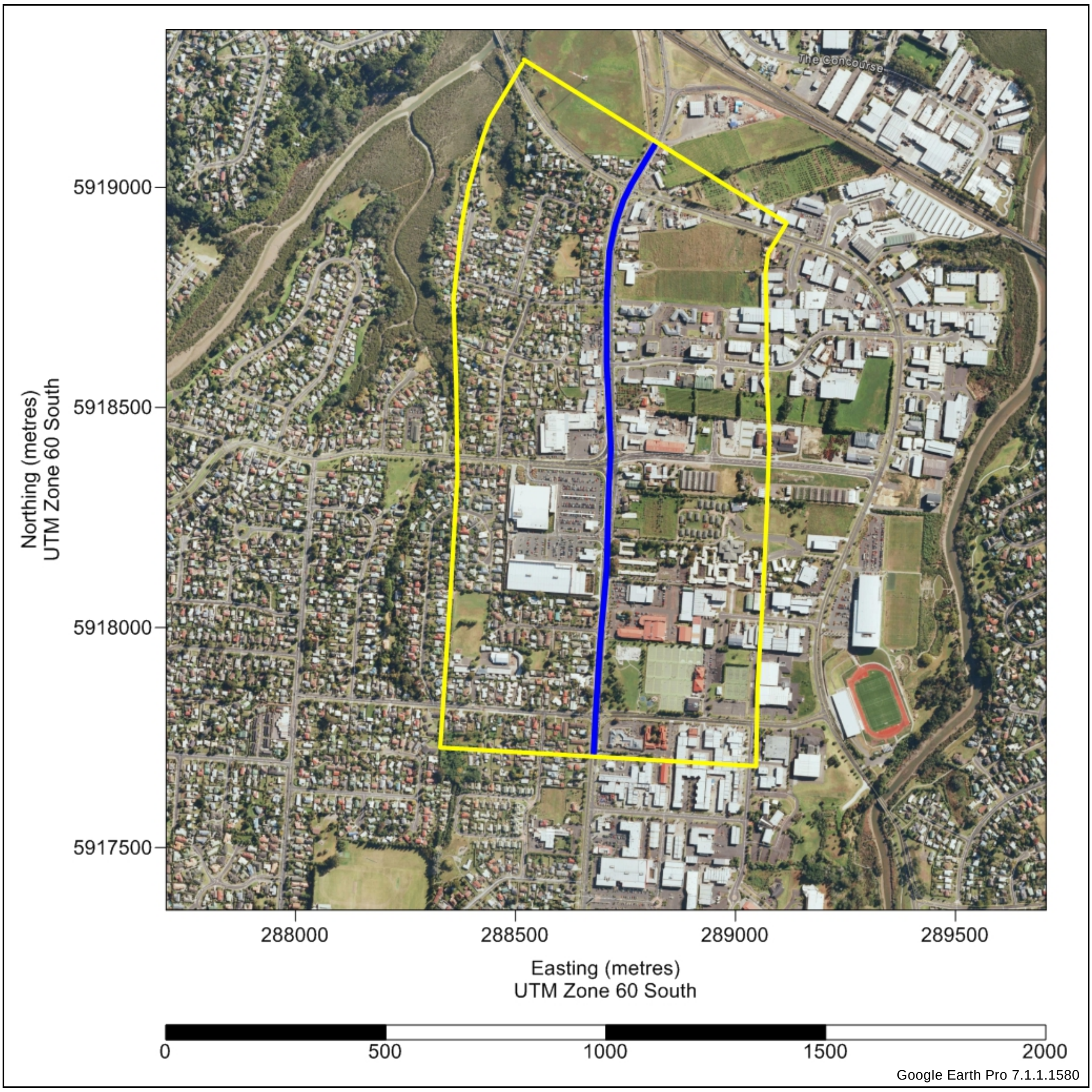

Figure 2-3: Construction Phase Receptors within 350m of the Proposed Route Alignment

Figure 2–4 shows a Google Earth aerial basemap for the same 2km by 2km area with the addition of a 200m buffer line (shown in yellow) from the proposed Lincoln Road route alignment (shown in blue). The UK Highways Agency's (HA) Design Manual for Roads and Bridges (DMRB) considers any receptor within 200m of a road source to be potentially affected by that operation[3].

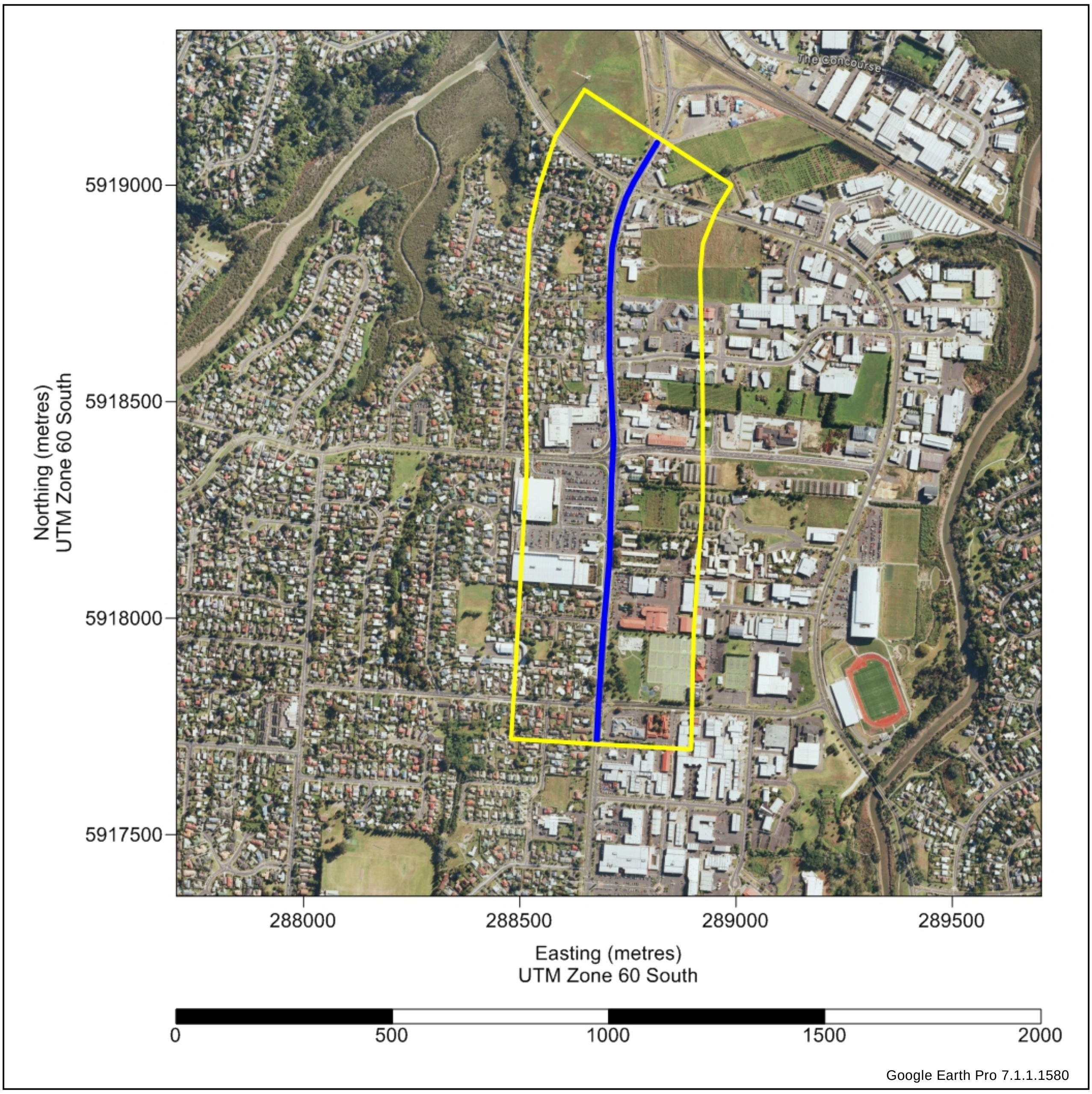

Figure 2-4: Operational Phase Receptors within 200m of the Proposed Route Alignment

For clarity, the dust-sensitive receptors have been assigned a buffer distance of 350m from the proposed construction site boundary, whilst the receptors deemed sensitive to road traffic pollutants have been given a buffer distance of 200m from the proposed route alignment.

[3] Highways Agency, 2007. Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 1 Air Quality HA 207/07, UK Highways Agency (HA), May 2007.

Discrete receptor locations deemed sensitive to changes in baseline air quality as a result of the project were identified from a desktop GIS study. These discrete receptors are shown in **Table 2–1**, and include six residential properties, two areas of public open space, one child care facility and one school. Whilst there are considerably more sensitive receptors located within 200 m and 350 m of the proposed route alignment, these sensitive receptors are some of the closest and are therefore considered to have the greatest potential to be affected by the proposed scheme.

Table 2-1: Sensitive (Discrete) Receptors Locations

Ref.	Address / Receptor Type	Distance from Lincoln Road (Existing Layout) (m)	Distance from Lincoln Road (Proposed Layout) (m)	Distance from Proposed Construction Site (m)
R1	370 Triangle Rd / Residential	11	<10	<10
R2	314 Lincoln Rd / Residential	18	<10	<10
R3	310 Lincoln Rd / Residential	20	<10	<10
R4	292 Lincoln Rd / Residential	15	<10	10
R5	174 Lincoln Rd / Residential	14	<10	<10
R6	Te Pai Park, Lincoln Rd / Open Space (Recreation)	28	10	20
R7	160 Lincoln Rd / Child Care	20	10	12
R8	156 Lincoln Rd / Residential	15	<10	<10
R9	Daytona Reserve, Lincoln Rd / Open Space (Recreation)	60	<10 (access road)	<10 (access road)
R10	Pomaria Road Primary School	130	125	115

Figure 2–5 shows the location of the discrete receptors identified in this assessment (blue circles), the proposed alignment of Lincoln Road (blue line), the 350 m buffer (yellow line) and the location of other sensitive receptors (transparent yellow polygon within the 350 m buffer line).

A number of residential properties have been earmarked for acquisition by Auckland Transport in order to secure the route alignment and to provide for the access roads and transit lanes (e.g. numbers 298, 306a and 322 Lincoln Road), and for stormwater treatment at 312 Lincoln Road. These properties have not been included as sensitive receptor locations. Furthermore, the construction of the proposed access road that will run behind the existing residential properties and along the eastern boundary of Daytona Reserve to the stormwater treatment facility at 312 Lincoln Road has the potential to generate dust emissions. A number of properties are located within 10 m of the proposed construction site footprint of the proposed access road.

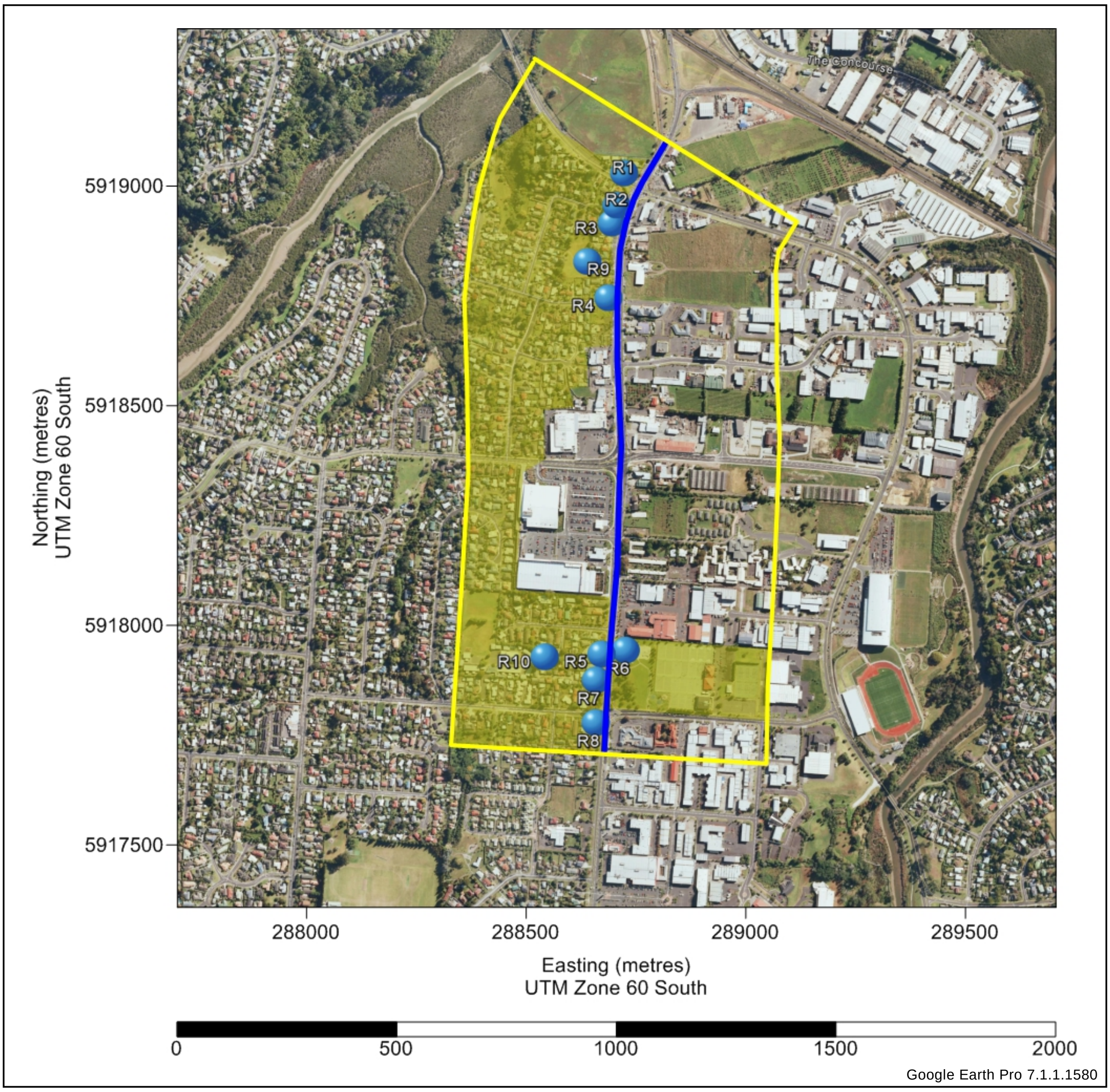

Figure 2-5: Discrete Receptor Locations

2.3 Limitations

MWH has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of AT. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person.

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This report is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report was prepared between 14 September 2015 and 14 December 2015 and is based on the conditions encountered and information reviewed at the time of preparation. MWH disclaims responsibility for any changes that may have occurred after this time. This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

3 Assessment Criteria

3.1 National and Regional Ambient Air Quality Standards and Guidelines

Table 3–1 summarises the ambient air quality assessment criteria relevant to this assessment. The key pollutants of concern in this study are particulate matter (as total suspended particulate or 'TSP', PM_{10} and $PM_{2.5}$), carbon monoxide (CO) and nitrogen dioxide (NO_2).

Table 3-1: Ambient Air Quality Assessment Criteria

Pollutant	Averaging Period	Ambient Air Quality Standard or Guideline	Reference
Carbon monoxide	1-hour 8-hour*	30 mg/m^3 10 mg/m^3	AAQG / AAAQS NES / AAQG / AAAQS
Nitrogen dioxide	1-hour** 24-hour Annual	200 µg/m^3 100 µg/m^3 40 µg/m^3	NES / AAQG / AAAQS AAQG / AAAQS WHO / AAAQS
Particulate matter <10 µm (PM_{10})	24-hour* Annual	50 µg/m^3 20 µg/m^3	NES / AAQG / AAAQS AAQG / AAAQS
Particulate matter <2.5 µm ($PM_{2.5}$)	24-hour Annual	25 µg/m^3 10 µg/m^3	WHO / AAAQS WHO / AAAQS
Total suspended particulates (TSP)	24-hour***	80 µg/m^3	MfE GPG
Benzene	Annual	3.6 µg/m^3	AAQG / AAAQS

N.B. * One exceedance permitted in a 12-month period

** Nine exceedances permitted in a 12-month period

*** Trigger level for a sensitive area (e.g. residential area)

Pursuant to Section 43 of the Resource Management Act 1991 (RMA), the Ministry for the Environment (MfE) first promulgated the Resource Management (National Environmental Standards for Air Quality) Regulations on 6 September 2004 ('the NES' or 'the Regulations'). Since that time there have been a number of amendments to the NES, with the most recent amendment occurring in 2011. The NES applies standards to five air pollutants: particulate matter (as PM_{10})[4], CO, NO_2, sulphur dioxide (SO_2) and ozone (O_3). The NES standards for CO, NO_2 and PM_{10} are presented in **Table 3–1**.

The Ambient Air Quality Guidelines (AAQG) were published by the MfE in 2002 following a comprehensive review of international and national research, and are widely accepted among New Zealand air quality practitioners. The AAQG criteria provide the minimum requirements that ambient air quality should meet in order to protect human health and the environment. The AAQG standards for CO, NO_2, PM_{10} and benzene (C_6H_6) are presented in **Table 3–1**.

The World Health Organisation (WHO) has recommended a set of ambient air quality guidelines for $PM_{2.5}$ and these have been adopted by Auckland Council as Auckland Ambient Air Quality Standards (AAAQS) in the proposed Auckland Unitary Plan (PAUP)[5]. The AAAQS standards for $PM_{2.5}$ are shown in **Table 3–1**[6]. The AAAQS standards for the remaining pollutants are the same as the NES or AAQGs.

4 'PM_{10}' refers to coarse particles less than 10 microns (µm) in diameter.

5 http://unitaryplan.aucklandcouncil.govt.nz/Pages/Plan/Book.aspx?exhibit=PAUPSept13

6 '$PM_{2.5}$' refers to fine particles less than 2.5 µm in diameter.

The MfE has recommended a trigger level for total suspended particulate (TSP) in its '*Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emissions*'[7]. The trigger level shown in **Table 3–1** is for a sensitive area (e.g. residential area) and is considered appropriate for the purposes of this assessment.

3.2 Significance Criteria

The MfE has recommended a set of criteria to determine whether the predicted concentrations of road traffic pollutants are likely to be 'significant' (MfE, 2008).[8] These are absolute criteria, are not related to the existing air quality and are for *incremental analysis* only.

The significance criteria relevant to this assessment are 5% of the 24-hour mean NES for PM_{10} of 50 µg/m^3 and the WHO's annual mean guideline for NO_2 of 40 µg/m^3 and are shown in **Table 3–2**.

Table 3-2: Ambient Air Quality Assessment Criteria

Pollutant	Averaging Period	Significance Criteria (µg/m^3)	Percentage of Ambient Air Quality Standard or Guideline (%)
NO_2	Annual	2.0	5
PM_{10}	24-hour	2.5	5

3.3 Auckland Council Regional Plan: Air, Land and Water

The general permitted activity rule (*Rule 4.5.1*) of the operative Auckland Council Regional Plan: Air, Land and Water states:

a) *"That beyond the boundary of the premises where the activity is being undertaken there shall be no noxious, dangerous, offensive or objectionable odour, dust, particulate, smoke or ash*

b) *That there shall be no noxious, dangerous, offensive or objectionable visible emissions*

c) *That beyond the boundary of the premises where the activity is being undertaken there shall be no discharge into air of hazardous air pollutants that does, or is likely to, cause adverse effects on human health, ecosystems or property…"*

In accordance with the above rule, the construction phase emissions of dust and odour should be kept to the minimum practicable level such that there are no "*offensive or objectionable odour, dust, [or] particulate"* beyond the construction site boundary. Furthermore, there should be *"no discharge into air of hazardous air pollutants that does, or is likely to, cause adverse effects on human health, ecosystems or property"* beyond the construction site boundary.

Providing that the mitigation measures recommended in **Section 5** of this report are adhered to at all times, it is considered that the conditions of *Rule 4.5.1* and the equivalent controls in the Proposed Auckland Unitary Plan (PAUP) will be met (i.e. the proposed construction works is considered to be a *permitted activity*).

7 Ministry for the Environment, 2001. Good Practice Guide for Assessing and Managing the Environmental effects of Dust Emissions September, 2001.
8 Good Practice Guide for Assessing Discharges to Air from Land Transport, Ministry for the Environment, June 2008.

4 Existing Conditions

4.1 Local Meteorology

Hourly wind speed and wind direction data from the Auckland Council's AUSPLUME dispersion model meteorological data input files for Avondale (site reference 'H4a') for the years 2005 and 2007 were analysed[9]. The Avondale meteorological station is approximately 4.2 km to the south-east of the Lincoln Road corridor.

The wind rose shown in **Figure 4–1(a)** presents the hourly wind speed and direction data for Avondale from 1 January 2005 (Hour 1) to 31 December 2005 (Hour 24), while **Figure 4–1(b)** presents the hourly wind speed and direction data for 1 January 2007 (Hour 1) to 31 December 2007 (Hour 24). The figure indicates that whilst winds from all directions are likely to be experienced at Lincoln Road, the predominant wind directions are from the south-west (SW), west-south-west (WSW), south-south-east (SSE), and west (W). The annual mean wind speeds in 2005 and 2007 were 2.8 m/s and the highest wind speeds (>10.5 m/s) were from the SW and WSW. The wind roses for 2005 and 2007 are very similar.

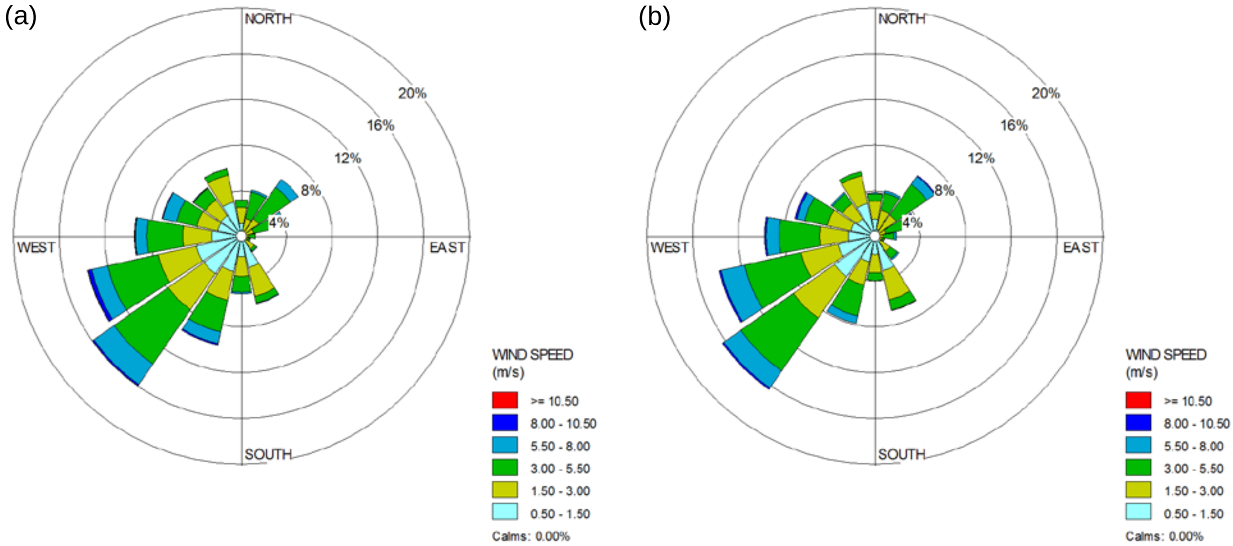

Figure 4-1: Annual Wind Roses for Avondale: (a) 2005 and (b) 2007

[9] Meteorological Datasets for the Auckland Region – User Guide, Auckland Regional Council and the NZ Transport Agency, May 2010.

Hourly wind speed and direction data were analysed for Auckland Council's meteorological station which is located at 70 Lincoln Road (Henderson Intermediate School) for the year 2014 (CliFlo agent number 22166). The monitoring location is situated on the roadside (on Lincoln Road) and approximately 650 m SSW of the Lincoln Road corridor study area. The wind rose is presented in **Figure 4–2** and is in good agreement with the annual wind roses shown in **Figure 4–1** for Avondale. The annual average wind speed measured at the Lincoln Road weather station was 1.8 m/s and the data capture for the period was 96.5%.

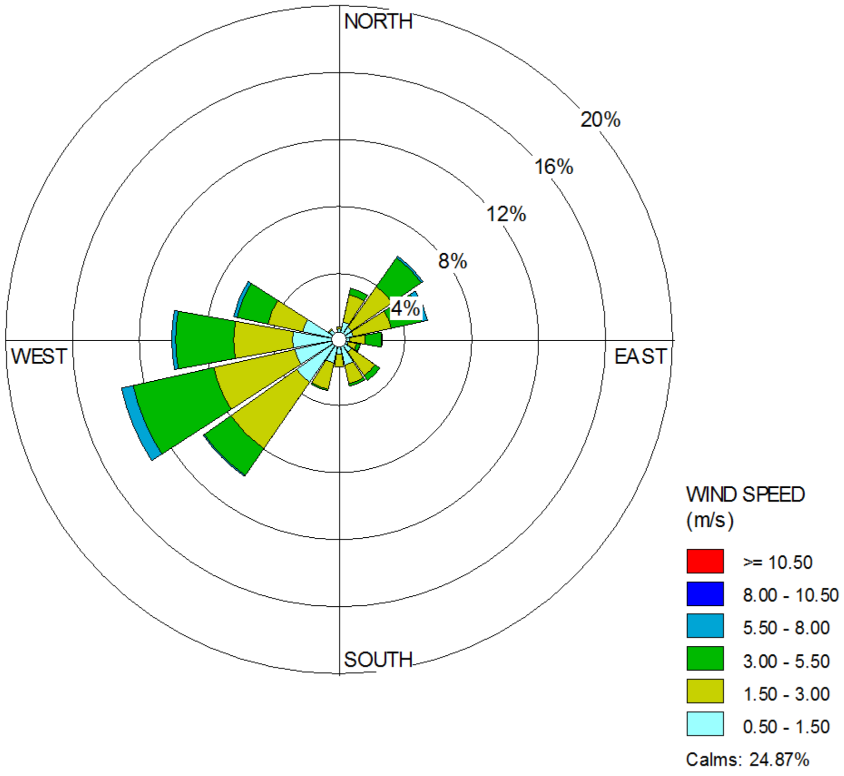

Figure 4-2: Annual Wind Rose for Lincoln Road for 2014

Figure 4–3 shows the wind speed frequency distribution for Avondale in 2005 and 2007. The majority of the wind speeds (90%) were low to moderate:

- Approximately 29% of winds were between 0.5 m/s and 1.5 m/s (low wind conditions);
- Approximately 30% were between 1.5 m/s and 3 m/s (light wind conditions); and,
- Approximately 31% were between 3 m/s and 5.5 m/s (light to moderate wind conditions).

Only 10% of wind speeds were above 5.5 m/s (moderate to strong wind conditions). It is noted that the percentage frequency of calms shown in **Figure 4–3** is not accurate as these conditions cannot be handled in the AUSPLUME model and, consequently, Auckland Council replaced all the calms with a wind speed value of 0.5 m/s.

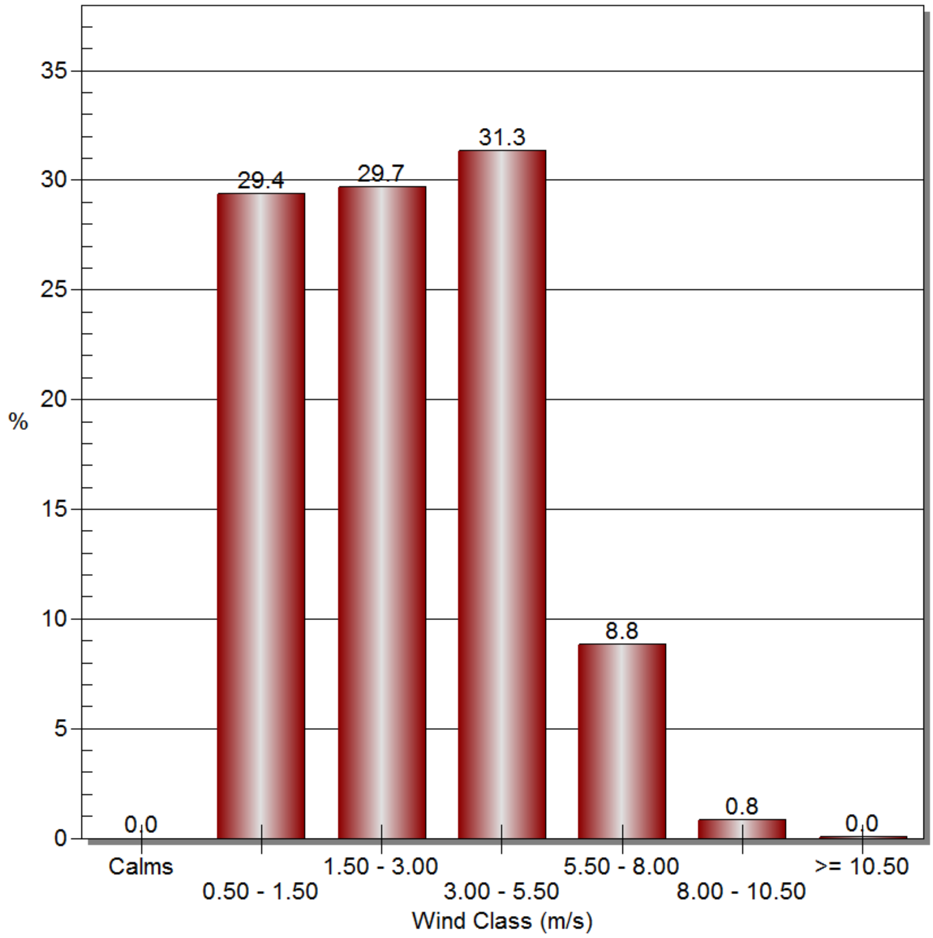

Figure 4-3: Wind Speed Frequency Distribution for Avondale in 2005 and 2007

The wind speed frequency distribution for Lincoln Road in 2014 was as follows:

- Approximately 25% of winds were less than 0.5 m/s (calm wind conditions);
- Approximately 22% of winds were between 0.5 m/s and 1.5 m/s (low wind conditions);
- Approximately 29% were between 1.5 m/s and 3 m/s (light wind conditions);
- Approximately 18% were between 3 m/s and 5.5 m/s (light to moderate wind conditions); and
- Approximately 2% were between 5.5 m/s and 8 m/s (moderate wind conditions).

The high frequency of calm wind conditions at the Lincoln Road meteorological station is not overly surprising given the close proximity of trees and buildings, which have the potential to inhibit wind flow at the monitoring site. However, despite the foregoing, this has a two-fold impact on air quality within the Lincoln Road project corridor: first, the risk of the propagation of construction dust by wind is slightly reduced and, second, the risk of air quality effects due to exposure to operational phase road traffic pollutants is slightly increased (as calm winds reduce the potential for the dispersion of pollutants in the atmosphere).

4.2 Background Air Quality

The Auckland Council and the New Zealand Transport Agency (NZ Transport Agency) have carried out ambient air quality monitoring along Lincoln Road for a number of years.

The ambient air concentrations of NO_2 measured by Auckland Council using a continuous, real-time analyser located at 70 Lincoln Road (Henderson Intermediate School) for the years 2011 to 2014 are presented in **Table 4–1**. The monitoring location is situated at the Lincoln Road meteorological station which is approximately 650 m SSW of the Lincoln Road corridor study area.

The maximum 1-hour mean and annual mean concentrations shown in the table are well below the 1-hour NES for NO_2 of 200 μg/m^3 and the WHO's annual mean guideline of 40 μg/m^3 (see **Section 3**).

Table 4-1: Ambient NO_2 Concentrations Measured on Lincoln Road in 2011 to 2014

Year	Max 1-hr Mean NO_2 (μg/m^3)	Annual Mean NO_2 (μg/m^3)	% Valid Data
2011	65.5	12.3	96
2012	66.5	12.8	96
2013	55.7	11.8	96
2014	56.9	10.4	96

The NZ Transport Agency has measured ambient concentrations of NO_2 using diffusion tubes at 70 Lincoln Road (Henderson Intermediate School) for the years 2009 to 2013, and the data are presented in **Table 4–2**. The NZ Transport Agency's diffusion tubes were deployed in triplicate and were co-located with Auckland Council's continuous analyser. Whilst the annual mean concentrations shown **Table 4–2** are higher than the concentrations shown in **Table 4–1** they are still well below the WHO's annual mean guideline of 40 μg/m^3.

Table 4-2: Ambient NO_2 Concentrations Measured on Lincoln Road in 2009 to 2013

Diffusion Tube / Site Location ID	Annual Mean NO_2 (μg/m^3)				
	2009	2010	2011	2012	2013
AUC054	17.5	17.4	18.9	17.8	16.4
AUC055	17.7	17.4	18.8	18.0	17.7
AUC056	17.5	17.7	18.7	17.5	17.9

The ambient air quality concentrations of PM_{10} measured by Auckland Council using a continuous (real-time) instrument located at 70 Lincoln Road for the years 2011 to 2014 are presented in **Table 4–3**. Data are shown for a continuous beta-attenuation monitor (BAM) and on a 1-in-3 day sampling basis for a Partisol (gravimetric) PM_{10} monitor. The data show good agreement between the two instruments and the concentrations measured are well below the NES for PM_{10} of 50 µg/m^3.

Table 4-3: Ambient PM_{10} Concentrations Measured on Lincoln Road in 2011 to 2014

Year	BAM		Partisol	
	Max 24-hr Mean PM_{10} (µg/m^3)	% Valid Data	Max 24-hr Mean PM_{10} (µg/m^3)	% Valid Data
2011	28	99	33	NA
2012	36	98	36	NA
2013	29	100	26	NA
2014	29	97	30	NA

The background concentrations of PM_{10} (as a 24-hour mean) and NO_2 (as an annual mean) used in this assessment are shown in **Table 4–4** and were taken from the NZ Transport Agency's online background air quality map[10] and generally agree with the monitoring results reviewed above.

Table 4-4: Background Air Quality used in this Assessment

Pollutant	Averaging Period	Concentration (µg/m^3)	Reference
NO_2	Annual	16	NZ Transport Agency
PM_{10}	24-hour	35	NZ Transport Agency

10 http://air.nzta.govt.nz/background-air-quality. Refer to: NZ Transport Agency, 2014, Background Air Quality Guide, Draft June 2014.

5 Assessment of Effects

5.1 Construction Phase Air Quality Effects

During the construction phase, the potential for dust to be emitted will be directly influenced by the nature of the activities taking place on site. Although no specific information on the scope or methodology of construction phase works is available at this stage, based on the proposed alignment drawings, the construction works are likely to comprise the following:

- Construction engineering works along the proposed route (e.g. the upgrade of Lincoln Road to maintain two lanes for general traffic in each direction, construction of a transit lane, dedicated cycle lanes and footpaths in each direction and a raised median in the centre of the road, and any necessary modifications that are required to existing highways and junctions, such as the construction of access roads and the stormwater treatment facility);
- Earthworks and unsealed site roadways and surfaces (including localised re-grading works);
- Demolition of existing buildings and structures (e.g. residential properties); and,
- Storage of material, vehicles and equipment in site construction compounds and facilities (which is proposed to be located at 322 Lincoln Road / 370 Triangle Road).

Whilst there is the potential for the release of odour and toxic compounds during earthworks involving contaminated soils, the likelihood of odour nuisance effects and/or health effects due to exposure to hazardous chemicals is considered to be low and any adverse effects can be suitably mitigated. For example, all dust-generating activities should cease in the event that a significant odour is detected which has the potential to cause nuisance in the surrounding community and/or if elevated concentrations of volatile organic compounds (VOCs) are measured using a handheld instrument such as a photoionization detector (PID). Dust-generating activities should only restart once the source of the odour or airborne contaminant has been detected and remedial action (where required) has been implemented. In view of the foregoing, the potential for odour effects or adverse health effects due to exposure to hazardous chemicals is considered to be low and is not considered further.

The construction engineering works have the potential to generate dust along the entire length of the corridor (approximately 1.3 km in length), within 350 m of the proposed ‘construction site’ boundary, as indicated in **Figure 2–3**. The construction phase activities have the potential to generate road vehicle movements during the import and export of construction material and equipment, and from employees and visitors travelling to and from the construction site. These movements have the potential to cause the re-suspension of loose dust on unsealed roads due to vehicle-produced turbulence, especially in dry and windy meteorological conditions. Construction works are also likely to require stockpiling of materials (e.g. aggregate, topsoil) on site compounds located within the corridor on a short-term basis, which would increase the potential for the generation of fugitive dust emissions.

Temporary elevation in dust levels is considered to be inevitable as part of the proposed construction works, particularly where the proposed activities are undertaken during dry and/or windy conditions. The magnitude of the potential impacts and environmental effects resulting from elevated dust emissions depends on the potential for dust to become and remain airborne prior to returning to the surface as a deposit. Unlike other atmospheric pollutants, the presence of dust and its deposition is particularly dependant on distance to nearby sensitive receptors and the prevailing meteorological conditions, with areas most consistently affected being located downwind of dust emission sources (e.g. stockpiles, unsealed roads, localised earthworks).

The scale of potential impacts related to construction phase dust emissions was predicted in this assessment on a qualitative basis. It is reasonable to assume that, in the absence of mitigation, the scale of potential dust impact at all locations within 350 m of the proposed construction site boundary will be *slight* to *negligible*. This is in view of the potential for dust nuisance complaints and surface soiling events due to dust deposition (e.g. the MfE’s trigger level for TSP), as opposed to the risk of exceeding any health-based ambient air quality assessment criteria (see **Section 3**). Although temporary elevation in dust levels is inevitable as part of the construction works, particularly during dry and windy conditions, it is considered that the implementation of suitable control measures (as outlined in the following sub-section) should effectively mitigate potential dust nuisance events and associated impacts. It is noted that the only sensitive receptor located downwind of the prevailing SW, WSW and SSW winds is receptor 'R6' which is Te Pai Park (i.e. non-residential and therefore less sensitive to potential dust deposition and soiling effects).

As the assessment of potential impacts resulting from construction phase dust has been undertaken qualitatively (i.e. without specific ambient air quality monitoring or atmospheric dispersion modelling) and in the absence of information regarding the location and numbers of construction plant and vehicle movements, confidence in this prediction is less certain than it would otherwise be.

The implementation of the mitigation measures outlined below will reduce the potential for dust nuisance effects at sensitive receptors located within the Lincoln Road corridor during the construction phase of the scheme. Providing that these measures are implemented, it is anticipated that there will be no significant adverse air quality effects during the construction phase.

5.2 Construction Phase Mitigation Measures

Recommended mitigation measures to control dust emissions during the construction phase include:

- Dampen-down exposed soils and stockpiles during excavation works, clearance works, material handling and other site preparations (including storage of construction materials) to reduce the propagation of dust by wind;
- Exposed soils should be hydro-seeded and/or covered with geotextile material as soon as possible following construction (where possible and practicable) and should be maintained in a visibly damp condition until the vegetation prevents wind erosion;
- Screen the construction site and/or stockpiles with suitable debris screens and sheets, where possible and practicable, to prevent wind loss;
- Storage locations for all materials that create dust, including soil and aggregate, should be positioned away from the construction site boundary (where possible and practicable), and consolidate all materials together where possible to avoid the creation of several different stockpile sites;
- Install signage on the construction site to limit vehicle speeds to 15 kilometres per hour (km/hr), where appropriate;
- Vehicle loads should be sheeted to prevent loss of materials off site;
- Drop heights should be minimised and chutes should be used where possible;
- All site vehicles should have vertical exhausts to limit surface dust re-suspension;
- Waste materials should not be burnt onsite;
- Avoid prolonged storage of materials onsite prior to use and/or disposal; and,
- Minimise mud and dust track-out from unpaved areas by the use of wheel wash facilities and/or regular cleaning of paved surfaces (e.g. using a mobile vacuum sweeper or water flushing), where practicable.

Daily onsite and offsite visual inspections (e.g. track-out onto paved roads) should also be undertaken to monitor deposited dust on sealed road surfaces and visible dust plumes, and all inspection results should be recorded in a log-book. In the event that visible dust plumes are observed which have the potential to cause offsite dust nuisance (soiling) effects, real-time, continuous particulate (as TSP and/or PM_{10}) monitoring could be undertaken at a fenceline (site boundary) location as a dust management tool. The monitor could be configured with trigger levels to warn site staff or the person accountable for air quality and dust issues onsite (e.g. via an SMS alert) when onsite particulate concentrations are in breach of the trigger levels[11], thereby reducing the potential for offsite dust nuisance effects. All dust-generating activities should cease in the event that a trigger level has been exceeded to allow the emission source to be identified and to implement appropriate mitigation measures. An automatic

[11] Example trigger levels for PM_{10} and TSP could be 250 µg/m^3 (as a 15-minute mean concentration) and 80 µg/m^3 (as a 24-hour mean concentration), respectively.

weather station could also be used to measure, as a minimum, wind direction and wind speed in order to assist in the analysis of the particulate monitoring results and the implementation of dust mitigation measures.

Dust monitoring at key locations would also allow for a quantitative assessment of actual construction phase impacts, particularly if it is carried out before, during and after all construction works and would reduce the potential for any regulatory compliance action that may occur as a result of causing nuisance events. The monitoring should be carried out by appropriately trained and experienced personnel. Additional dust mitigation measures may be required to be implemented following an analysis of the monitoring results.

The above mitigation measures should be incorporated into a site Dust Management Plan (or wider Environmental/Construction Management Plan).

5.3 Operational Phase Air Quality Effects

5.3.1 Methodology

During the operational phase, the principal emissions to air are likely to be generated by vehicles using Lincoln Road, including the proposed transit lanes. A screening modelling assessment was undertaken to assess the potential air quality effects associated with additional vehicles travelling along Lincoln Road following the opening of the scheme. The proposed upgrade will focus primarily on Central Park Drive / Triangle Road, Universal Drive and the Te Pai Place / Pomaria Road intersections.

The following models were used in this assessment:

- NZ Transport Agency's online air quality screening model (Version 2.0);[12]
- The Auckland Council and NZ Transport Agency's Vehicle Emissions Prediction Model (VEPM, Version 5.1).[13]

Whilst the NZ Transport Agency's air quality screening model only allows for the assessment for annual mean NO_2 concentrations and 24-hour mean PM_{10} concentrations it is considered unlikely that the assessment criteria for other averaging periods for NO_2 and PM_{10} or for other traffic-related pollutants such as CO, $PM_{2.5}$ and benzene (see **Section 3**) will be exceeded as a result of the scheme, providing that the annual mean NO_2 and 24-hour mean PM_{10} criteria are met.

According to the email from AT to MWH dated 9 December 2015[14], the existing Annual Average Daily Traffic (AADT) flow along Lincoln Road between Central Park Drive and Universal Drive is approximately 39,200 vehicles per day, while the AADT between Universal Drive and Te Pai Place is approximately 28,400 vehicles per day. The percentage of heavy commercial vehicles (HCVs) in the vehicle fleet is approximately 9%. Based on the projected traffic flow data, the AADT flow along Lincoln Road between Central Park Drive and Universal Drive will be approximately 52,500 vehicles per day, while the AADT between Universal Drive and Te Pai Place will be approximately 41,600 vehicles per day. The existing and projected AADTs are shown in **Table 5–1**.

Table 5-1: AADTs for Lincoln Road for Base Year 2015 and Assessment Year 2026

Section	Base Year 2015 AADT (Do Nothing)	Assessment Year 2026 AADT (Do Minimum)
Central Park Drive to Universal Drive	39,200	52,500
Universal Drive to Te Pai Place	28,400	41,600

12 http://air.nzta.govt.nz/screening-model. Refer to: NZ Transport Agency, 2014, Air Quality Screening Model Users' Notes, June 2014.

13 http://air.nzta.govt.nz/vehicle-emissions-prediction-model. Refer to: Vehicle Emissions Prediction Model (VEPM 5.1) User Guide, June 2013.

14 Email from Greig McDonnell at Auckland Transport to Matthew Soper at MWH on 9 December 2015.

For the purposes of a conservative (worst-case) assessment, the following assumptions were made:

- The opening year is anticipated to be 2036, however, the current version of the screening model does not extend beyond 2030 and so the opening year was assumed to be 2026;
- A sensitive receptor was assumed to be located 10 m (e.g. sensitive receptor 'R2') from the existing alignment of Lincoln Road (base year 2011) and the proposed route alignment (e.g. transit lane) in 2026. In reality, the proposed transit lane when it opens in 2026 will create a greater separation distance between the main vehicles travelling along Lincoln Road and the nearby sensitive receptors;
- The average vehicle speed in the fleet is 50 km/hr (i.e. travelling at the speed limit);
- The AADT flows along both sections of Lincoln Road (i.e. Central Park Drive to Te Pai Place) were assumed to be the highest existing and projected flows shown in **Table 5–1**;
- Adverse air quality impacts are associated with a net deterioration in air quality as a result of the opening of a scheme, whereas beneficial impacts are associated with a net improvement in air quality. This impact assessment should, therefore, ideally take into consideration the 'change in prediction' following the opening of the scheme ('do something' minus 'do minimum') for each pollutant and averaging period. However, in accordance with the email from AT to MWH dated 9 December 2015[15], there was assumed to be no discernible difference between the 2026 'do minimum' (without scheme) and 2026 'do something' (with scheme) AADT flows. Therefore, any adverse air quality impacts are likely to be negligible following the opening of the scheme. In order to provide a robust assessment and in the absence of actual 'do something' AADT flows, the ambient NO_2 and PM_{10} concentrations predicted for assessment year 2026 were compared against base year 2015;
- The percentage of HCVs in the vehicle fleet was assumed to be 9%; and,
- The background concentrations were assumed to remain constant between 2015 and 2026.

The data input into the screening model are shown in **Table 5–2**.

Table 5-2: ADDT Flows for Lincoln Road for Base Year 2015 and Assessment Year 2026

Parameter	Value
Distance from road emission source (m)	10
Base Year 2015 AADT	39,200
Assessment Year 2026 AADT	52,500
Percentage of HCVs in Vehicle Fleet (%) for 2015 and 2026 (%)	9
Average Vehicle Speed for 2015 and 2026 (km/hr)	50

15 *Ibid*.

The vehicle fleet profiles input into VEPM are shown in **Table 5–3**.

Table 5-3: Vehicle Fleet Profiles for Base Year 2015 and Assessment Year 2026

Vehicle Type	Vehicle Weight (tonnes)	Fuel Type	Base Year 2015 (Do Nothing)	Assessment Year 2026 (Do Minimum)
Cars	< 3.5 t	petrol	67.0%	51.0%
	< 3.5 t	diesel	8.0%	17.1%
	< 3.5 t	hybrid	0.8%	5.2%
LCV	< 3.5 t	petrol	2.2%	2.2%
	< 3.5 t	diesel	12.9%	12.9%
	< 3.5 t	hybrid	0.2%	1.6%
HCV	3.5 - 7.5 t	diesel	1.4%	1.5%
	7.5 - 12 t	diesel	0.7%	0.7%
	12 - 15 t	diesel	0.2%	0.2%
	15 - 20 t	diesel	0.3%	0.3%
	20 - 25 t	diesel	1.1%	1.1%
	25 - 30 t	diesel	1.0%	1.1%
	> 30 t	diesel	1.2%	1.4%
Buses	> 3.5 t	diesel	3.2%	3.2%
		TOTAL	100%	100%

The emission factors in grams per vehicle-kilometre travelled (g/veh-km) for PM_{10} (which include exhaust emissions and brake and tyre wear) and NO_2 predicted by VEPM are shown in **Table 5–4**. The data shown in the table indicate that the emissions predicted for 2026 are likely to be lower compared with 2015 due to improvements in vehicle technology and/or changes in vehicle fleet characteristics (e.g. increase in use of hybrid vehicles).

Table 5-4: Emission Factors for Base Year 2015 and Assessment Year 2026

Pollutant	Emission Factor (g/veh-km)	
	Base Year 2015 (Do Nothing)	Assessment Year 2026 (Do Minimum)
NO_2	0.650	0.400
PM_{10}	0.039	0.023

It is important to note that the current version of the screening model does not account for inter-annual variations in emissions (as shown in **Table 5–4**) for NO_2, however, it does take these factors into account for PM_{10}. Based on a recent study undertaken in the UK[16], NO_2 emissions from diesel cars has increased overall from a 10-15% proportion of nitrogen oxide (NO_x) emissions for Euro 3 standard vehicles or older to an average of almost 30% for newer Euro 4 or 5 vehicles. Given that there is currently some uncertainty as to whether the fleet average NO_2 emissions will be lower in 2026

[16] 'Road Sensing of NO_2 Exhaust Emissions from Road Vehicles - A report to the City of London Corporation and London Borough of Ealing, David Carslaw (King's College London) and Glyn Rhys-Tyler (Newcastle University), July 2013.

compared with 2015 (as they are predicted to be for PM_{10}) it is considered appropriate that the NO_2 emissions should remain constant for the purposes of this screening assessment.

5.3.2 Results

The results from the screening assessment (10 m receptor location) are shown in **Table 5–5**. The table shows the background and total predicted concentrations. The latter are the sum of the background and predicted road contributions. The results indicate that there are unlikely to be any exceedances of the ambient air quality criteria at a distance of 10 m for the road emission source, and therefore, at any sensitive receptor location before or after the opening of the scheme. Furthermore, there was predicted to be a slight decrease in the total predicted 24-hour mean PM_{10} concentration in 2026 compared with 2015 (primarily due to lower emissions caused by improvements in vehicle technology). The incremental change in the 24-hour mean PM_{10} concentration following the opening of the scheme was predicted to be -0.8 µg/m^3. In other words, there was predicted to be a *slight, beneficial* impact for PM_{10}, following the opening of the scheme.

Table 5-5: Predicted PM_{10} and NO_2 Concentrations

Pollutant	Averaging Period	Background Concentration (µg/m^3)	Total Predicted Concentration (µg/m^3)	
			Base Year 2015	Assessment Year 2026
NO_2	Annual	16	22.8	25.1
PM_{10}	24-hour	35	39.0	38.2

Table 5–5 indicates that the maximum predicted 24-hour mean PM_{10} concentration at any receptor location following the opening of the scheme in 2026 will be 38.2 µg/m^3 (the background concentration was assumed to be 35 µg/m^3 and the road contribution was predicted to be 3.2 µg/m^3).

Table 5–5 indicates that whilst the incremental change in the annual mean NO_2 concentration following the opening of the scheme is likely to be 2.3 µg/m^3 (i.e. greater than the MfE significance criterion of 2 µg/m^3), the potential air quality effects are not considered to be significant given the following:

- The margin of the exceedance is only 0.3 µg/m^3 or less than 1% of the WHO's annual mean assessment criterion for NO_2 of 40 µg/m^3;
- The potential margin of error of the modelling is likely to be more than the margin of the exceedance of the MfE significance criterion;
- Confidence in the annual mean background concentration for NO_2 of 16 µg/m^3 is high given that it is based on recent and local ambient air quality monitoring data; and,
- The total annual mean NO_2 concentration was predicted to be 25.1 µg/m^3 (i.e. well below the annual mean WHO assessment criterion of 40 µg/m^3). The background concentration was assumed to be 16 µg/m^3 and the road contribution was predicted to be 9.1 µg/m^3.

The results from the screening assessment (10 m receptor location) for base year 2015 and assessment year 2026 are shown graphically in **Figure 5–1** and **Figure 5–2**, respectively. The figures show the background concentrations (in blue) and the predicted road contributions (in red). The figures show that the total 24-hour mean PM_{10} and annual mean NO_2 concentrations at a distance of 10 m for the road emission source were predicted to be well below the relevant assessment criteria (50 µg/m^3 and 40 µg/m^3, respectively).

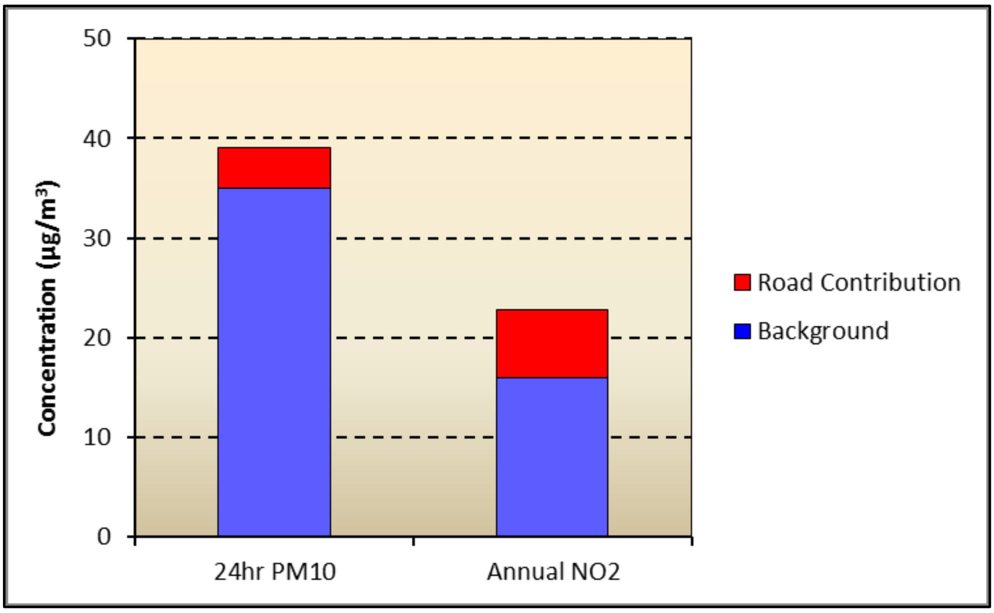

Figure 5-1: Predicted Air Quality Impacts for the Base Year 2015

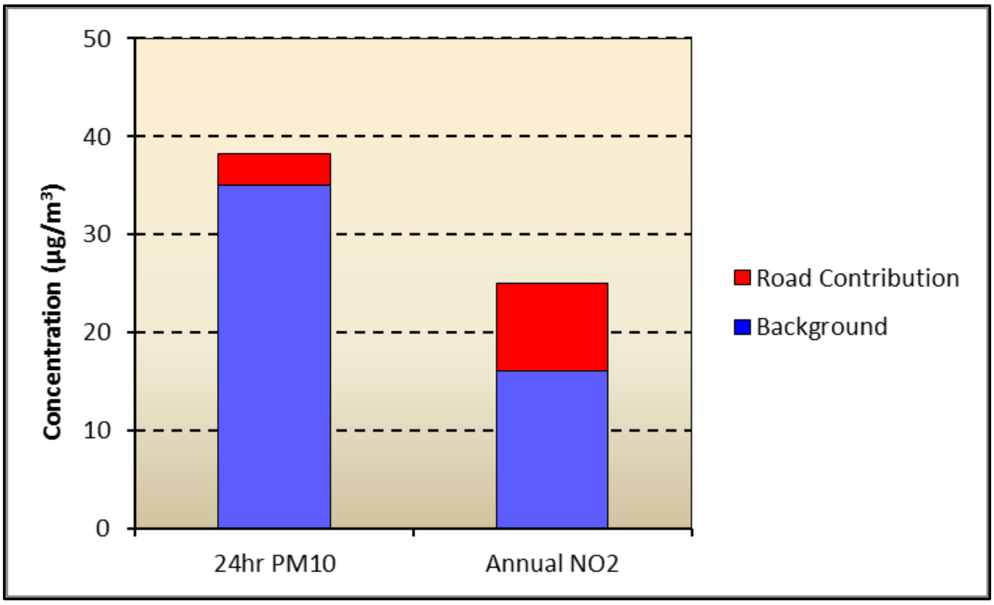

Figure 5-2: Predicted Air Quality Impacts for Assessment Year 2026

Figure 5–2 shows the total predicted annual mean NO_2 (blue lines with circle symbols) and 24-hour mean PM_{10} concentrations (red lines with square symbols), in other words, the background concentration plus the predicted road contribution, at 10 m intervals from the proposed route alignment. The figure shows the predicted concentrations for base year 2015 (solid lines with filled symbols) and for assessment year 2026 (dashed lines with open symbols). The figure indicates that concentrations are predicted to decrease with distance from the new road and reach background levels at approximately 100 m from the source. The figure also shows that the PM_{10} concentrations are likely to be lower in 2026 compared with 2015, while the NO_2 concentrations are likely to be slightly higher in 2026 compared with 2015.

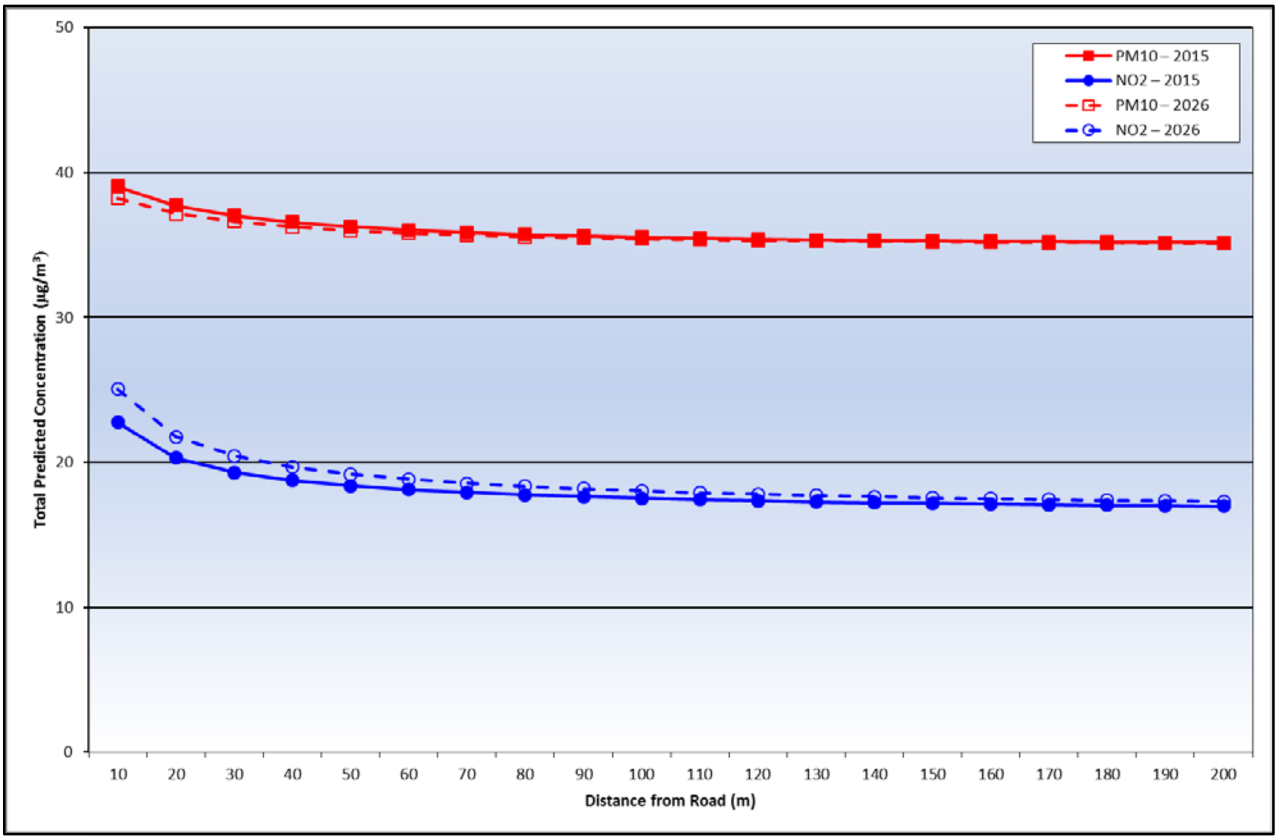

Figure 5-3: Total Predicted 24-hour Mean PM_{10} and Annual Mean NO_2 Concentrations

For the worst-case receptor located 10 m from the existing and proposed route alignment, the screening results indicate that following the opening of the scheme in 2026, the total predicted annual mean NO_2 concentration will be 25 µg/m^3, which is 63% of the NO_2 assessment criterion (WHO), while the predicted 24-hour mean PM_{10} concentration will be 38 µg/m^3, which is 76% of the assessment criterion (NES for PM_{10}). Even if the average vehicle speed were to drop to 10 km/hr (e.g. during congested traffic conditions or stop/start flows)[17], which is highly unlikely for a 24-hour period, the total predicted 24-hour mean PM_{10} concentration would be 43 µg/m^3, which would be 86% of the assessment criterion (NES for PM_{10}). In other words, compliance with the NES for PM_{10} would still be achieved for a 10 km/hr scenario.

The outputs from the NZ Transport Agency's online air quality screening model (accessed on 14 December 2015) are shown in **Appendix A** for the worst-case receptor located 10 m from the existing and proposed route alignment for a 50 km/hr scenario.

5.4 Operational Phase Mitigation Measures

Based on the results of the screening assessment, the potential air quality effects following the opening of the scheme are likely to be *slight, beneficial* for PM_{10} and *slight, adverse* for NO_2 as the ambient air quality criteria are likely to be met at all sensitive receptor locations and the project road contributions are relatively low (i.e. the potential air quality effects are unlikely to be significant at any sensitive receptor location). The results indicate that there are unlikely to be any adverse health effects to members of the public located within the Lincoln Road corridor study area as a result of the scheme, as the total predicted annual mean NO_2 concentration was predicted to be 63% of the health-based NO_2 assessment criterion (WHO), while the 24-hour mean PM_{10} concentration was predicted to be 76% of the assessment criterion (NES for PM_{10}).

In view of the foregoing, the implementation of specific mitigation measures to address operational phase air quality effects is not considered to be necessary.

17 The PM_{10} emission factor predicted by VEPM for this scenario was 0.057 g/veh-km.

5.5 Opportunities and Constraints

There are a number of potential benefits (or opportunities) relating to air quality as a result of the project. These include but are not limited to:

- An increase in the number of buses using the proposed transit lane and the potential for greater usage of cycling and walking on Lincoln Road during the operational phase (post 2026) may offset low occupancy car emissions compared with the base year (2015), although this has not been quantified in this report. It is noted that *Policy 10.4.4* of the Auckland Council Regional Policy Statement promotes the use of more efficient transport modes, such as buses, and non-polluting transport modes such as cycling and walking;
- Through the implementation of a robust Dust Management Plan (or wider Environmental/Construction Management Plan), the potential for dust deposition and nuisance complaints during the construction phase will be reduced; and,
- Engaging with the public regarding air quality concerns/existing air quality issues.

There are a number of potential constraints (or impacts) associated with the construction phase of the project including:

- Construction phase dust emissions from construction compounds and from the construction of the busway and associated structures have the potential to cause dust nuisance effects at sensitive receptor locations in the absence of appropriate mitigation measures. However, these impacts can be effectively controlled through the implementation of a Dust Management Plan; and,
- Dust monitoring at key locations would allow for a quantitative assessment of actual project impacts, particularly if it is carried out before, during and after all construction works and would reduce the potential for any regulatory compliance action that may occur as a result of causing nuisance events.

6 Summary and Conclusions

6.1 Construction Phase

In this report, the potential construction phase dust impacts have been assessed on a qualitative basis. It is considered that in the absence of appropriate mitigation, there is the potential for *slight* to *negligible* dust nuisance effects to occur at sensitive receptors located in close proximity to the construction compounds and construction works. However, with the implementation of a Dust Management Plan (or wider Environmental/Construction Management Plan), potential construction phase dust emissions (including odour and/or hazardous air pollutants) are likely to be effectively controlled and the potential for dust nuisance effects will be greatly reduced. It is recommended that a condition be imposed requiring a Dust Management Plan that includes the mitigation measures identified in this report. It is also recommended that a programme of dust monitoring is carried out before, during and after the construction phase in order to quantitatively assess the ambient concentrations of particulate matter in the vicinity of the construction compounds and construction works. This monitoring requirement would be appropriate to include as a condition of the designation.

Providing that the mitigation measures are adopted into a site Dust Management Plan and are adhered to at all times during the construction phase, the Auckland Council's permitted activity standards for dust in the operative Auckland Council Regional Plan: Air, Land and Water (see **Section 3**) and the equivalent controls in the Proposed Auckland Unitary Plan (PAUP) are likely to be met.

6.2 Operational Phase

The operational phase road traffic emissions that will be generated along the Lincoln Road corridor have been assessed on a quantitative basis using a screening modelling assessment. The results indicate that the potential air quality effects following the opening of the scheme are likely to be *slight, beneficial* for PM_{10} and *slight, adverse* for NO_2 as the ambient air quality criteria are likely to be met at all sensitive receptor locations and the project road contributions are relatively low (i.e. the potential air quality effects are unlikely to be significant at any sensitive receptor location).

The results indicate that there are unlikely to be any adverse health effects to members of the public located within the Lincoln Road corridor study area as a result of the scheme, as the total predicted annual mean NO_2 concentration was predicted to be 63% of the health-based NO_2 assessment criterion (WHO), while the 24-hour mean PM_{10} concentration was predicted to be 76% of the assessment criterion (NES for PM_{10}).

Appendix A Outputs from the NZ Transport Agency's Air Quality Screening Model (V2.0)

Base Year 2015

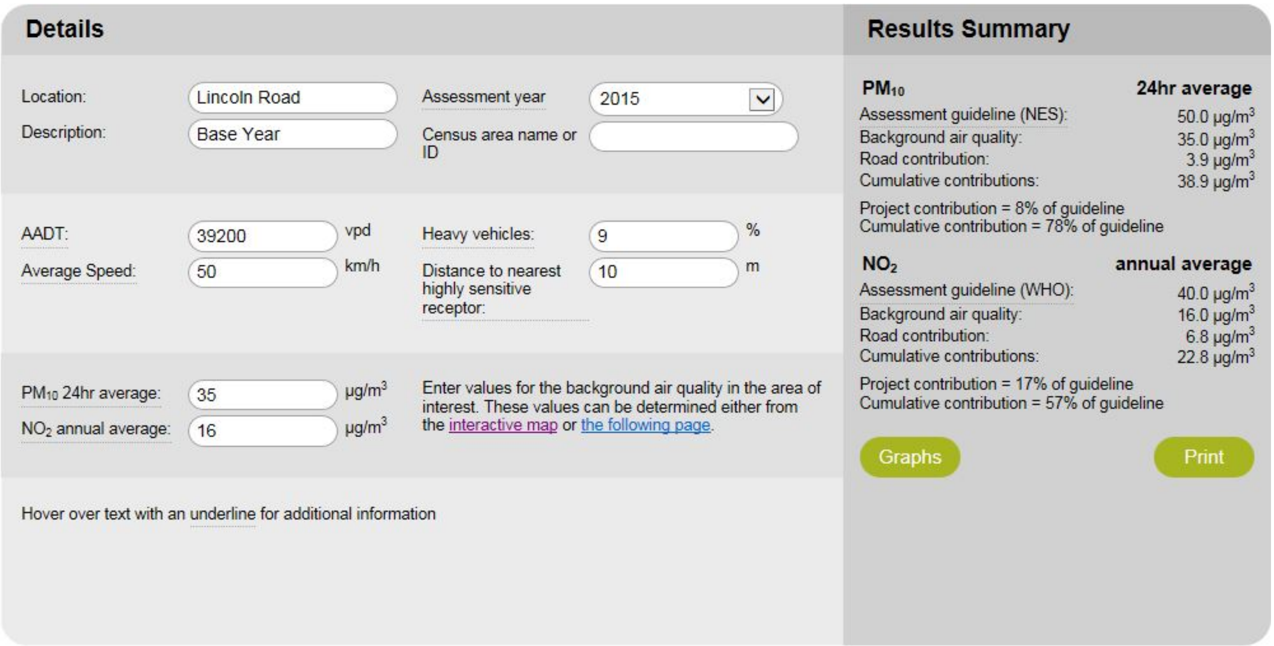

Figure A–1 **Base Year 2015 Total Predicted 24-hour Mean PM_{10} and Annual Mean NO_2 Concentrations—Input Data**

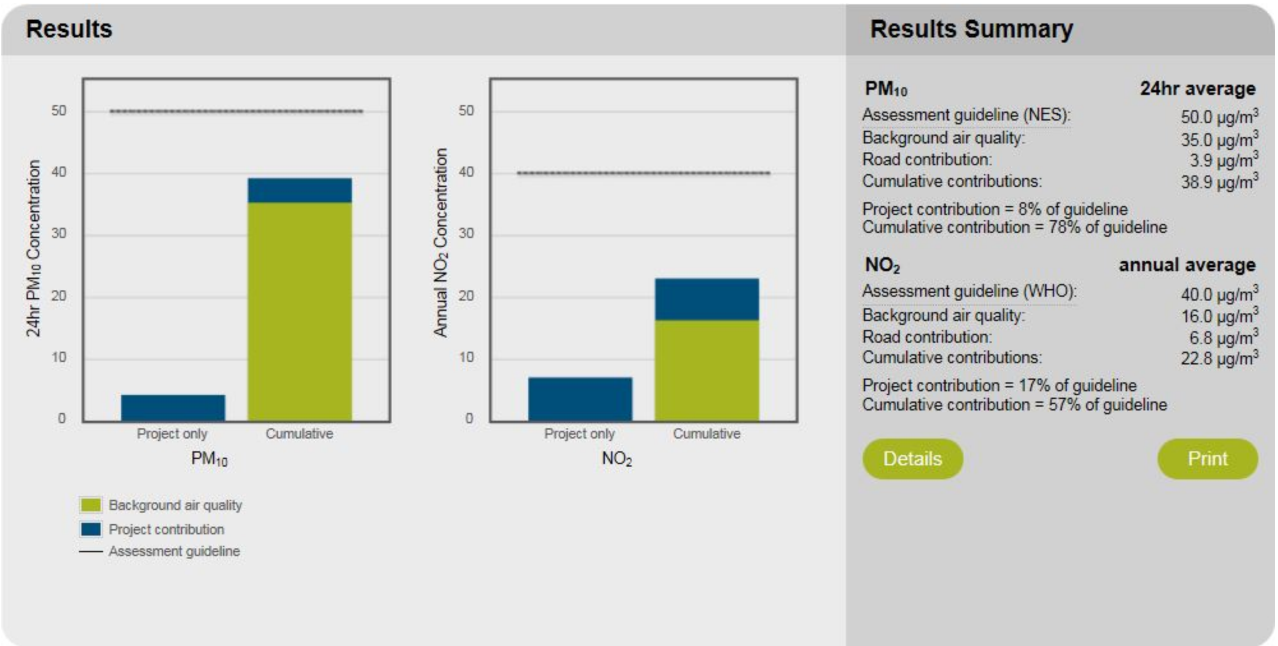

Figure A–2 **Base Year 2015 Total Predicted 24-hour Mean PM_{10} and Annual Mean NO_2 Concentrations—Output Data**

Assessment Year 2026

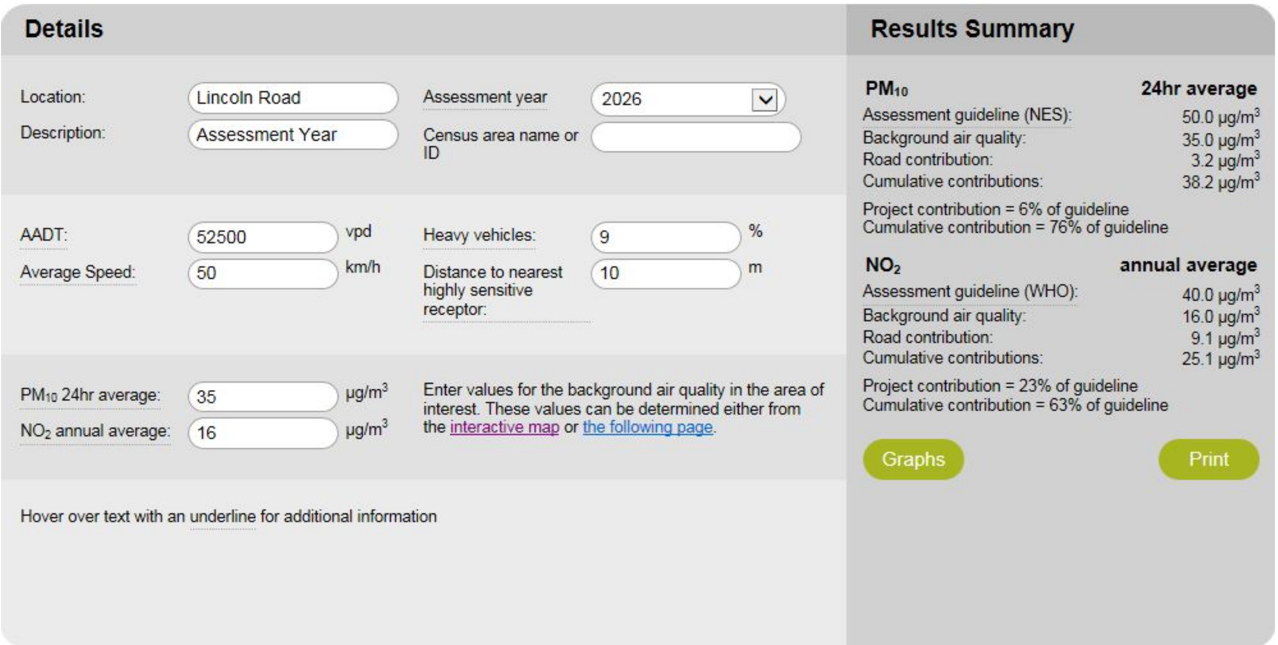

Figure A–3 **Assessment Year 2026 Total Predicted 24-hour Mean PM_{10} and Annual Mean NO_2 Concentrations—Input Data**

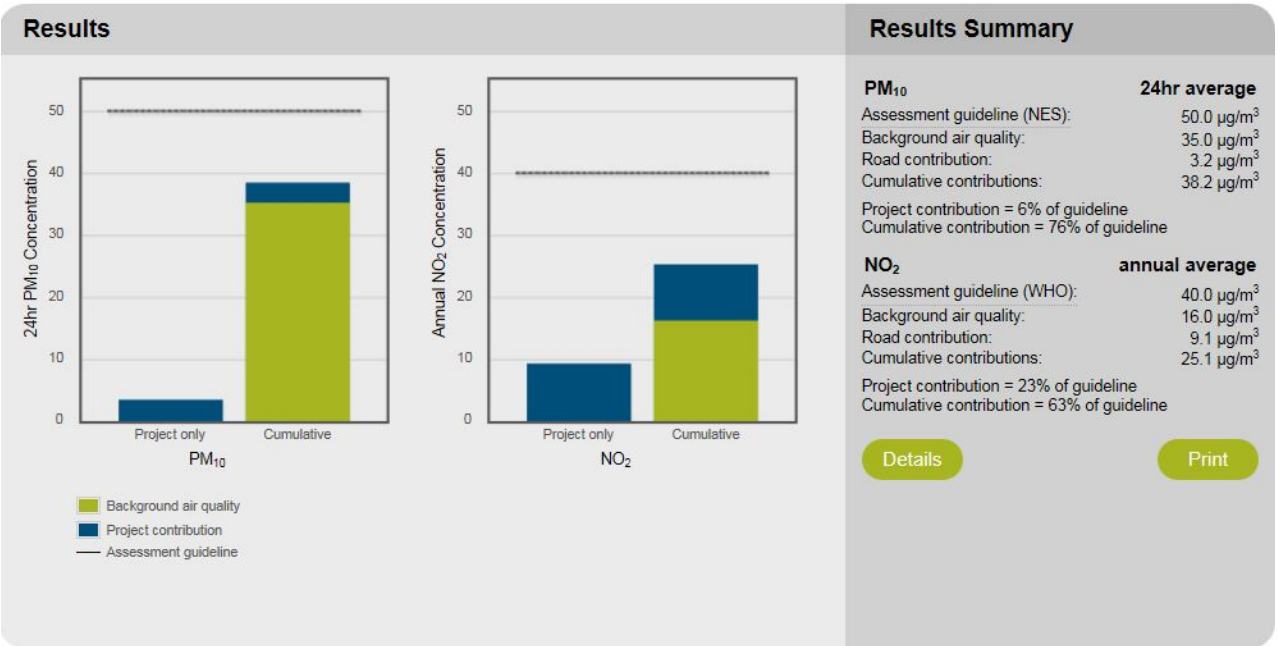

Figure A–4 **Assessment Year 2026 Total Predicted 24-hour Mean PM_{10} and Annual Mean NO_2 Concentrations—Output Data**