Regional Roads Victoria

Beaufort Bypass

Air Quality Impact Assessment Report

January 2021

Consulting Environmental Engineers

CEE Version Control.

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Contents

Abbreviations

BoM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_{2e}	Carbon dioxide equivalent
DOEE	Department of Environment and Energy (Commonwealth)
EES	Environment Effects Statement
EPA	Environment Protection Authority
g/VKT	Grams per Vehicle Kilometre Travelled
GHG	Greenhouse gases
HCV	Heavy commercial vehicles
m/s	Metres per second
NEPM	National Environment Protection Measures
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NEPC	National Environment Protection Council
NPI	National Pollutant Inventory
PAH	Polycyclic Aromatic Hydrocarbon
PM_{10}	Particulate Matter with diameter of less than 10 µm
$PM_{2.5}$	Particulate Matter with diameter of less than 2.5 µm
SEPP(AAQ)	State Environment Protection Policy Ambient Air Quality
SEPP(AQM)	State Environment Protection Policy Air Quality Management
SO_2	Sulphur dioxide
TSP	Total suspended particulates
µg/m^3	Micrograms per cubic metre
VKT	Vehicle kilometres travelled

Executive Summary

This report assesses the effects of the Beaufort Bypass on air quality during the construction and long- term operation of the project. At present, traffic on the Western Highway travels through the centre of Beaufort.

Four alternative routes for the Bypass across the north of Beaufort were developed for assessment. The routes A0 and A1 are located further to the north, further from the town and are marginally longer. The two other routes (C0 and C2) are to the south of the A alignments, and are closer to the town and marginally shorter. The route options have many common features in terms of length, number of intersections, railway crossings and variation in gradient, and some differences in terms of closeness or distance from the town and other existing land uses, amount of excavation and fill, and implications from environmental and amenity viewpoints. A detailed assessment was made of dust during construction and the extent of vehicle emissions from Option C2, which is the preferred route.

The report on air quality:

- Characterises existing air quality and meteorological conditions.
- Describes meteorological conditions in terms of winds, dispersion conditions, rainfall and evaporation, and identifies implications for construction.
- Identifies sensitive receptors in the study area.
- Assesses potential effects of road construction on sensitive receptors due to an increase in dust or other emissions.
- Assesses potential effects of vehicle emissions during the long term operation of the Bypass.
- Evaluates the proposed project's energy consumption and greenhouse gas emissions during construction and identifies measures to improve energy efficiency and reduce greenhouse gas emissions.
- Addresses the requirements of the State Environment Protection Policy (Air Quality Management) and the State Environment Protection Policy (Ambient Air Quality) and the implications of these policies for the project.
- Identifies proposed measures to avoid, mitigate and manage any potential effects, including techniques and methods to be used during construction to manage dust.

The Bypass routes traverse rural residential and rural land across the north of Beaufort. Depending on the route, there are 2 to 4 residences within 100 m of the Bypass and 9 to 12 residences within 300 m of the Bypass roadways.

Beaufort has a temperate climate with a warm summer and cool winter. Rainfall occurs sporadically throughout the year and has a regular seasonal pattern (higher in winter and spring). The average annual rainfall is 680 mm/yr. Over a typical 20-year period, the lowest annual rainfall can be around 490 mm/yr while the highest annual rainfall can be about 870 mm/yr.

The extent of dust during the construction period depends on the weather in that period, and in particular, the number of hot days with strong winds. Light winds come mostly from the south and east. Hot summer winds from the north pose the greatest risk in terms of nuisance dust being experienced at sensitive receptors and in and near the town. The location of sensitive receptors is shown on plans in Appendix A.

The Bureau of Meteorology (BoM) weather station at Beaufort records temperature and rainfall but not wind, therefore, wind records from the stations at Ballarat, 40 km to the south-east of Beaufort, and from Ararat (43 km to the north-west) were used in the assessment. The wind pattern at Beaufort is considered to be similar to Ararat and Ballarat, with dominant winds from the north and the south, but with north-east, south-west and south-east winds also being common.

The air quality impacts of Option C2 assessed in detail are (1) dust emissions from excavation, filling and other construction activities; and (2) vehicle emissions during operations. Modelling of both construction and operation emissions was carried out to predict the potential impacts on the local environment.

The extent of dust raised during construction depends on the weather and stage of construction. There will be more dust on days with high temperatures and strong winds. To address this, dust management procedures have been strengthened.

Dust impacts during construction are expected to extend a short distance beyond the construction corridor on dry days with moderate to strong winds. Construction dust concentrations are predicted to be highest during filling operations and to be less during later stages of construction. The zone of nuisance dust is predicted to extend up to about 200 m from the edge of construction on days of unfavourable weather, although generally the nuisance zone should be less than 150 m for most of the construction period.

The construction period is expected to be two years, and dust impacts will generally be localized in extent and limited to summer where warmer weather predominates. A range of management measures have been recommended to limit the extent of dust and adverse effects on sensitive receptors

Air quality impacts during operations are expected to be negligible at sensitive receptors adjoining the Bypass because there are only a small number of vehicles using the Bypass (traffic is predicted to be 8,970 vehicles per day in 2031). Significant changes in air quality near roadways generally occur with more than 50,000 veh/day. Outside the road reserve, the concentrations of air contaminants from vehicles on the Bypass are predicted to be within the SEPP requirements for air quality.

When operating, the Bypass will result in an improvement in air quality along the main street of Beaufort because the majority of through traffic will have been diverted to the Bypass.

1 Introduction

Regional Roads Victoria (RRV), formerly VicRoads proposes to construct a new freeway section of the Western Highway to bypass the town of Beaufort (the project), linking completed sections of the Western Highway duplication to the east and west of Beaufort.

On 22 July 2015, the Minister for Planning determined an Environment Effects Statement (EES) would be required under the *Environment Effects Act 1978* (EE Act) to assess the potential environmental effects of the project. The EES includes consideration of four alternative alignments and selection of a preferred bypass alignment which identifies the land to be reserved for the future construction. The EES process provides for identification and analysis of the potential environment effects of the project and the means of avoiding, minimising and managing adverse effects. It includes public involvement and allows stakeholders to understand the likely environmental effects of the project and how they will be managed.

1.1 Project Background

The Western Highway is the primary road link between Melbourne and Adelaide. It serves interstate trade between Victoria and South Australia and is a key transport corridor through Victoria's west. Over 6,500 vehicles utilise the Western Highway, west of Ballarat each day. Of these 6,500 vehicles, 1,500 are classed as commercial heavy vehicles. These traffic volumes are expected to increase to approximately 7,500 by 2025 and 9,500 by 2040.

RRV have identified the need to upgrade the Western Highway from Ballarat to Stawell to:

- improve road safety at intersections
- improve safety of access to adjoining properties
- enhance road freight efficiency
- reduce travel time
- provide better access to local facilities
- improve roadside facilities.

As part of planning studies commissioned by the Commonwealth and State Governments, bypass route options around the town of Beaufort have been considered to meet the objectives identified by RRV and the National Land Transport Network's Nation Building Program.

The project would include construction of a dual carriageway, connections to major intersecting roads, interchanges to connect Beaufort to the Western Highway at the eastern and western tie-in points, several waterway crossings, an overpass of the Melbourne-Ararat rail line, and intersection upgrades at local roads and provision for service roads as required.

1.2 Project Objectives

The objectives of the project are to:

- improve road safety and maintain the functionality of Beaufort's road network
- improve freight movement and efficiency across the road network
- improve Beaufort's amenity by removing heavy vehicles
- improve access to markets and the competitiveness of local industries.

2 Project Description

The project would comprise of an 11 km freeway standard bypass to the north of the township of Beaufort, connecting the two recently duplicated sections of the Western Highway to the east and west of Beaufort. The project would be constructed under a Design and Construct or Construct only contract administered by a superintendent at RRV/MRPV, following a competitive tender process. Department of Transport would manage and maintain the asset.

2.1 Freeway Standard Bypass

The project would connect the duplicated sections of the Western Highway to the east and west of Beaufort via the Option C2 bypass to the north of Beaufort that avoids Snowgums Bushland Reserve and cuts through Camp Hill. The bypass would include the following key components:

- designed as a freeway standard bypass
- approximately 11 km long
- designed to 120 km/hr and sign posted to 110 km/hr for its entirety
- two tie-in interchanges
- one road over rail bridge
- waterway crossings
- diamond interchange to connect with the local road network
- four overpass bridge structures over the local road network.

2.2 Interchanges

The project would have interchanges at the following locations:

- tie-in points to existing Western Highway at the eastern and western ends of the bypass
- diamond interchange at existing local road network connection (Beaufort-Lexton Road).

2.3 Bridges and Culverts

The route option would have bridge structures at the following locations:

- road over rail bridge structure for the Melbourne-Ararat rail line
- several waterway bridge structures over Yam Holes Creek
- overpass bridge structures for the existing local road network:
    - Main Lead Road
    - Beaufort-Lexton Road (diamond interchange)
    - Racecourse Road
    - Back Raglan Road.

2.4 Alignment Description

Four alignment options, referred to as Options A0, A1, C0 and C2, were assessed in order to identify a preferred bypass. Following extensive community consultation and technical assessments, Option C2 was selected as the preferred route.

2.4.1 Options Assessed

Option A0

Option A0 is shown in Figure 2.1. The A0 bypass alignment is 11.2 km in length and is the northern most bypass option. From the western tie-in point, approximately 3 km from the Beaufort township, this alignment curves north – north east, where there will be a west-facing, half diamond interchange to maintain access to private properties and the township via the existing Western Highway. The alignment passes over Main Lead Road then climbs through the State Forest north of Camp Hill. From here it descends to a full diamond interchange at Beaufort-Lexton Road, which will provide access to the north and south of the township, before re-joining the Western Highway at its eastern extent, approximately 4.5 km from Beaufort. An outbound exit ramp at the eastern interchange will allow for eastern access to Beaufort via the existing Western Highway. Bridges will pass over Main Lead and Racecourse Roads, as well as over the Melbourne-Ararat train line. The main areas of fill occur at bridge and interchange locations with a large cut section north of Camp Hill.

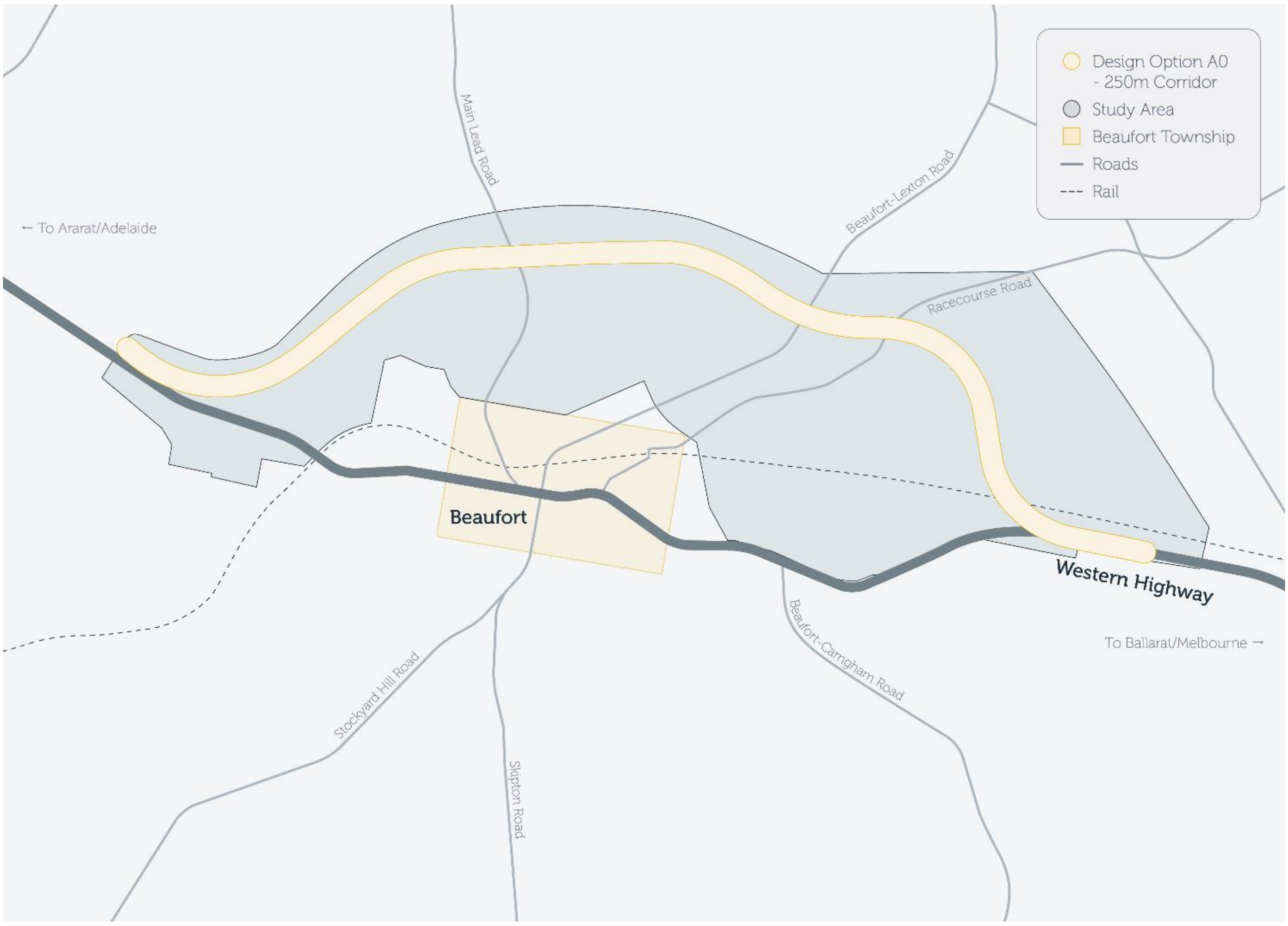

Figure 2.1 Beaufort Bypass A0 Alignment Option

Option A1

Option A1 is shown in Figure 2.2. The A1 bypass alignment option is 11.1 km in length. Approximately 3 km from the Beaufort township, this alignment deviates north-east from the Western Highway, staying slightly south of option A0 until a point east of Main Lead Road, where it re-joins the A0 alignment. There will be a west-facing, half diamond interchange at the western tie-in to maintain access to private properties and the township of Beaufort via the existing Western Highway, and a full diamond interchange at Beaufort-Lexton Road to maintain north-south access. The A1 alignment will re-join the Western Highway approximately 4.5 km to the east of the township. An outbound exit ramp at the eastern interchange will allow for eastern access to Beaufort via the existing Western Highway. Bridges will pass over Main Lead and Racecourse Roads, as well as over the Melbourne-Ararat train line. The main areas of fill occur at bridge and interchange locations, with cuts north-east of Back Raglan Road, and north of Camp Hill.

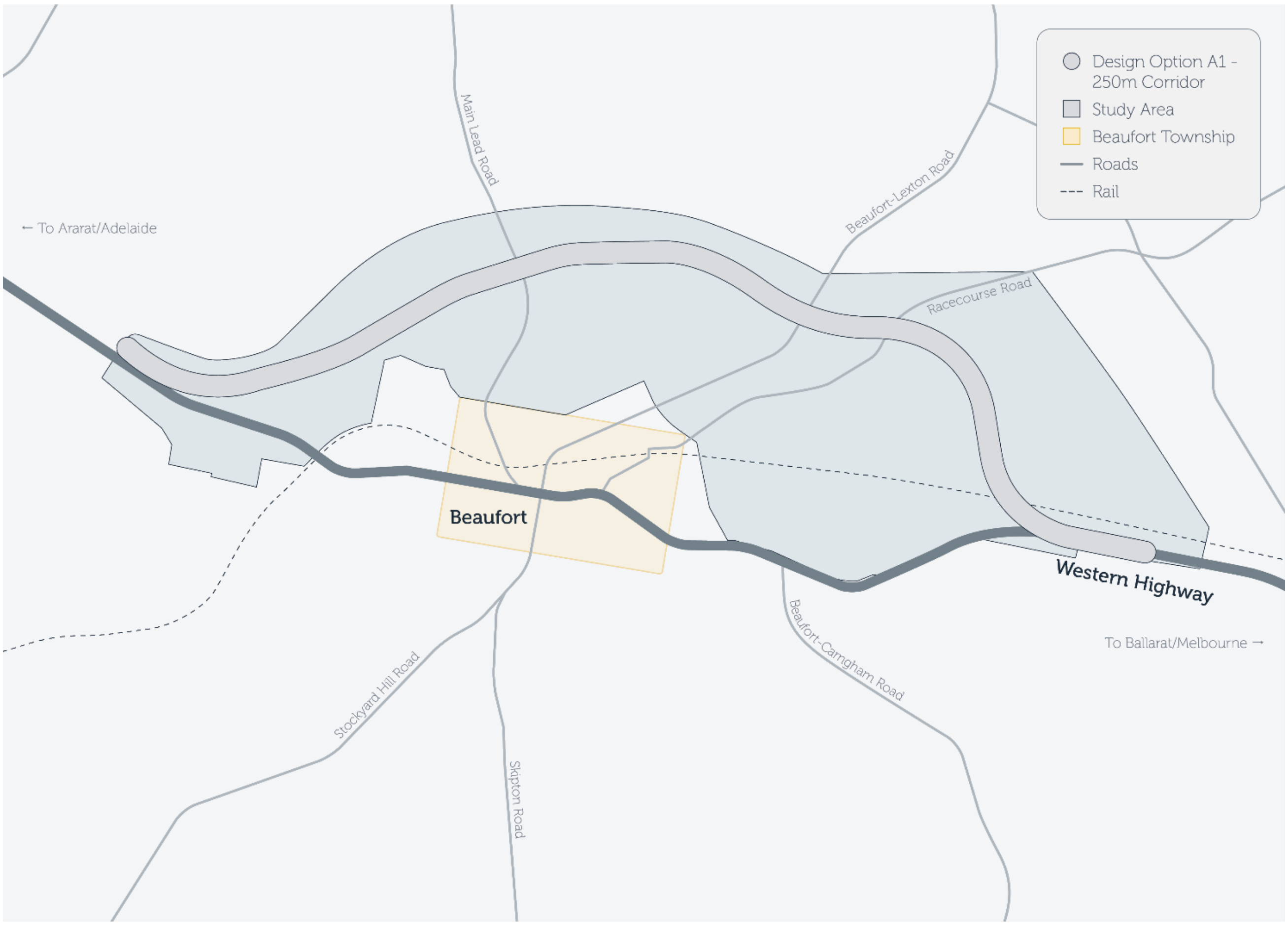

Figure 2.2 Beaufort Bypass A1 Alignment Option

Option C0

Option C0 is shown in Figure 2.3. The southernmost option, C0, is approximately 10.6 km in length from the west to east tie-in points of the Western Highway. Access to the Beaufort township via the existing Western Highway will be maintained by a west -facing, half diamond interchange in the west. The C0 option follows the A0 option from the western tie-in point, approximately 3 km from the Beaufort township, before deviating at Back Raglan Road in a more easterly direction almost parallel to the existing Western Highway. This option passes close to the north of Camp Hill, with some cut and fill required in this section, before curving south-east to a full diamond interchange at Beaufort-Lexton Road, providing north-south access. The C0 alignment will re-join the Western Highway approximately 4.5 km to the east of the township. Bridges will pass over Main Lead and Racecourse Roads, as well as over the Melbourne-Ararat train line. The main areas of fill occur at bridge and interchange locations, with the largest cut and fill areas north and north-east of Camp Hill.

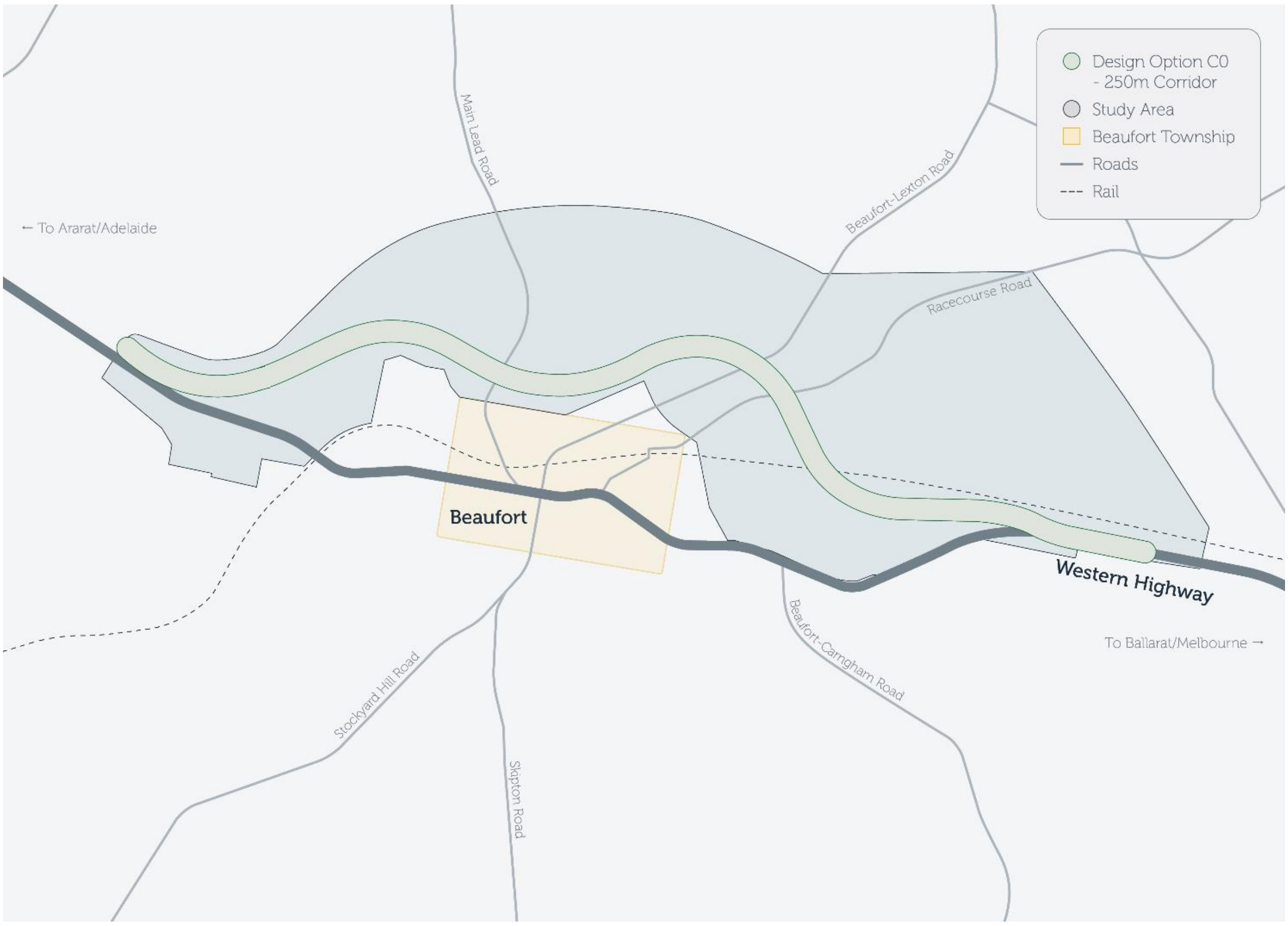

Figure 2.3 Beaufort Bypass C0 Alignment Option

2.4.2 Preferred Alignment

Option C2

The preferred Option C2 is shown in Figure 2.4. Option C2 is 11 km in length and is a hybrid between the A0 and the C0 options. It follows the C0 option from the western tie-in point (approximately 3 km from the Beaufort township) until Beaufort-Lexton Road, where it continues in an easterly direction and joins the A0 alignment near Racecourse Road. The C2 alignment will re-join the existing Western Highway at the eastern tie-it point, approximately 4.5 km from the township. At the western extent, access to Beaufort via the existing Western Highway will be maintained by a half diamond interchange, and there will be a full diamond interchange over Beaufort-Lexton Road. Access to Beaufort via the existing Western Highway at the eastern approach will be maintained by an outbound exit ramp at the eastern interchange. Again, bridges will pass over Main Lead and Racecourse Roads, as well as over the Melbourne-Ararat train line. The main areas of fill occur at bridge and interchange locations, with the largest cut and fill areas north and north east of Camp Hill.

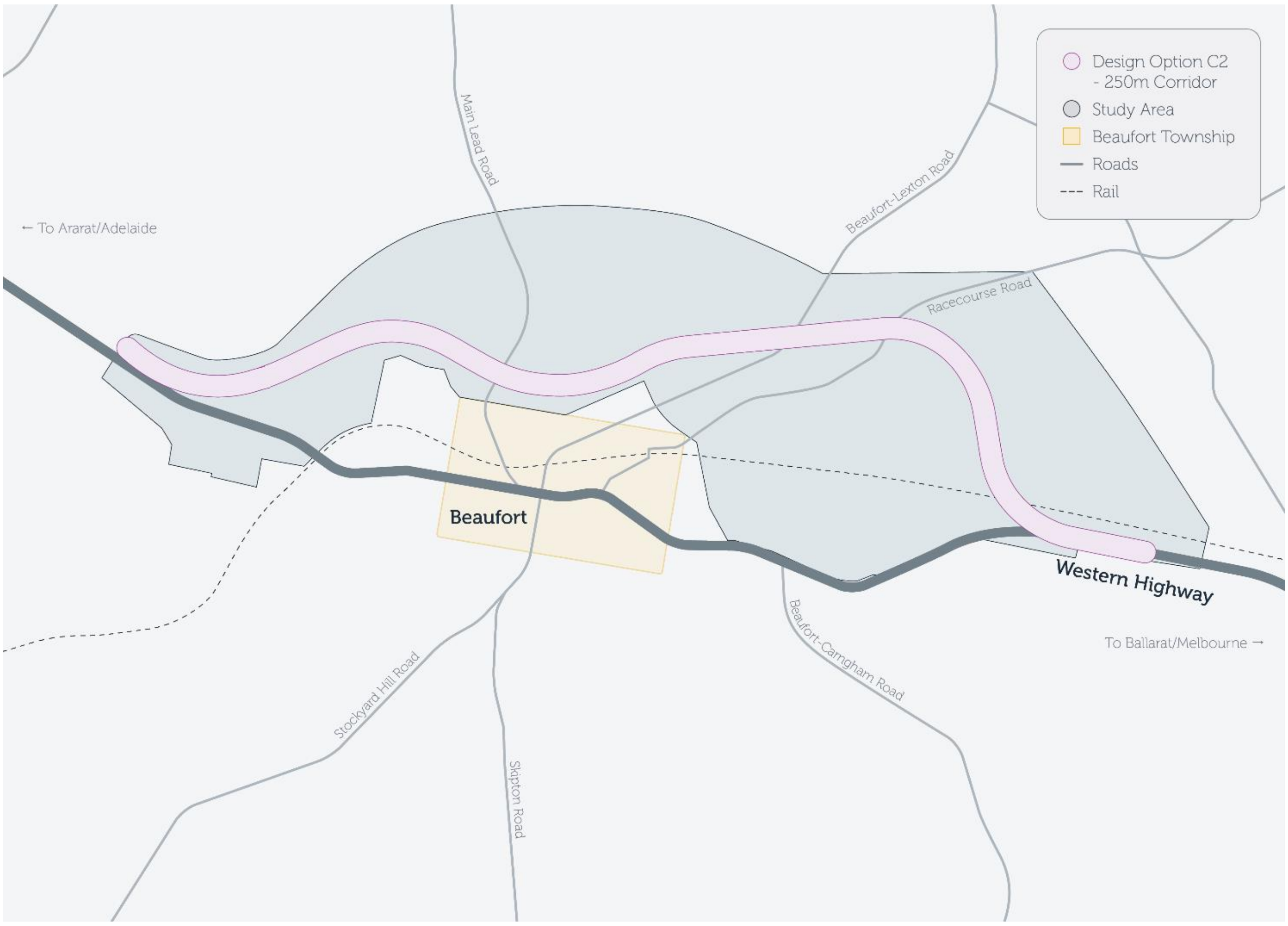

Figure 2.4 Beaufort Bypass C2 Alignment Option

Figure 2.5 shows the four alignment options that were assessed. All extend around the north of the township of Beaufort, and have similar lengths, ranging from 10.6 km to 11.2 km.

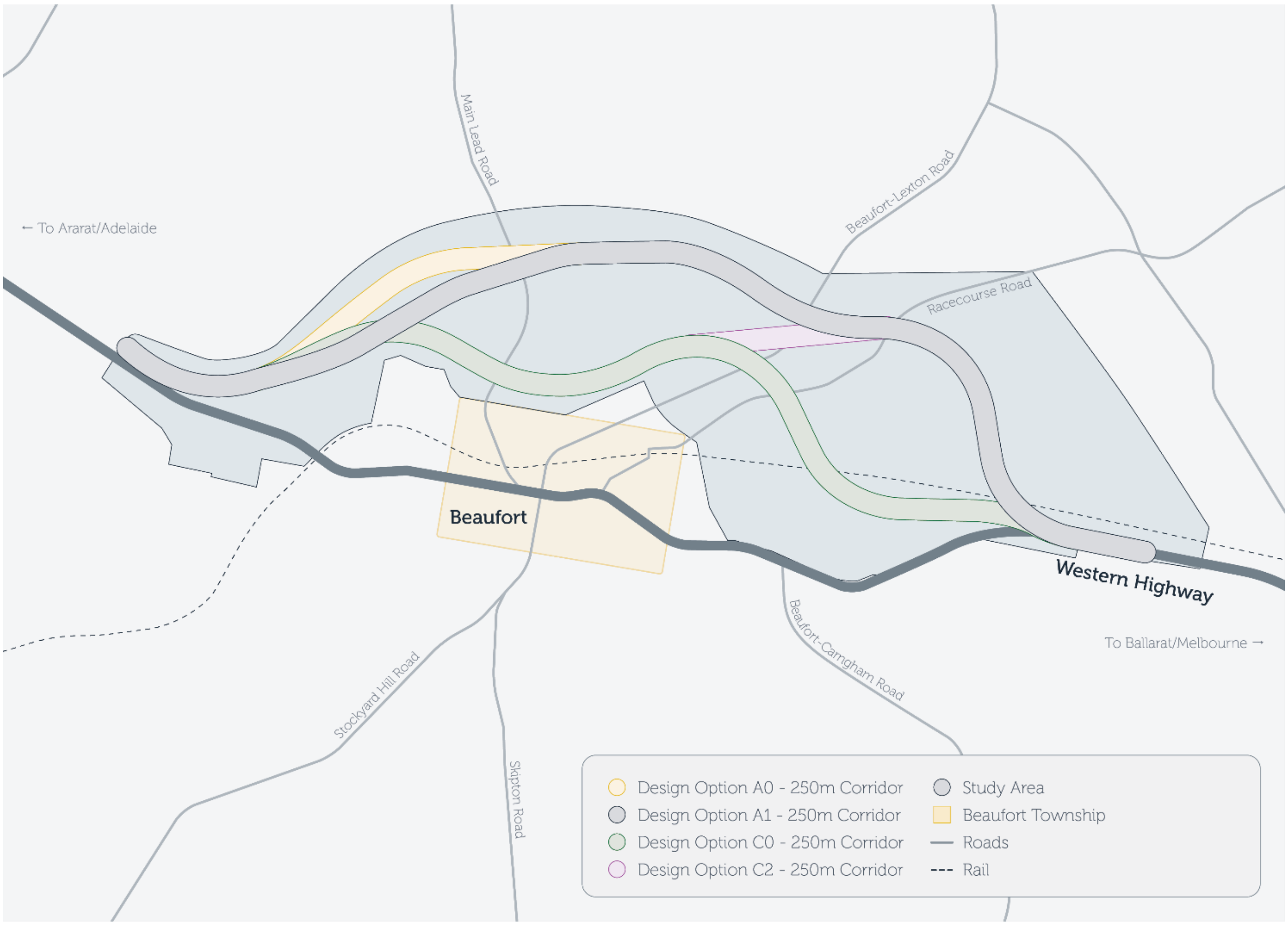

Figure 2.5 Beaufort Bypass Study Area and Alignment Options

2.5 Project Construction

The following sections describe the construction activities for the project. Construction of the bypass is expected to take two years and commence once construction funding and approvals are obtained.

2.5.1 Construction Activities

Construction activities would include:

- preconstruction site delineation and compound setup, which may include (but not be limited to) tree clearance and vegetation lopping / removal, and establishment of construction site(s) and access tracks;
- establishment of environmental and traffic controls;
- route clearance and relocation and / or protection of utilities;
- channel realignments to maintain existing flow paths;
- construction drainage and sediment and erosion control mitigation;
- general earthworks:
  - excavation of a cut including stripping of topsoil and placement of fill;
  - import, export and stockpiling of fill;
  - treatment of contaminated soil or removal of hazardous material, if required;
- development of structures, interchanges, batters, drainage and pavement;
- development of ancillary infrastructure:
  - noise barriers;
  - lighting;
  - safety barriers;
  - line marking; and
- landscaping and site reinstatement.

2.6 Operations and Maintenance

Operations and maintenance of the project would be consistent with current practices and standards, including the VicRoads' *Roadside Management Strategy* (2011). Key objectives include:

- asset management of:
  - landscaped areas;
  - stormwater drains;
  - bridges and culverts;
  - road pavement;
  - signage;
  - barriers;
  - line marking;
- enhancement of transport safety, efficiency and access;
- protection of environmental and cultural heritage values;
- management of fire risk;
- preservation and enhancement of roadside amenity;
- routine and life cycle maintenance activities throughout operations; and
- monitoring and management of areas of environmental sensitivity such as water bodies and wildlife corridors.

3 EES Scoping Requirements

The *Scoping Requirements for Beaufort Bypass Project Environment Effects Statement* (DELWP 2016) (Scoping Requirements) have been prepared by DELWP on behalf of the Minister for Planning. The Scoping Requirements set out the specific environmental matters to be investigated and documented in the EES, which informs the scope of the EES technical studies.

The following matters of the Scoping Requirements are relevant to the air quality impact assessment:

EES evaluation objective:

AMENITY: *To minimise adverse air quality, noise or vibration effects on the amenity of residents and local communities, as far as practicable during construction and operation.*

SCOPING REQUIREMENTS SUB-SECTION	MATTER TO BE ADDRESSED	RELEVANT ASSESSMENT	ADDRESSED IN THIS ASSESSMENT
Key issues	Increased noise levels from the project's construction and operation could affect amenity in areas in close proximity to the road alignment alternatives.	Noise & Vibration Impact Assessment	EES Chapter 14 (Amenity)
Priorities for characterising the existing environment	Characterise the existing noise setting in adjacent established residential, rural residential, commercial and open space areas and at other sensitive land use locations.	Noise & Vibration Impact Assessment	EES Chapter 14 (Amenity)
Design and mitigation measures	Identify design responses or other mitigation measures to avoid, reduce or manage any significant noise, air quality or vibration effects at sensitive land use locations during the project construction and operation, in the context of relevant guidelines, planning policy and VicRoads Traffic Noise Reduction Policy 2005.	Noise & Vibration Impact Assessment	EES Chapter 14 (Amenity)
		Air Quality Assessment	✓
Assessment of likely effects	Assess likely noise increases (due to operation) at sensitive land use locations along each alignment alternative, both with and in the absence of the proposed mitigation measures.	Noise & Vibration Impact Assessment	EES Chapter 14 (Amenity)
Approach to manage performance	Identify proposed measures to manage residual effects on amenity during project implementation, including: noise and dust emissions and the effects of vibration during and after project construction.	Air Quality Assessment	✓
		Noise & Vibration Impact Assessment	EES Chapter 14 (Amenity)
	Include identified measures in the EMF.	Air Quality Assessment	✓

4 Methodology

4.1 Study Area

The terminology used throughout the current technical assessment relating to the study area and alignment options is defined below.

Study area: The study area for the Beaufort Bypass EES project includes approximately 1,800 ha of land north of the Beaufort township, which contains the four bypass options assessed in this report. During the development stages of the alignment options, the study area was assessed to determine potential environmental impacts and constraints of individual alignment options.

Alignment options: Alignment options (A0, A1, C0 and C2) refer to the four selected bypass options assessed within the study area. Each alignment option consists of a 250 m corridor in which the specific bypass option has been designed. Each alignment option, unless otherwise stipulated, is the area assessed for direct and indirect impacts resulting from the construction, operation and maintenance of the project.

4.2 Existing Conditions Assessment

The existing conditions assessment for air quality examined the local climate, monthly and annual variations in air temperature and rainfall, wind patterns and ambient air quality. Beaufort has a temperate climate with a warm summer and cool winter. Rainfall occurs sporadically throughout the year and has a regular seasonal pattern (higher in winter and spring). The average annual rainfall is 680 mm/yr.

The Bureau of Meteorology (BoM) weather station at Beaufort records temperature and rainfall but not wind, therefore, wind records from the stations at Ballarat, 40 km to the south-east of Beaufort, and from Ararat (43 km to the north-west) were used in the assessment.

The prevailing meteorology and climate influences the generation of emissions and the dispersion of emissions. A meteorological file of hourly wind speed and direction over a year was derived for modelling air quality.

4.3 Risk Assessment

An environmental risk assessment (ERA) has been used in the Beaufort Bypass EES to identify environmental impacts associated with the construction and operation phases of the project. The risk assessment process is consistent with the guidance provided in Sections 3.1 and 4 of the *Scoping Requirements for the Beaufort Bypass Project EES* (DELWP 2016) and the Ministerial guidelines for assessment of the environmental effects under the Environment Effects Act 1978 (DSE 2006).

The purpose of the ERA was to provide a systematic approach to the identification and further assessment of potential impacts resulting from the project, whether they be environmental, social or economic. The ERA articulates the probability of an incident with environmental, social and economic effects occurring and the consequence of that impact to the environment. Identified impacts with a medium or higher initial risk are subject to detailed impact assessment and mitigation treatments, detailed within each discipline impact assessment.

RRV defines environmental risk and environmental impact as follows.

- **Environmental risk** reflects the potential for negative change, injury or loss with respect to environmental assets" (DSE 2006). This approach is consistent with ISO 31000: 2018, which defines risk as "the effect of uncertainty of [environmental] objectives". Both definitions reflect the fact that risk is typically expressed in terms of the likelihood of a change occurring and the consequence of that change.
- **Environmental impact** is any change to the environment as a result of project activities.

The risk assessment is a critical part of the EES process as it guides the level and range of impact assessment for the EES and facilitates a consistent approach to risk assessment across the various disciplines.

4.3.1 Risk Assessment Process

The ERA has guided the environmental impact assessment for the project. The objectives of the ERA are to:

- Identify primary environmental risks that relate to the construction and operation of the project.
- Guide the extent of investigation and data gathering to accurately characterise the existing environment and assess the project's environmental impact.
- Identify mitigation measures to avoid, minimise and mitigate environmental risks.
- Assess likely residual effects expected to be experienced after standard controls and proposed mitigations have been implemented.

The risk assessment process for the EES adopts a risk management framework as detailed in the VicRoads Environmental Sustainability toolkit. The process includes:

- An environmental management approach aligned with ISO 31000:2018.
- Systems to manage environmental risk and protect the environment, that are implemented at different stages of road construction, operation and maintenance.
- Tools and reporting requirements which provide guidance in managing environmental issues throughout the project.

The ERA identifies impact events for each relevant element of the environment, details the primary risks and informs the level and range of technical reporting required to address predicted impacts. The ERA uses a risk matrix approach where the likelihood and consequence of an event occurring are considered. All risks are reassessed at regular intervals during the project, from the development of the EES to operation and maintenance, to ensure they are still applicable, that controls are appropriate and effective, and that they reflect most recent outcomes of specialist technical studies.

Table 4-1 Risk Assessment Matrix

			LIKELIHOOD				
CONSEQUENCE	Risk Categories		Rare (A)	Unlikely (B)	Possible (C)	Likely (D)	Almost Certain (E)
	Catastrophic	5	Medium	High	High	Extreme	Extreme
	Major	4	Medium	Medium	High	High	Extreme
	Moderate	3	Low	Medium	Medium	High	High
	Minor	2	Negligible	Low	Low	Medium	Medium
	Insignificant	1	Negligible	Negligible	Negligible	Low	Low

Based on the project objectives and context, a set of project-specific and appropriate assessment, likelihood and consequence criteria were developed. The likelihood categories and consequence descriptions are used as a guide for evaluating risk and are shown below in Table 4.2 and Table 4.3.

Table 4-2 Likelihood Categories

RARE (A)	UNLIKELY (B)	POSSIBLE (C)	LIKELY (D)	ALMOST CERTAIN (E)
Less than once in 12 months OR 5 % chance of recurrence during course of the contract	About once in 6 months OR 10 % chance of recurrence during course of the contract	About once in 4 months OR 30 % chance of recurrence during course of the contract	About once in 2 months OR 50 % chance of recurrence during course of the contract	About once in a month OR 100 % chance of recurrence during course of the contract
The event may occur only in exceptional circumstances	The event could occur but is not expected	The event could occur	The event will probably occur in most circumstances	The event is expected to occur in most circumstances
It has not happened in Victoria but has occurred on other road projects in Australia.	It has not happened regionally but has occurred on other road projects in Victoria	It has happened in the Beaufort region	It has happened on an adjoining section of the Western Highway	It has happened on more than one of the adjoining Western Highway projects OR It has happened multiple times on an adjoining Western Highway project.

Consequence criteria have been developed for the project in consultation with technical specialists. The result is a discipline and aspect-specific set of consequence descriptors used to define what would be considered an Insignificant, Minor, Moderate, Major and Catastrophic consequence associated with a risk event.

Table 4-3 Air Quality Risk Assessment - Consequences Descriptors

ASPECT	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
Dust	Not noticeable	Minor dust seen	Cleaning needed	Bad amenity	Beathing difficulty
Dust in roof water	No change	Minor effect on quality	Evident in showers/ washing	Discoloration	Exceeds drinking water guideline
Elevated contaminants from vehicle emissions	Well under EPA limits	Minor local change	Large change from now	Exceeds EPA Guideline	Health impacts

The risk assessment was undertaken for each discrete alignment option as each option had a distinct profile, type and extent of environmental impacts. The assessment of these impacts is detailed within Sections 7 and 9 of this report.

4.4 Impact Assessment

The impact assessment for the project has utilised the environmental risk assessment to inform the areas for further investigation. Impacts assessed within this assessment have typically been identified as having a medium or higher initial risk within the risk assessment when standard controls were applied. The impact assessment was prepared in two stages, initially to inform the options assessment and then, following the selection of the preferred alignment, the impact assessment was revised to report impacts and mitigations specifically on the preferred alignment. The project describes and assesses impacts in terms of the following:

- Description of impact
- Identification of whether impacts are direct or indirect
- Prediction of the magnitude, extent and duration of impact
- Overall rating of impact (without mitigation)
- Residual rating of impact (with mitigation).

The impact assessment for air quality examined the amount of dust generated during construction and the dust levels at nearby receptors during construction.

The assessment also included prediction of the concentrations of the principal air quality pollutants emitted from vehicles, and the concentration of these pollutants at nearby receptors, including the contribution from background sources. The EPA air quality limits were used to assess potential impacts.

4.4.1 Dust Modelling

The assessment of potential impacts from dust emissions during construction is presented in Section 7.1. The methodology used was to:

- Obtain the volume of excavation and fill for each route;
- Obtain the construction period (2 years);
- Estimate the type, number and characteristics of construction equipment;
- Estimate the dust emissions using the volume of cut and fill, and published information on dust generation from typical construction equipment that may be used;
- Model the transport and dispersion of dust as total dust and as fine particulates (PM_{10});
- Plot the distribution of peak dust and PM_{10} concentration during construction activities; and
- Compare the predicted levels to acceptable levels and assess the zone of potential impact.

4.4.2 Emissions Modelling

The assessment of potential impacts from vehicle emissions during operations is presented in Section 7.2. The methodology used was to:

- Obtain the number of vehicles per day and in the peak hour each day from traffic data provided by WSP;
- Establish the number of vehicles per day and in the peak hour each day;
- Establish the types of vehicles (fleet composition);
- Estimate the vehicle emissions, using EPA data, for carbon monoxide (CO), nitrogen dioxide (NO_2) and fine particles (PM and $PM_{2.5}$);
- Model the transport and dispersion of these contaminants at the 99.9 percentile frequency (i.e., for the highest 8 hours in a year) or at appropriate averaging periods;
- Plot the distribution of concentration on a cross-section of the road, up to 300 m on each side (eg, north and south) of the roadway; and
- Compare the predicted near-road air quality at sensitive receptors, including the background air quality, against;
    - the design limits in Schedule A of the SEPP(AQM),
    - the intervention limits in Schedule B of the SEPP(AQM), and
    - the environmental objectives in the SEPP(AAQ).

4.4.3 Greenhouse Gas Assessment

The assessment of potential greenhouse gas (GHG) emissions during construction and operations from vehicle emissions is presented in Section 10. The methodology used was to:

- Establish the fuel use of construction equipment and estimate GHG emissions during construction;
- Establish the fuel use of the vehicle fleet during operations and estimate GHG emissions; and
- Use comparative GHG emissions data as the basis for assessment.

4.5 Mitigation

Mitigations for identified impacts were developed by discipline specialists in consultation with RRV. All identified mitigations developed for the project have been informed by specialist experience with proven feasible control measures for major civil infrastructure projects, industry best practice measures and regulatory measures defined by State, Commonwealth and International Government agencies.

Mitigations for the project were developed throughout the impact assessment process to inform the residual impacts of the preferred alignment defined in Section 11.

4.6 Options Assessment

The alignment refinement for the Beaufort Bypass has been undertaken in three distinct phases since project inception. These are discussed in the *Beaufort Bypass Options Assessment Report* as:

- Phase 1 – Concept alignment development
- Phase 2 – Option development and assessment
- Phase 3 – Identification of preferred alignment.

This options assessment method section considers the Phase 3 assessment and details the process for selection of the preferred alignment.

The Phase 3 assessment considered four alignment options to select the preferred alignment, utilising a customised comparative options assessment to rank each option against the following areas:

- Biodiversity
- Catchment values and hydrology
- Cultural heritage (Aboriginal and Historic)
- Social and Community
- ***Amenity (including air quality)***
- Landscape and Visual.

Multiple scoring scenarios and sensitivity testings were undertaken against each option to ensure the environmental, social, heritage and economic assessment criteria aligned with the EES evaluation objectives. The scoring framework developed sought to ensure a wholistic decision-making process was undertaken, and that no single scoring or sensitivity scenario would be the primary determining factor in the identification and selection of the preferred alignment.

Weightings for the assessment included the application of six scenarios and sensitivity tests to eliminate bias of specific environmental constraints. These scenarios included:

- Scenario 1: Apply a score of 1 to 4 from least to highest impact
- Scenario 2: Alignment with highest number of least impact scores
- Scenario 3: Apply a score of 1 to the highest impact and the subtract the percentage difference between alignments
- Scenario 4: Apply a score of 1 to least impact and then add the percentage difference between remaining alignments
- Scenario 5: As per Scenario 3, but minus criteria that can be mitigated
- Scenario 6: As per Scenario 4, but minus criteria that can be mitigated

The sensitivity tests included:

- Scoring sensitivity scenario 1:
    - Options with the lowest impact and other options within 5% of the lowest impact are apportioned a score of one point and a green light
    - Options within 5-20% of the lowest impact option are apportioned a score of zero points and an amber light
    - Options with an impact of 20% or greater than the lowest impact option are apportioned a score of minus one and a red light.
- Scoring sensitivity scenario 2:
    - Options with the lowest impact and other options within 5% of the lowest impact are apportioned a score of one point and a green light
    - Options within 5-25% of the lowest impact option are apportioned a score of zero points and an amber light
    - Options with an impact of 25% or greater than the lowest impact option are apportioned a score of minus one and a red light.
- Scoring sensitivity scenario 3:
    - Options with the lowest impact and other options within 5% of the lowest impact are apportioned a score of one point and a green light
    - Options within 5-15% of the lowest impact option are apportioned a score of zero points and an amber light
    - Options with an impact of 15% or greater than the lowest impact option are apportioned a score of minus one and a red light.

The assessment process included an iterative process with RRV, the Technical Reference Group (TRG), legal and discipline specialists to refine the assessment environmental risk workshops and develop a customised assessment matrix. The suite of assessment criteria are detailed within the EES Attachment IV: *Beaufort Bypass Options Assessment Report.*

5 Legislation

This section assesses the project against the Commonwealth and State legislation, policies and guidelines relevant to the air quality assessment.

5.1 Commonwealth Legislation

The National policies relevant to the air quality assessment are listed in Table 5-1.

Table 5-1. Relevant National Air Quality Policies

Legislation/Policy	Description
National Environmental Protection Air Quality Measure **AQ NEPM**	AQ (NEPM) defines the national standards for air pollutants in Australia. These establish protection levels for exposure to air pollutants. The key air pollutants relevant to a road project are: • Carbon monoxide; • Nitrogen dioxide; and • Particulate matter (PM_{10} and $PM_{2.5}$).
National Environment Protection (Air Toxics) Measure **Air Toxics NEPM**	The Air Toxics NEPM establishes "monitoring investigation levels" for air toxics: • Benzene; • Toluene; • Formaldehyde; • Xylenes; and • Benzo(a)pyrene as an indicator for Polycyclic Aromatic Hydrocarbons (PAH).

In December 2015, Australian Environment Ministers agreed to adopt reporting standards for annual average and 24-hour $PM_{2.5}$ particle levels of 8 µg/m^3 and 25 µg/m^3, respectively. The aim is to reduce the $PM_{2.5}$ standards to 7 µg/m^3 and 20 µg/m^3, respectively, by 2025. The NEPM was varied to include these changes on 3 February 2016.

Victoria has adopted the more stringent annual average PM_{10} standard of 20 µg/m^3 and this change has been incorporated into an updated SEPP(AAQ). Thus, from 2016, the SEPP(AAQ) incorporates the future $PM_{2.5}$ limits of 7 µg/m^3 as an annual average and 20 µg/m^3 as a 24-hour average.

5.2 State Legislation, Regulation and Policy

The EPA administers the:

- Environment Protection Act 1970
- National Environment Protection Council (Victoria) Act 1995
- Environment Protection Act 2017
- Environment Protection Amendment Act 2018

The State Government proposes to implement a new environmental protection legislative regime no later than December 2021 when the EP Act 1970 will be repealed and will be replaced by the EP Act 2017 as amended by the Environment Protection (Amendment) Act 2018. At this stage, it does not appear that there will be changes to the air quality design criteria or regional air quality guidelines.

Subordinate legislation sits under the Environment Protection Act 1970 and aims to protect air, water and land. It includes:

- State Environment Protection Policies (SEPPs)
- Waste Management Policies (WMPs)
- Regulations.

SEPPs express community expectations and priorities for using and protecting the environment. They establish the beneficial uses and values of the environment, define environmental quality objectives and describe attainment and management programs to ensure environmental quality is maintained and improved. The State environment protection policies (SEPPs) concerning air quality are:

- State Environment Protection Policy (Ambient Air Quality)
- State Environment Protection Policy (Air Quality Management).

Victorian legislation and government policies relevant to the air quality assessment are listed in Table 5-2.

Table 5-2. Relevant Victorian Air Quality Legislation and Policies

Legislation/Policy	**Description**
Transport Integration Act 2010	Part 2, Division 2, Section 10 of the Act outlines the transport objectives relating to environmental sustainability. These are: ‘The transport system should actively contribute to environmental sustainability by: • Protecting, conserving and improving the natural environment; • Avoiding, minimising and offsetting harm to the local and global environment, including transport-related emissions and pollutants and the loss of biodiversity; • Promoting forms of transport and the use of forms of energy and transport technologies which have the least impact on the natural environment; • Improving the environmental performance of all forms of transport and the forms of energy used in transport’.
Environment Protection Act 1970	Air quality in Victoria is managed by the *Environment Protection Act 1970* (EP Act); and the relevant State environment protection policies created under Section 16 of the Act. The two policies for air quality are: • State Environment Protection Policy (Air Quality Management) 2001 – SEPP (AQM); and • State Environment Protection Policy (Ambient Air Quality) 1999 – SEPP (AAQ).

The *State Environment Protection Policy for Air Quality Management (SEPP (AQM))* requires road projects to be assessed under Part D of Schedule C, which includes modelling of emissions to air from proposed transport corridors. These models require definition of the emissions, transport due to winds, dispersion and background (ambient) concentrations of contaminants.

SEPP(AQM) sets out intervention levels (specified in Schedule B) for specific contaminants that are normally applied adjacent to road projects during construction and operations. The intervention levels for major contaminants are listed in Table 5-3. Note that sulphur dioxide and air toxics are not listed as they are not significant issues for this study, where there is a low traffic volume in an essentially rural area, a low background level of sulphur dioxide and vehicles are a minor source of SO_2 emissions.

Table 5-3 Intervention Levels for Air Contaminants

Contaminant	Intervention Level	Averaging Period
Carbon monoxide (CO)	33,200 µg/m^3	1-hour
Nitrogen dioxide (NO_2)	263 µg/m^3	1-hour
Fine particles (PM_{10})	60 µg/m^3	24-hours
Very fine particles ($PM_{2.5}$)	36 µg/m^3	24-hours

For the Mordialloc Bypass project, the EPA recommended that the design criteria in Schedule A of the SEPP(AQM) should be used as well as the intervention criteria. The design criteria all use a 1-hour averaging time and are listed in Table 5-4 for the major contaminants. The design levels have lower concentrations limits for CO and NO_2, but higher levels for PM_{10} and $PM_{2.5}$ (as the design criteria have shorter averaging periods for PM_{10} and $PM_{2.5}$).

Table 5-4 SEPP(AQM) Design Criteria for Air Contaminants

Contaminant	Design Criteria	Averaging Period
Carbon monoxide (CO)	29,000 µg/m^3	1-hour
Nitrogen dioxide (NO_2)	190 µg/m^3	1-hour
Fine particles (PM_{10})	80 µg/m^3	1-hour
Very fine particles ($PM_{2.5}$)	50 µg/m^3	1-hour

SEPP(AAQ) adopts the Air Quality objectives of the *National Environment Protection Measures (NEPM)* and sets out objectives for average contaminant levels in regional areas (and thus compliments the intervention levels that specify the maximum allowable contaminant levels). These limits are listed in Table 5-5. The regional average levels are more stringent than the intervention levels.

In July 2021, the SEPP(AAQ) will be replaced by an *Environment Reference Standard* made under the Environment Protection Act 2017. The current environmental indicators and objectives in the current SEPP(AAQ) also are listed in Table 2-2 of the *Environmental Reference Standard*.

Table 5-5 SEPP(AAQ) and NEPM Regional Air Quality Guideline Levels

Contaminant	Design Objective	Averaging Period
Carbon monoxide (CO)	7,700 µg/m^3	8-hours
Nitrogen dioxide (NO_2)	228 µg/m^3	1-hour
Nitrogen dioxide (NO_2)	57 µg/m3	1-year
Fine particles (PM_{10})	50 µg/m3	24-hours
Fine particles (PM_{10})	20 µg/m^3	1-year
Very fine particles ($PM_{2.5}$)	25 µg/m^3	24-hours
Very fine particles ($PM_{2.5}$)	8 µg/m3	1-year

Although not required by the SEPP(AQM), some community members seek reporting of air quality impacts in terms of the NEPM limits as used in the SEPP(AAQ) as they are often familiar with the NEPM limits. To avoid any risk of delay in the assessment of air quality impacts for the project, and recognizing that these design objectives are incorporated in the future EPA Environmental Reference Standard, this air quality assessment provides air quality predictions from near-road air quality modelling for all the air quality requirements listed in Tables 5-3, 5-4 and 5-5.

5.3 Guidelines

SEPP(AQM) has a design limit for total suspended particulates (TSP) (nuisance dust) of 330 µg/m^3 as a 3-minute average. This translates to a 24-hour average limit of approximately 100 µg/m^3 (which is about 60 per cent higher than the PM_{10} limit listed in Table 4-2).

The *Protocol for Environmental Management for Mining and Extractive Industries* (EPA Publ. 1191, 2007) sets limits for acceptable dustfall as:

- 4 g/m^2/month total, averaged over 30 days; and
- 2 g/m^2/month increase over elevated background, averaged over 30 days.

These limits apply to long term operations rather than during construction but have been adopted by RRV for the construction phase. Note that dust generation will be much lower during operations when vehicles are travelling on a sealed pavement.

6 Existing Conditions

6.1 Local Climate

The Beaufort Bypass study area has a temperate climate with a warm summer and cool winter. Rainfall occurs sporadically throughout the year. Three weather monitoring stations were identified as having climate data relevant to the study area: Beaufort (for rainfall), Ararat (rainfall, temperature and part winds) and Ballarat (for rainfall, temperature and 24-hour winds); it is also the closest site to Beaufort with recorded hourly values of wind speed and wind direction).

6.2 Air Temperature

Dust generation from construction sites is highest on hot days with gusty winds. The number of days per month with ambient temperature above 20 deg C provides an indication of the likelihood of events with high levels of dust transport from excavated areas or soil stockpiles.

Figure 6-1 shows the monthly temperature range recorded at Ararat, which is expected to be essentially the same as the temperature range at Beaufort. There is no temperature monitoring at Beaufort. It can be seen that the air temperature at Ararat is generally below 20 deg C for the months of May to September but above 20 deg C for the remainder of the year. Dust generated from excavation is sensitive to soil moisture levels as well as seasonal temperature variations, however, it can be controlled by regular watering.

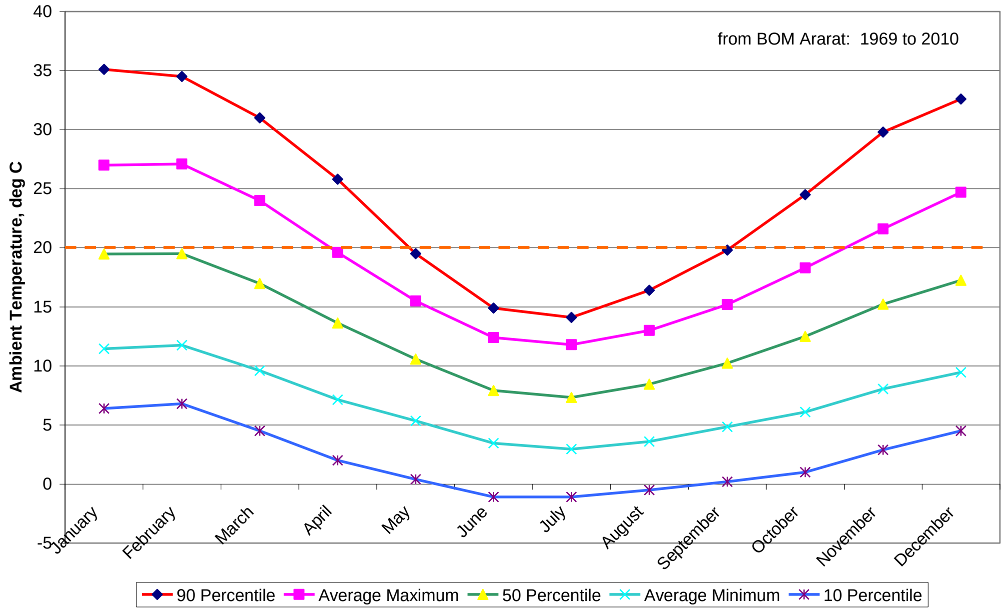

Figure 6-1 Monthly Temperature Range Recorded at Ararat

6.3 Rainfall

There is a clear pattern of lower annual rainfall with distance heading west from Ballarat. The mean annual rainfall is highest in Ballarat at 690 mm/yr, slightly lower at 680 mm/yr in Beaufort, decreases further to 580 mm/yr at Ararat and reduces down to 490 mm/yr at Stawell aerodrome.

Figure 6-2 shows the variation in monthly rainfall recorded at Beaufort. The "autumn break", which encourages farmers to sow crops, mostly occurs in April (but can be delayed to May or even June in some years). The wettest months occur in winter and spring with an average rainfall of about 60 mm/month. Lowest rainfall occurs in February and March (which are typically the driest and dustiest months of the year).

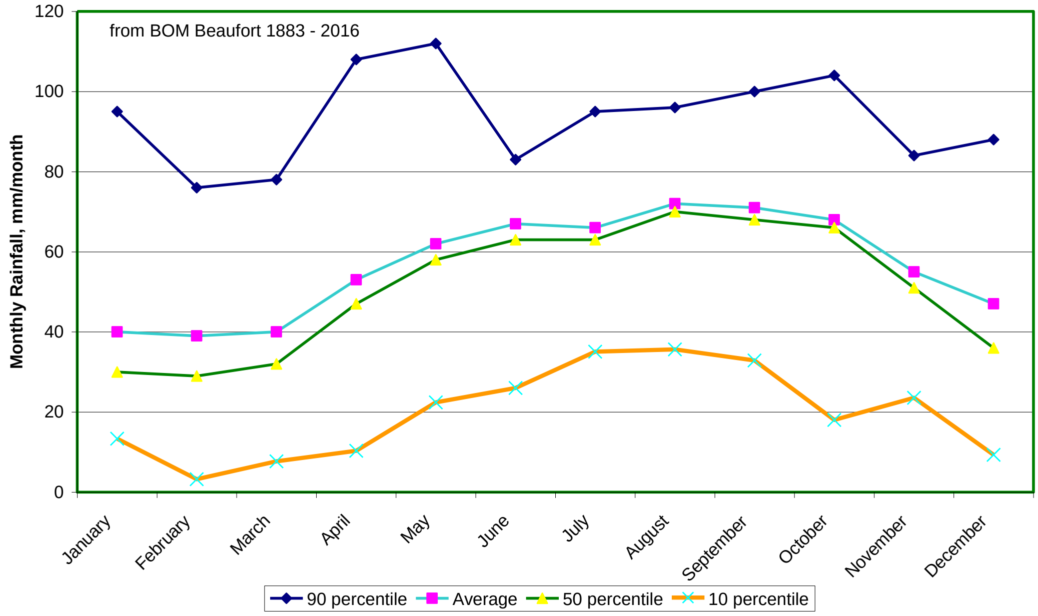

Figure 6-2 Monthly Rainfall Range Recorded at Beaufort

As is generally understood, there is a large variability in the pattern of annual rainfall and the total rainfall from year to year. For example, in 2016, the annual rainfall at Beaufort was 810 mm/yr. In the previous year (2015), the annual rainfall was only 519 mm/yr.

Over a typical 20-year period, the rainfall in the lowest year will be around 490 mm/yr while the rainfall in the highest year will be about 870 mm/yr. Thus, there is +/- 30 per cent range in annual rainfall over a 20-year period. As well as the year-to-year variation in rainfall, there are longer term patterns with sequences of wet years and sequences of mostly dry years (droughts).

This variability makes it impossible to predict the rainfall in the period of construction of the Beaufort Bypass. Hence a conservative approach has been taken: dust management is recommended assuming conditions that could occur in dry years while erosion control plans reflect conditions that could occur in wet years (high runoff but less dust).

For practical reasons, it is usually necessary to carry out earthworks in dry periods. The implication for the project is that higher dust generation occurs in dry months and thus dust management measures will be an important part of the environmental controls. The standard RRV specification for road construction has a number of environmental control measures as discussed in this assessment report.

Figure 4-3 shows the number of days for each month with rainfall that results in low or very low dust generation (more than 1 mm/d and more than 10 mm/d of rain, respectively), averaged over the last five decades. It can be seen that there is 1 to 1 ½ days per month with 10 mm/d or more of rainfall.

There are 4 to 14 days/month (on average) when there is 1 mm/d or more of rain. These smaller events are sufficient to keep the surface damp. The implication for the project is that exposed surfaces may need watering on 16 to 26 days/month to keep exposed soil and road construction surfaces damp and limit dust generation.

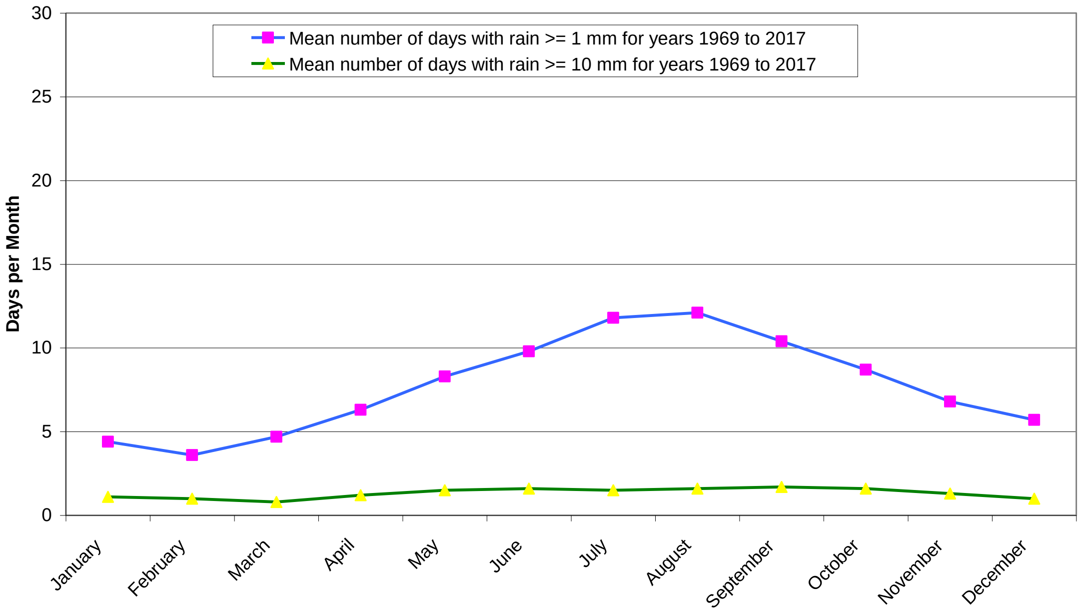

Figure 6-3. Monthly Days of Rainfall Recorded at Beaufort

6.3 Wind Patterns

The (BoM) weather station at Beaufort records temperature but not winds. From an examination of the topography of the area, it is considered that winds recorded at the BoM Ballarat station (40 km to the south-east of Beaufort) and at Ararat (43 km to the north-west) provide a reasonable representation of winds at Beaufort.

Figure 6-4 shows the annual wind rose for Ballarat for the year 2017. The colour indicates the wind speed, while the length of the bars indicates the proportion of winds from each sector of the compass. It can be seen that the dominant wind directions at Ballarat are from the north (38 % of winds) and the south (27 % of winds), with north-east, south-west and south-east winds also being common. The Ararat wind rose shows the same dominant north and south wind pattern (BoM website-Climate Data – Ararat).

The wind pattern at Beaufort is considered to be similar to Ararat and Ballarat, with dominant winds from the north and the south, but with north-east, south-west and south-east winds also being common. Light winds come mostly from the south and east. Hot summer winds from the north pose the greatest risk in terms of nuisance dust being experienced at sensitive receptors and in and near the town.

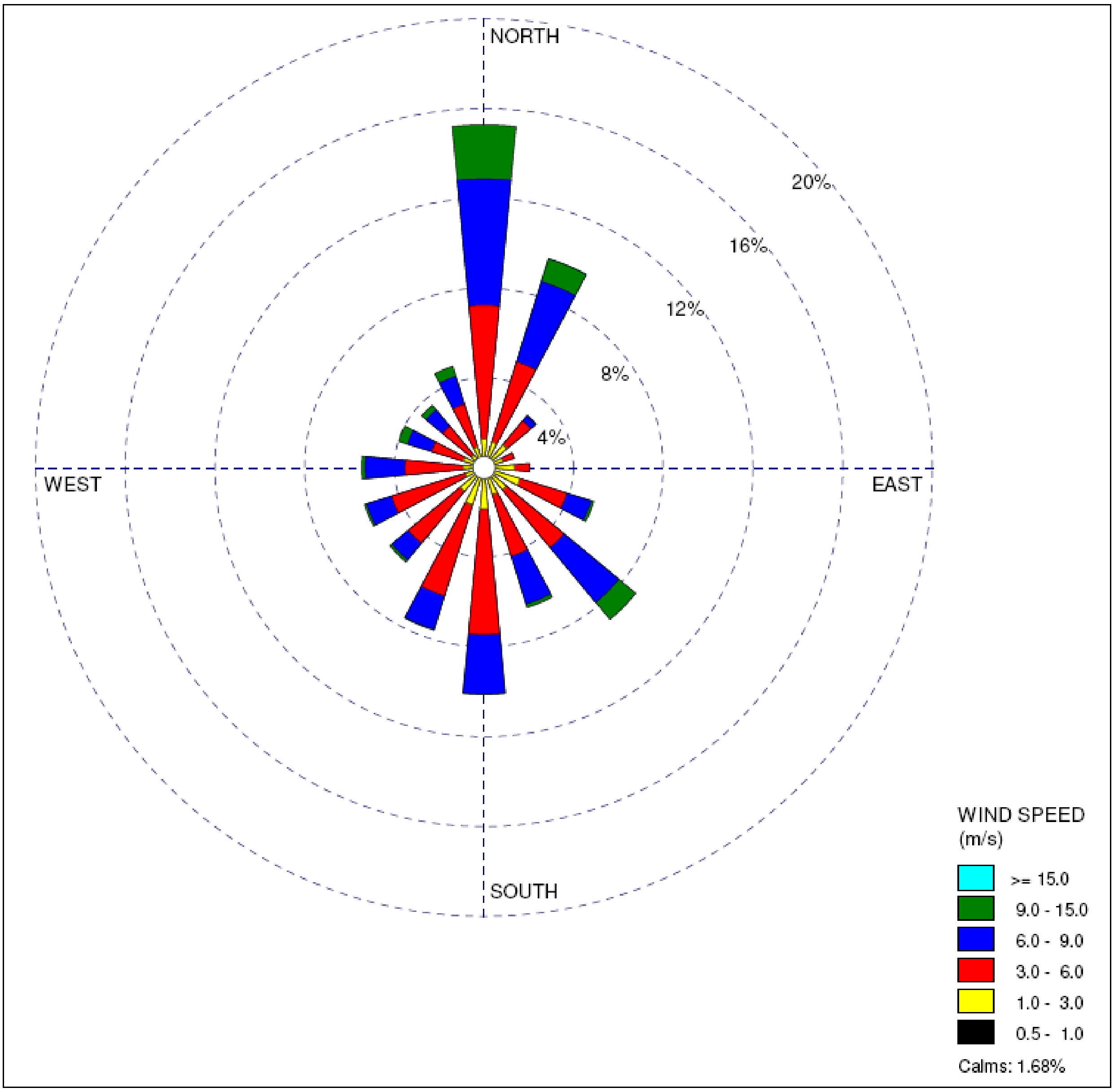

Figure 6.4. Annual Wind Rose for Ballarat

Figure 6-5 shows the annual wind roses for Ararat, based on the two readings each day (at 9 am and 3 pm), averaged over the last ten years (note that wind is recorded only at 9 am and 3 pm at Ararat). The wind roses for Ararat show dominant wind directions are also from the north (typically in winter) and the south (typically in summer), with regular winds from the south-west and west. There are very few winds from the east at Ararat, as at Ballarat. The wind patterns at Ballarat and Ararat are similar and, it is inferred, similar to wind patterns at Beaufort.

The wind records for Ararat show that morning wind speeds (8 km/hr to 14 km/hr) are consistently lower than afternoon wind speeds (13 km/hr to 18 km/hr). There is a strong seasonal wind cycle, with higher wind speeds in spring and early summer, and lower wind speeds in winter. There is a high proportion of calm (periods of weak winds) in autumn and winter mornings, which leads to a risk of higher concentrations of air contaminants at those times.

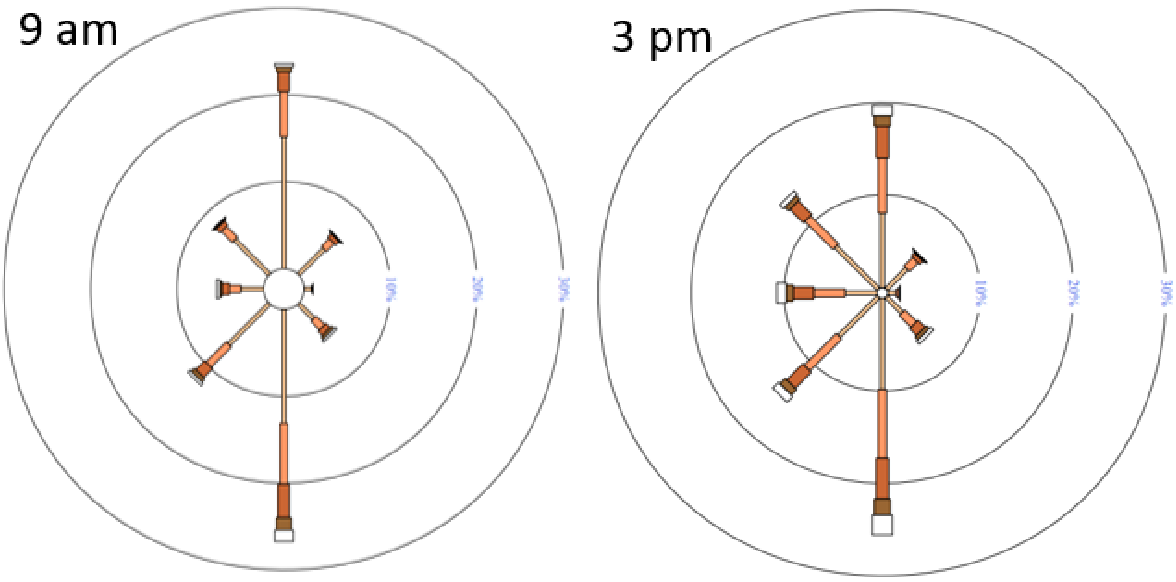

Figure 6-5. Morning and Afternoon Wind Roses at Ararat

Referring to the alignment options in Section 2, it can be seen that all of the alignments extend to the north around Beaufort. Thus, winds from the north, north-west and north-east sectors would transport dust (and other emissions) towards Beaufort. Over the year, winds from these sectors comprise about 40 per cent of the total winds, with north winds being dominant. Winds from the south will carry any contaminants away from Beaufort, although there are a few sensitive receptors (rural residences) to the north of the route options.

At present all traffic travels through the centre of Beaufort. Thus, the effects of emissions from vehicles will be experienced close to the road within the town. The Bypass is further from town. There will be an improvement in air quality in the town as many wind directions carry emissions away from the town, and there is a greater distance from the road to receptors, allowing more dispersion to occur.

On the other hand, the Bypass options pass near a small number of rural residences that will experience higher concentrations than at present, although the increment will be small to very small, depending on the distance from the new roadway.

6.4 Ambient Air Quality

There is no known air quality monitoring data from the Beaufort Bypass study area. The EPA Report titled "*Future Air Quality in Victoria*" (EPA Publication 1535, 2013) concluded that:

> *Based on measurements taken in a limited number of Victorian regional towns (including Ballarat, Bendigo, Bright, Mildura, Shepparton, Wangaratta and Warrnambool) and evidence from emission studies, it is clear that air quality in regional Victorian centres is generally better than in Melbourne. However, there are some exceptions to this rule: during dust storms, bushfires and planned burning activities, regional Victoria may experience very poor air quality.*

Near some industries (such as intensive animal industries), odour and dust can be serious local problems. In some rural areas, particularly in enclosed valleys, smoke from the use of wood heaters in winter can be a problem.

As Beaufort is a rural area well away from large urban and industrial sources, the background ambient air quality values for carbon monoxide (CO) and nitrogen dioxide (NO_2) are likely to be close to zero. Particulate matter is, however, elevated in rural areas (although not as high as in Melbourne) due to bushfires, controlled burns and farming.

Dust levels are generally elevated in a rural environment due to agricultural activities such as ploughing, harvesting, erosion of bare ground and vehicles using unsealed roads.

The 2013 EPA study did not make a detailed assessment of air quality in smaller regional towns such as Beaufort. However, a preliminary analysis of fine particle levels throughout Victoria was undertaken using a regional air quality model (EPA Publ. 1535, 2013). The EPA's results indicated little change between 2006 and 2030 in regional Victoria for fine particle concentrations. Thus, recent historical air quality measurements can be used to establish background concentrations at Beaufort.

6.4.1 Particulate Matter

Particulate matter in SEPP(AQM) is concerned with the respirable size fractions of particulates that are less than 10 micron (PM_{10}) and less than 2.5 microns ($PM_{2.5}$).

EPA had two monitoring data campaigns (2002/2003 and 2005/2006) at Ballarat which found similar concentrations of air contaminants (EPA Publication 1111, 2007). Ballarat is the closest monitoring site to the study area and the 70^{th} percentile of the measured PM_{10} concentration in Ballarat (17 $\mu g/m^3$) for particulate matter has been adopted as the background level for Beaufort.

Data collected at South Geelong (another regional city) shows that the background $PM_{2.5}$ level is approximately 45 to 50 per cent of the background PM_{10} level. Using this ratio, a background $PM_{2.5}$ level for the project of 8 $\mu g/m^3$ has been adopted (corresponding to 47 per cent of the background PM_{10} level at Ballarat) (EPA Publication 1749, 2019) .

The EPA Air Monitoring Report for 2014 - 2018 shows carbon monoxide and nitrogen dioxide concentrations have been stable with no upward or downward trend over the period. The median PM_{10} and $PM_{2.5}$ concentrations also have been stable at Geelong and elsewhere, although there has been an increase in peak concentrations for fine particulates over the period due to bushfires and more frequent hazard-reduction burns (EPA Publ. 1749, 2018). Thus, recent historical data can be used to establish background concentrations in Beaufort.

6.4.2 Air Quality Monitoring in Ballarat

The EPA monitored air quality in Doveton Street, Ballarat from August 2005 to August 2006. The contaminants monitored were carbon monoxide (CO), nitrogen dioxide (NO_2), fine particles (PM_{10} and $PM_{2.5}$) and ozone.

The results showed that Ballarat had generally good air quality but was locally impacted by bushfires and, on colder evenings, contributions from domestic wood smoke. Ballarat's air quality was generally similar to or better than other regions in Victoria (Melbourne, Geelong and the Latrobe Valley).

Particles (as PM_{10}) met the air quality objectives in 2005-06 on all days measured and on average was similar to the levels measured during the previous monitoring campaign during 2002-03. PM_{10} levels in Ballarat were similar to levels in Geelong and the Latrobe Valley, and are considered to be much the same as in Beaufort.

Sulphur dioxide is not modelled in this study because of the very low levels of this contaminant in rural Australia. In 2017, for example, the peak 1-hour concentration of sulphur dioxide at Geelong was 1 per cent of the EPA limit (EPA Publication 1749 – Table 45, 2019).

The maximum carbon monoxide, nitrogen dioxide and ozone levels at Ballarat did not exceed the air quality objectives. Air quality for these pollutants was classed by the EPA as *Good to Very Good* at all times. The maximum and average carbon monoxide levels in Ballarat were lower than levels in Melbourne, and similar to levels in Geelong. The maximum and average nitrogen dioxide levels in Ballarat were similar to levels in Geelong and the Latrobe Valley, and lower than levels in Melbourne. The background levels for air contaminants in Beaufort are calculated as the 70 percentile concentrations in Ballarat or Geelong, and are listed in Table 6-1.

Table 6-1 Background Levels for Air Contaminants

Contaminant	Averaging Period	Background Level
Carbon monoxide (CO)	1-hour	1,000 µg/m^3
Carbon monoxide (CO)	8-hours	700 µg/m^3
Nitrogen dioxide (NO_2)	1-hour	40 µg/m^3
Nitrogen dioxide (NO_2)	1-year	17 µg/m^3
Fine particles (PM_{10})	1-hour	20 µg/m^3
Fine particles (PM10)	24-hour	17 µg/m^3
Fine particles (PM_{10})	1-year	10 µg/m^3
Very fine particles ($PM_{2.5}$)	1-hour	15 µg/m^3
Very fine particles ($PM_{2.5}$)	24-hour	8 µg/m^3
Very fine particles ($PM_{2.5}$)	1-year	6 µg/m^3

7 Impact Assessment – Four Alignment Options

This section provides a generalised assessment for each of the four bypass options and the impacts associated in terms of dust, vehicle emissions and the impact of sensitive receptors. As the four options have the same traffic volume, the emissions per kilometre from vehicles on the four options are essentially the same for each option. There are small differences in the volume of cut and fill for the four options, and this was addressed in the assessment of construction dust. A further factor in consideration of construction dust is the number of dust-sensitive receptors and their distance from construction activities for each option.

7.1 Construction Dust Assessment

The assessment of potential impacts from dust emissions during construction involved the steps listed in Section 4.4.1.

7.1.1 Quantity of Excavation and Fill

Figure 7-1 shows the quantity of cut (excavation) and fill for each of the options (data supplied by WSP). The amount of excavation is similar for Options A0, A1 and C2 at 1.4 million m^3, and slightly less for Option C0. The fill ranges from 2.3 million m^3 for Option A0 to 2.8 million m^3 for Option C2. As the fill exceeds the cut, about half the fill must be imported from quarries and pits outside the study area.

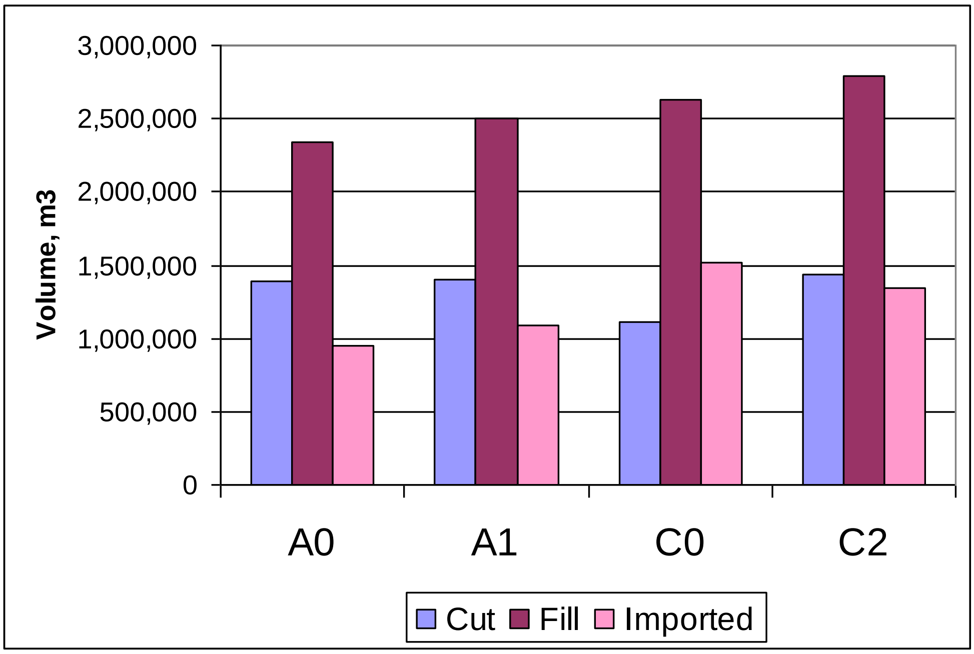

Figure 7-1 Estimated Cut and Fill for Route Options

7.1.2 Equipment Used in Construction

Construction operations can be divided into two periods: (1) excavation, involving removal and stockpiling of topsoil, excavation and stockpiling of subsoil, gravel, boulders, pavement material, and other construction materials; and (2) formation of embankments and overpasses, grading, watering, compaction, sealing, mulching, painting, incorporation of all barriers, signs and items to complete the roadways and associated structures (bike paths, pedestrian controls).

The equipment used during the construction stage comprise bulldozers, scrapers, dump trucks, excavators, trucks with trailers, rollers, compactors and water trucks, with a typical indicative list of equipment listed in Table 7-1 (based on observations of the construction fleet used for other sections of the Western Highway). The table also lists the vehicles used to bring supplies and personnel to the site.

Table 7-1 Equipment Used in Excavation Stage and Fill Stage.

Excavation Stage	Number		Filling Stage	Number
Bulldozers	2			
Scrapers	2		Graders	2
Dump trucks	6		Dump trucks	6
Excavators	6		Excavators	4
Truck/trailer	12		Truck/trailer	16
Rollers/compactors	1		Rollers/compactors	3
Water trucks	2		Water trucks	2
Light Trucks	7		Light Trucks	7
Utes/vans	20		Utes/vans	20
Cars	20		Cars	20

7.1.3 Construction Emission Rates

The dust emission rate for each stage of construction was developed from estimates of the dust generation by major items of equipment and wind erosion of dust from exposed soil surfaces and stockpiles of soil. The derived emission rates were developed using emission factors published in the National Pollutant Inventory (NPI) Emission Factor Estimation Techniques Manual (Commonwealth of Australia, 2012).

The default emission factors listed by NPI assume dry conditions. Dust control methods that are part of the standard RRV requirements have been considered, and appropriate reductions in emission rates have been included.

It is assumed that work on the Bypass would be carried out during the recommended hours for construction work set out in the VicRoads standard specification (VicRoads, April 2012). Thus, heavy construction equipment would generally operate from 7 am to 6 pm. Wind erosion occurs over 24-hours, with the rate depending on the wind speed. The dispersion modelling is based on the standard mitigation measures listed in Section 9.1 of this report being implemented.

7.1.4 Dust Dispersion Model

Dust modelling was carried out using the AERMOD and Ausroads dispersion models to predict the PM10 and TSP concentrations on a typical cross section extending north to south across the roadway for each of the route options (with the same numbers of vehicles on each option). The cross-section of the road used in modelling was the typical section in cut as shown in Figure 7-2.

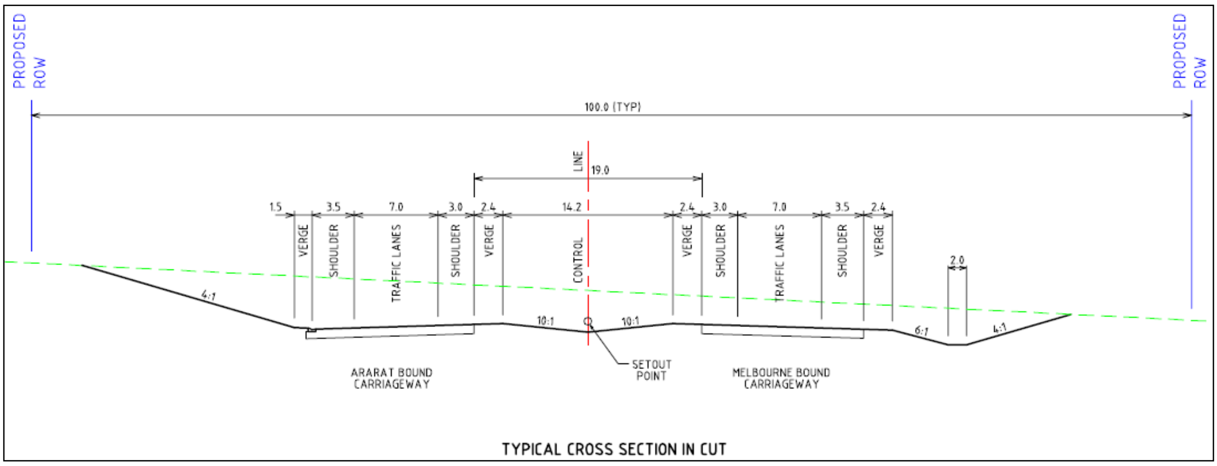

Figure 7-2 Typical Road Cross-section

The modelling assumed excavation every working day (although this is unlikely to occur in wet weather) and also excavation at every site along the route, although in practice excavation may progress from hill to hill.

Transportation of material between a cut site and a fill site in scrapers or dump trucks has the potential to generate significant dust due to the characteristics of the ground materials along the routes. The 2017 Ballarat wind file, as discussed in Section 6, was used for the dust dispersion modelling. For this project, excavation sites for the A alignment options will be somewhat protected from erosion by the deep side walls of the excavation and therefore may experience lower wind speeds, and less erosion, than calculated in the model which assumes open conditions.

It is acknowledged that dust dispersion modelling involves a large number of estimates about construction practices by a Contractor, yet to be appointed, and on ground materials for which there is limited knowledge at this stage. Thus, the results must be interpreted as indicative, perhaps with a likely variation of + 20 per cent to - 30 per cent about the predicted values. Dust emission rates may be greater in some sections of excavation than in other roadway formation areas because more and heavier equipment is required and dust control measures (particularly watering) may be more difficult because access by water trucks may be constrained during the bulk excavation.

7.1.5 Dust Model Structure

To model the construction dust emissions, a line of sources over a length of 500 m was used. The total emission rate was proportioned along the line with discrete receptors set at 5, 10, 20, 40, 60, 80, 100, 150, 200, 300 and 500 m intervals on each side of the route. Dust concentrations (as TSP and PM10) were predicted for each hour of the year, with the 24-hour average concentration then being calculated.

Peak dust concentrations were plotted as a function of distance from the roadway for both TSP (fine and coarse dust particles) and PM10 (fine dust particles).

7.2 Vehicle Emissions Assessment

The methodology used for the assessment of potential impacts from vehicle emissions during operations is listed in Section 4.4.2.

7.2.1 Vehicle Emissions

Emission controls for vehicles are becoming more stringent over time and, as a result, vehicle emissions are decreasing with time. The minimum emission standard for vehicles produced from November 2013 must comply with ADR 79/03 – Emission Control for Light Vehicles that adopts the core requirements of the international standard developed through the United Nations World Forum for the Harmonisation of Vehicle Emissions (UN Regulation 83/06) commonly known as Euro 5.

From November 2016, new vehicles are required to comply with ADR 79/04 - Emission Control for Light Vehicles which adopts the full requirements of Euro 5. Diesel vehicles are required to meet a particle limit under this standard.

There is expected to be a progressive reduction over time in car and truck emissions due to the replacement of old vehicles by new vehicles and the increasingly stringent emission controls over time.

According to the EPA, in Melbourne in 2006, motor vehicle emissions contributed the following proportions of pollutants to the overall air emissions:

- 72 per cent of all carbon monoxide (CO) emissions;
- 70 per cent of all nitrogen oxides (NOx) emissions;
- 28 per cent of all volatile organic compounds (VOC) emissions;
- 27 per cent of all emissions of particles smaller than 10 microns (PM10);
- 31 per cent of all emissions of particles smaller than 2.5 microns (PM2.5); and
- 6 per cent of all sulphur dioxide (SO2) emissions.

Despite increasing numbers and use of motor vehicles, the total emissions of contaminants from all vehicles have been dropping since 1990. EPA's air monitoring stations have found NO2 and CO levels have been steadily reducing since monitoring began in the 1980's (see annual NEPM monitoring reports issued by the EPA). The number of summer smog days in Melbourne has decreased from 18 events per year down to about one event a year. With the introduction of unleaded petrol, the amount of airborne lead has decreased so much that EPA stopped monitoring for lead in 2005.

By 2030, the EPA predicts that total motor vehicle exhaust emissions will have significantly reduced, despite the large growth expected in the use of cars and trucks. This is because improved technology is entering the vehicle fleet faster than the rate of growth in vehicle use. The net effect is a reduction in the impacts of exhaust-related pollutants: carbon monoxide, nitrogen dioxide and air toxics such as benzene (EPA and CSIRO, EPA Publ 1535, July 2013).

Some aspects of motor vehicle emissions are expected to increase over time – these include particles from road dust, brake wear and tyre wear. These emissions increase directly with traffic volume and will continue with the introduction of electric cars (which are generally heavier than small petrol cars leading to more tyre and pavement wear).

Predictions of near-road concentration are made for the following contaminants:

- Carbon monoxide (CO);
- Nitrogen dioxide (NO_2); and
- Fine particles (PM_{10}; and $PM_{2.5}$).

These are the key Class 1 contaminants for which vehicle emissions are a major source. Predictions were not made for lead (as Australia has lead-free fuels), sulphur dioxide (as Australia as low sulphur fuels) and air toxics (as these are only a concern when the concentrations of PM_{10} exceed the limits).

The fleet emission rates were derived from use of the COPERT software to calculate emission factors, vehicle testing data provided by EPA Victoria, current and predicted PIARC emission factors for Australian traffic and the actual emission rates from the City Link tunnel exhausts. The adopted emission rates for the years 2021 and 2031 are shown in Table 7-1. Emission rates in 2041 are expected to be significantly lower than in 2031.

Table 7-1 Vehicle Emission Rates for Various Contaminants

Year	Fleet Emission Rate, g/km			
	Carbon monoxide	Nitrogen Dioxide	PM_{10}	$PM_{2.5}$
2021	4.0	0.46	0.064	0.045
2031	3.6	0.41	0.057	0.040

7.2.2 Traffic Projections

WSP provided traffic predictions for the years 2017 and 2031, as listed in Table 7-2. The total traffic volume is 7,870 veh/day in 2017 and 8,970 veh/day in 2031, of which 26 per cent are heavy commercial vehicles (HCV or trucks). As shown in Table 7-2, the traffic fleet has a high proportion of heavy commercial vehicles. The remaining vehicle fleet on the Western Highway was estimated to be 17 per cent light commercial vehicles and rigid trucks, and 57 % passenger cars.

Table 7-2 Traffic Projections for Beaufort Bypass

Traffic Projections	2017		2031	
	Average day	Peak hour	Average day	Peak hour
East Bound	4,300	464	4,900	528
West Bound	3,570	380	4,070	433
Total vehicles	7,870	844	**8,970**	961
Proportion HCV	26 %	27 %	26 %	27 %

Traffic Projections from WSP on 5 Feb 2018

Figure 7-3 shows the hourly distribution of traffic in the year 2031. The Western Highway has an unusual hourly traffic distribution compared to metropolitan roads, compared to most metropolitan arterial roads, with a small morning traffic peak and a large afternoon traffic peak in both directions, as can be seen in Figure 7-3.

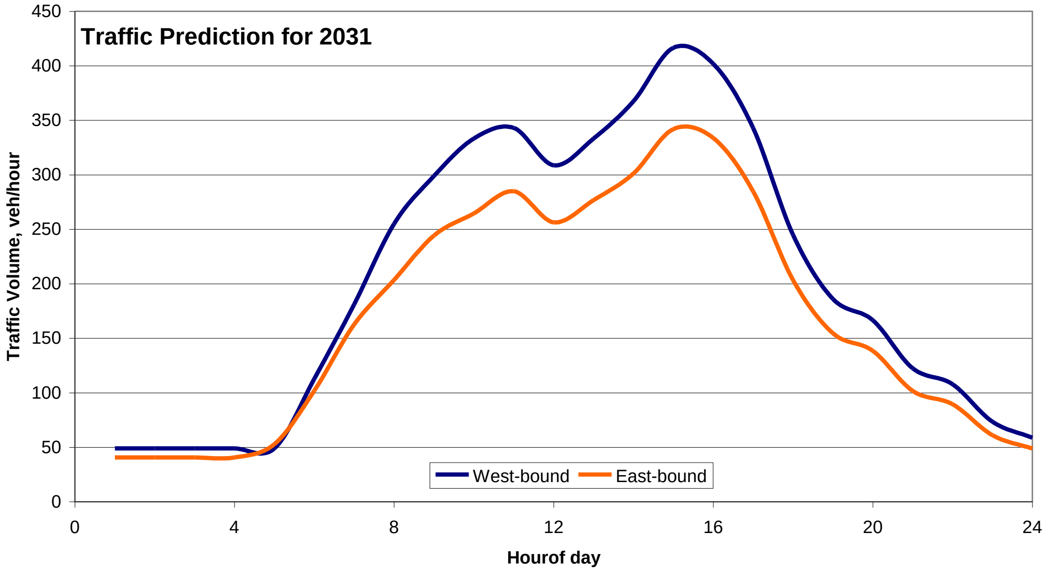

Figure 7-3 Diurnal Distribution in Year 2031 Traffic

7.2.3 Dispersion Model

Modelling of vehicle emissions after the Bypass is in operation was carried out for the year 2031 using the Ausroads dispersion model, to predict the concentrations of the four Class 1 contaminants on a typical cross section. This is the standard model used to predict near-road concentrations of contaminants. The predictions were checked using the Aermod line model, which predicted essentially the same concentration patterns, as would be expected as both are similar line-source models (see comparison of model predictions in Appendix B). Ausroads has the benefit of being able to model multiple crossed roads at intersections.

The Ballarat wind file, as discussed above, was used for the modelling. The cross-section of the road used in modelling was derived from the design drawings for the Bypass provided by RRV.

The roadway was modelled as four rows of sources (two rows for the westbound lanes and the two rows for the eastbound lanes). Emissions varied each hour in accordance with the directional traffic volumes.

7.3 Sensitive Receptors Assessment

The receptors near the route options that are considered sensitive to air quality effects (either dust during construction or vehicle emissions during operation) were identified and are plotted. These receptors comprise mostly existing houses and existing residential blocks zoned for residential use.

Other types of receptors that were considered in the air quality assessment are rural houses with roof water supplies (possibly affected by contaminants in dust or vehicle emissions that settle on the roof) and vineyards (possibly affected by dust). The routes of Options A0 and A1 are near a vineyard that is about 340 m to the north of the centreline of the routes.

The implications of dust on local flora and fauna are addressed in the ecological assessment, drawing on the dust predictions in this report.

Some receptors are restricted to one route option while others are close to several route options. Table 7-3 lists the number of sensitive receptors that are within 300 m of the road centreline for each route option – receptors beyond this distance are not expected to be affected to any significant extent by changes in air quality.

Table 7-3 Number of Sensitive Receptors at Various Distances from Routes

Route option	Number of Sensitive Receptors		
	within 100 m	within 200 m	within 300 m
A0	4	5	12
A1	2	5	10
C0	2	6	12
C2	2	4	9

Note that there is a receptor to the east of Beaufort that is adjacent to the Western Highway and thus within 20 m of the centre of the roadway for all four route options. At present, the front boundary of this property is only 11 m from the edge of the nearest land of the Western Highway. Along the four alignments, the two nearest receptors are 45 m and 60 m from the roadway.

Two receptors north-west of Beaufort are very close to the centreline of Route A0 and they may be acquired if that route is adopted. If these two receptors are acquired, it is apparent that each route option has only 2 receptors within 100 m of the proposed roadway, a similar number (4 to 6) within 200 m of the route centreline and a similar number (9 to 12) within 300 m of the route centreline.

7.4 Greenhouse Gas Emissions Assessment

This section presents the greenhouse gas (GHG) emission estimates resulting from the construction and operation of the Project. The assessment has been carried out to meet the requirements of the SEPP(AQM) and the requirements of the *Protocol for Environmental Management (PEM) – Greenhouse Gas Emissions and Energy Efficiency in Industry 2002 (PEM).*

The greenhouse gas emissions inventory has been estimated in accordance with:

ISO 14064-1:2006 Greenhouse gases -- Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals and the *PEM.*

7.4.1 Assessment Methodology

The assessment of potential impacts from dust emissions during construction involved the following steps:

- Establish the fuel use of construction equipment and estimate GHG emissions during construction;
- Establish the fuel use of the vehicle fleet during operations and estimate GHG emissions; and
- Use comparative GHG emissions data as a basis for assessment.

7.4.2 Estimated GHG Emissions During Construction

Section 2.1 of the PEM sets out the steps for estimation as follows:

- Step 1 – estimate energy consumption – annual energy consumption by energy type and associated GHG emissions;
- Step 2 – estimate direct (non-energy related) GHG emissions.

Emissions are categorised as follows:

- **Scope 1** – Direct emissions from sources that are owned or operated by a reporting organisation (examples – combustion of fuel by equipment and vehicles used in construction).
- **Scope 2** – Indirect emissions associated with the import of energy from another source (examples – import of electricity or heat). In this Project there are no Scope 2 emissions in construction. There will be very minor Scope 2 emissions in operations due to electricity used for lights along the roadway and at intersections.
- **Scope 3** – Other indirect emissions (other than Scope 2 energy imports) that are a direct result of the operations of the organisation but from sources not owned or operated by them (examples include supply of equipment, disposal of wastes and product use). There is significant GHG release in the production of the many products incorporated into the roadway (barriers, walls, reflectors, lighting poles and lights, signs, paint, reflectors) but these amounts are already included in GHG estimates by the producing organizations. Thus, to avoid double-counting, they are not included as part of this Project.

GHG emissions during construction are based on the use of fuel (principally diesel) by construction equipment, employee vehicles and delivery vehicles that are directly associated with the construction of the Bypass. The total number of operating hours per year are calculated from the quantities of material (or personnel) to be transported (with fill transported an average of 10 km), fuel usage is determined from published information and the quantity of diesel used is multiplied by the conversion factor 1 L of diesel results in 2.7 kg of GHG (*Source: Australian Greenhouse Office*).

Table 10-1 summarises the estimate of GHG emissions from the various items of equipment in the main stages of construction: (1) excavation and (2) filling and road preparation, based on a Bypass route of 11 km. During the period of excavation, the GHG production will total about 12,600 t of CO2-e while during the period of filling and road formation, the GHG production will total about 12,000 t of CO2-e.

Table 10-1 Estimated GHG Emissions During Construction for 11 km

Excavation Stage	**No**	**Hours/d**	**Fuel/hr**	**L/yr**	**CO2-e t/yr**
Bulldozers	2	10	120	192,000	518
Scrapers	2	10	120	240,000	648
Excavators	6	10	80	1,440,000	3,888
Truck/trailer/dump	12	8	80	2,048,000	4,147
Water trucks	2	12	60	432,000	1,166
Light Trucks	7	3	40	252,000	680
Utes/vans	20	2	36	432,000	1,166
Cars	20	1	30	180,000	432
Total for Excavation Stage					**12,647**
Filling Stage	**No**	**Hours/d**	**Fuel/hr**	**L/yr**	**CO2-e t/yr**
Graders	2	10	72	144,000	389
Excavators	4	10	80	960,000	2,592
Truck/trailer/dump	16	10	80	2,048,000	5,530
Water trucks	2	8	60	432,000	1,166
Light Trucks	7	12	40	252,000	680
Utes/vans	20	3	36	432,000	1,166
Cars	20	2	30	180,000	432
Total for Filling Stage					**11,956**

This assessment has not examined the effects of vegetation clearance and replanting on GHG generation. However it is understood that following re-vegetation of the construction corridors, there will be <u>more</u> trees and vegetation in the road reserve and offset areas after the Project than before the Project, so there will be no net clearing.

As reported in the most recent *State and Territory Greenhouse Gas Inventories* report (DoEE, 2017), the total GHG emissions for Victoria in 2015 were 120 million tonnes of carbon dioxide-equivalent gases (MtCO2-e). The Bypass project GHG emissions are very minor in this context. The trigger for a referral of a project under the *Environment Effects Act 1978* is 200,000 t CO2-e per year (0.2 MtCO2-e). It is apparent that the Bypass project is well under the level of GHG generation that would require referral on the basis of GHG generation.

7.4.3 Estimated GHG Emissions During Operations

The GHG implications of vehicles using the 11 km long Beaufort Bypass was estimated as follows. The projected year 2031 traffic volume of 8,970 vehicles per day is adopted, of which 26 per cent are heavy commercial vehicles. Table 10-2 summarises the estimate of GHG emissions from the vehicle fleet using the Bypass in 2031, assuming current levels of fuel consumption (a conservative assumption). It can be seen that vehicles using the Bypass will generate about 13.5 t of CO2-e per year. Of course, the increasing proportion of hybrid and electric vehicles may cause this estimate to be on the high side.

Table 10-2 Estimated GHG Emissions During Operation

Operations Stage	No/day	Hours/d	Fuel/hr	L/yr	CO2-e t/yr
Cars	6,300	0.11	8	2,023,000	5,400
Light Commercial	270	0.11	9	97,000	260
Heavy Commercial	2,400	0.11	35	3,373,000	9,100
Total	**8,970**				**13,460**

The GHG emissions during operations are about the same as GHG emissions during construction. Although there are fewer vehicles during construction, they mostly have powerful engines and high fuel consumption, compared to the predominance of cars during operations.

As described in Section 2, the routes have slightly different lengths with only Option C2 being exactly 11.0 km long. The A0 option is 11.2 km long and A1 option is 11.1 km long while the C0 option is 10.6 km long. Figure 7-4 illustrates the GHG emissions from each of the four route options. It can be seen that the difference in emissions between the routes is small.

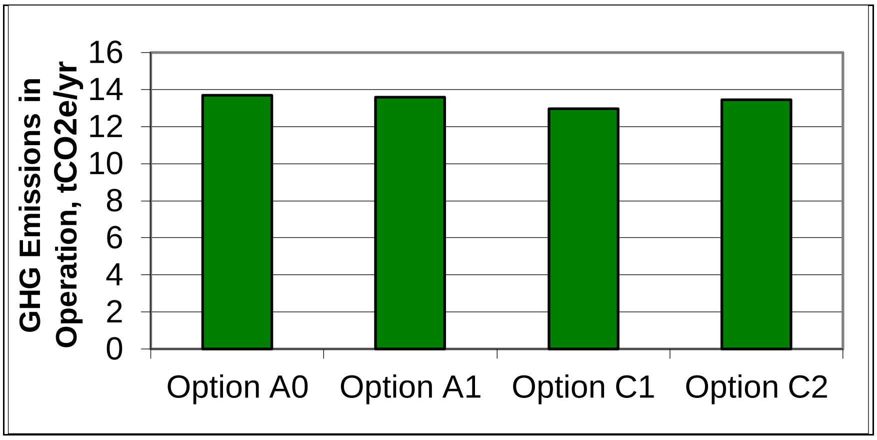

Figure 7-4 Estimated GHG Emissions from Route Options

7.4.4 Change in GHG Emissions with the Bypass

The Bypass is marginally longer than the current route through the centre of Beaufort. Vehicles travelling through Beaufort face speed restrictions, four changes in the allowable speed, and a proportion of vehicles must stop for traffic lights and pedestrians crossing the road, all of which cause vehicle speeds through Beaufort to be variable. A bypass of Beaufort has the advantage of no intersections or pedestrian crossings, and thus relatively constant vehicle speed.

As a result, there would be slightly higher fuel consumption on the average vehicle journey through Beaufort compared to the journey on the Bypass. As an indication, calculations of fuel use for typical vehicle journeys on the Bypass route (Option C2) and through the main street of Beaufort will result in a small (about 3 per cent) reduction in greenhouse gas emissions on the Bypass compared to travel through Beaufort. For completeness, Option C0 being the shortest will have a marginally higher saving in GHG while Option A0 being the longest and will have a marginally smaller reduction. However these differences are of no practical significance.

7.5 Air Quality Assessment of Route Options

The detailed assessment of air quality impacts for the four route options at all stages of the project are set out in Section 7.1. As described there, the impact of dust nuisance at sensitive rural receptors is assessed as low for all options. As shown in Table 7-3, and subsequent discussion, each route option has only 2 receptors within 100 m of the proposed roadway, a similar number (4 to 6) within 200 m of the route centreline and a similar number (9 to 12) within 300 m of the route centreline.

For the two receptors within 100 m of the roadway, there could be elevated dust levels on about 30 days per year during the period of construction. For the receptors within 100 m to 300 m of the roadway, there will be elevated dust levels on a few days per year during the period of construction. Because of the elevated dust at receptors close to the roadway, the impact of dust is assessed as medium, and extra dust control measures are recommended

Routes A0 and A1 are located further to the north, further from the town. The two other routes (C0 and C2) are to the south of the A alignments and closer to the town. However, all routes are sufficiently distant from the town area of Beaufort that the impact of dust affecting that zone during construction is low for all options. The impact of dust nuisance is assessed for the closer receptors, as listed above)

Table 8-1 Summary of Air Quality Impact Assessment

AIR QUALITY ASPECT	IMPACT FROM AIR QUALITY ASSESSMENT			
	ALIGNMENT A0	ALIGNMENT A1	ALIGNMENT C0	ALIGNMENT C2
Dust at sensitive receptors	Medium	Medium	Medium	Medium
Dust in township	Low	Low	Low	Low
Dust in roof water	Low	Low	Low	Low
Elevated contaminants from vehicle emissions	Negligible	Negligible	Negligible	Negligible

Dust in roof water or rural residences is assessed as low for all route options.

The concentrations of air contaminants at all receptors during operation of the Bypass are predicted to satisfy the SEPP(AQM) Intervention Levels and Design Criteria, and the SEPP(AAQ) Environmental Objectives, for all constituents and all averaging periods. As described in Section 9, the air quality predictions for vehicle emissions show that for all receptors outside the road reserve, but including those within 100 m of the roadway, there will be negligible impact from vehicle emissions during operations.

When operating, the Bypass will result in an improvement in air quality along the main street of Beaufort because the majority of through traffic will have been diverted to the Bypass.

8 RRV Options Assessment for All Criteria

The options assessment prepared by RRV for the project assessed options A0, A1, C0 and C2 against the set of criteria summarised in Section 4.5. The results of the options assessment and sensitivity testing are detailed in Table 8-2. Further detail on the options assessment process is provided in the *EES Attachment IV: Options Assessment*.

The results of the options assessment and sensitivity testing are detailed in Table 8-2. As well as the score for each alignment under each scenario, a colour coding has been applied to rank the performance of the options under each scenario as follows:

- Best performing Alignment Option: Green
- Second performing Alignment Option: Yellow
- Third performing Alignment Option: Orange
- Worst performing Alignment Option: Red.

Table 8.2 Combined Alignment Option Scenario Scoring

SCENARIO	ALIGNMENT A0	ALIGNMENT A1	ALIGNMENT C0	ALIGNMENT C2
Scenario 1	128	123	126	111
Scenario 2	18	22	20	27
Scenario 3	46	45	50	44
Scenario 4	81	78	94	74
Scenario 5	24	23	27	19
Scenario 6	48	43	56	35
Sensitivity Scenario 1	-6	-3	-5	9
Sensitivity Scenario 2	-3	2	-4	11
Sensitivity Scenario 3	-11	-6	-9	5

The results show that the best performing option is the C2 Alignment, while the worst performing options are the A0 and C0 Alignments. The primary drivers for this outcome were due to the C2 alignment having:

- The lowest amount of total native vegetation clearance
- The least impact on threatened vegetation communities identified under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and Flora and Fauna Guarantee Act 1988 (FFG Act).
- The least impact on wildlife corridors, particularly the core habitat areas
- The lowest amount of native vegetation with high conditions to be removed by Ecological Vegetation Class (EVC) Conservation Status
- The lowest potential impacts on known or registered sites of Aboriginal and historic heritage significance.

Further detail on the options assessment process is provided in the EES Attachment IV: *Options Assessment.*

9 Impact Assessment – Preferred C2 Alignment

9.1 Dust Assessment for Option C2

Figure 9-1 shows the predicted peak TSP concentration with distance from the road for the estimated two highest concentration days each year for the C2 alignment. To allow a larger scale in the plot, the TSP concentration has been shown for one side of the roadway, but the same distribution applies each side of the road – it will depend on the wind direction as to which side of the road is impacted.

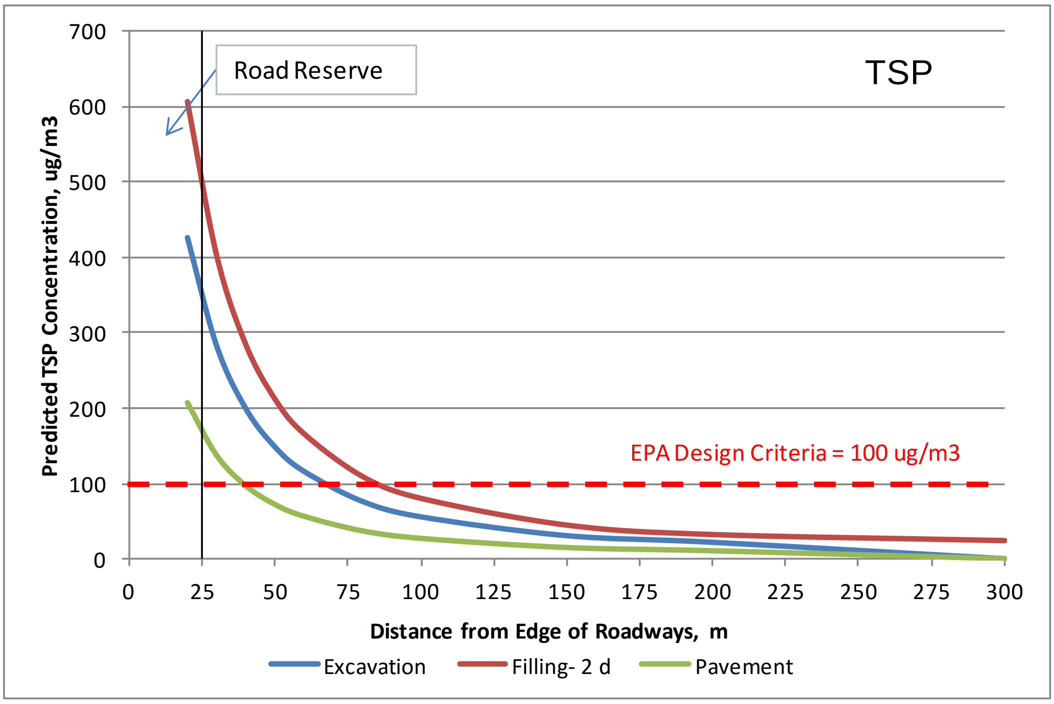

Figure 9-1. Predicted Peak TSP Concentration Distribution from the Edge of Proposed C2 Roadway

The peak TSP concentration is highest during the filling stage, when a lot of material is being placed and compacted in layers. Lower TSP emissions and concentrations will occur in the excavation stage, and lowest emissions and concentrations will occur in the pavement construction stage.

The concentration distributions shown in Figure 9-1 depict conditions on the two hottest days each year (based on the 2016 wind file used in modelling).

For this assessment dust concentrations were calculated using the 2017 wind file, as this is the latest year for which an annual wind file was available. In practice, any year may be hotter than average, with more events of high dust emissions, or wetter and cooler than average, with fewer or even no events of high dust emission events. As listed in Table 7-3, there are 2 receptors within 100 m of the roadway and 4 receptors within 200 m for the C2 route option. These receptors are likely to experience elevated TSP levels for a few days during the construction period, and marginally over the EPA design limit at the closest receptor.

The planning and practices of the Contractor will determine the outcome in terms of dust impacts. For example, if the Contractor maintains a high level of control over dust emissions, and schedules filling activities in the winter to spring seasons, the local impacts of dust could be significantly less than shown in Figure 9-1.

A more detailed analysis was made of predicted TSP concentrations during filling activities, as this is the critical construction stage with respect to dust emissions. Filling activities are expected to take approximately 12 months of the project and may continue for several months in any 500 m long section.

Figure 9-2 shows the predicted peak TSP concentration with distance from the road for the average year (2016) during filling activities for:

- the worst two days;
- the worst 10 days; and
- the worst 30 days.

This figure illustrates that an extended distance of nuisance dust could occur on only a few occasions during construction. For the majority of the construction period, dust will not extend beyond the road reservation at nuisance levels.

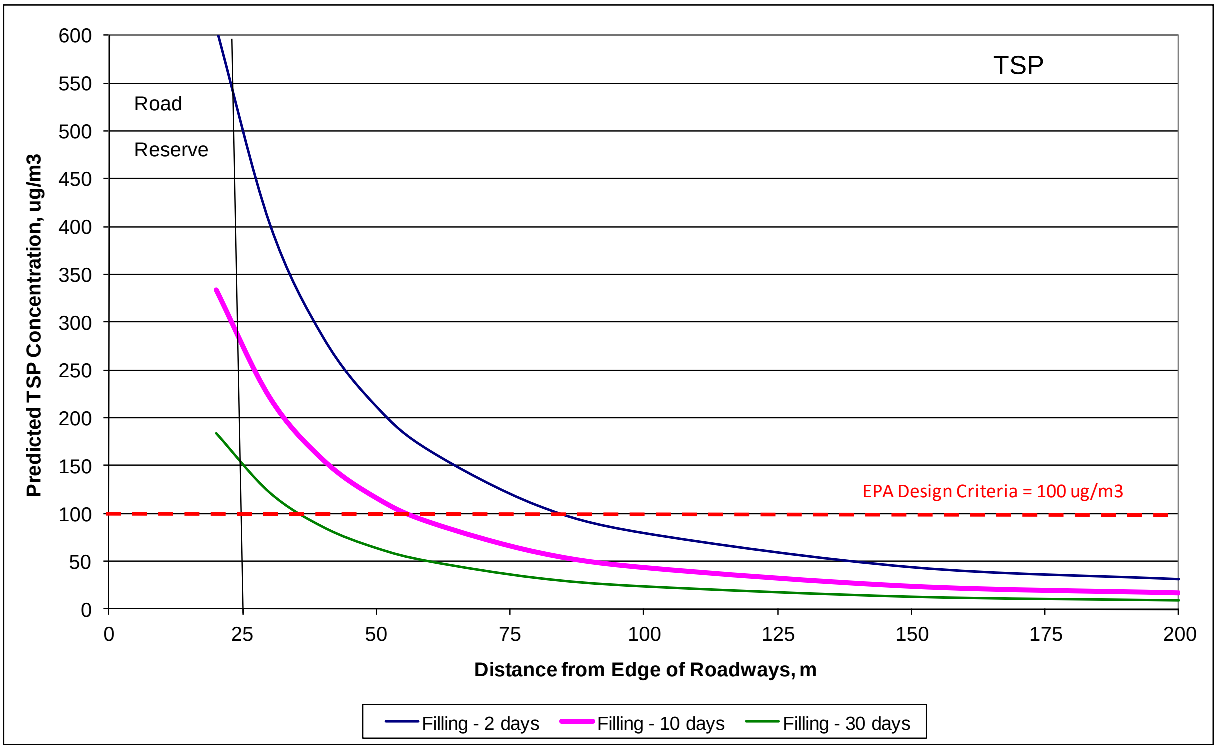

Figure 9-2. Predicted TSP Concentration Distribution with Duration in Days

The peak 2-day concentrations shown in Figure 9-2 represent the two worst days in the year (depending on the temperature and wind patterns). Hot dry conditions, generally with moderate northerly winds are worst for erosion and transport of dust and lead to higher dust levels. On the other hand, in cool conditions with some recent rain, there will be less-elevated dust conditions (as depicted by the 30-day line in Figure 9-2).

Figure 9-3 shows the predicted peak PM_{10} concentration distribution (highest day per year) including the 24-hour background PM_{10} of 17 µg/m^3. For reference, the SEPP(AQM) intervention level for PM_{10} is 60 µg/m^3.

It can be seen that the peak PM_{10} level is high on the roadway, as would be expected in the centre of construction activity. Note that OHS limits for PM_{10} apply on the roadway (which is a workplace) and these are substantially higher than the PM_{10} limits for the general population, which are based on long-term continuous exposure of people with compromised health. PM_{10} levels occur during the excavation period are lower than during filling while PM_{10} levels during pavement construction are lower than during excavation.

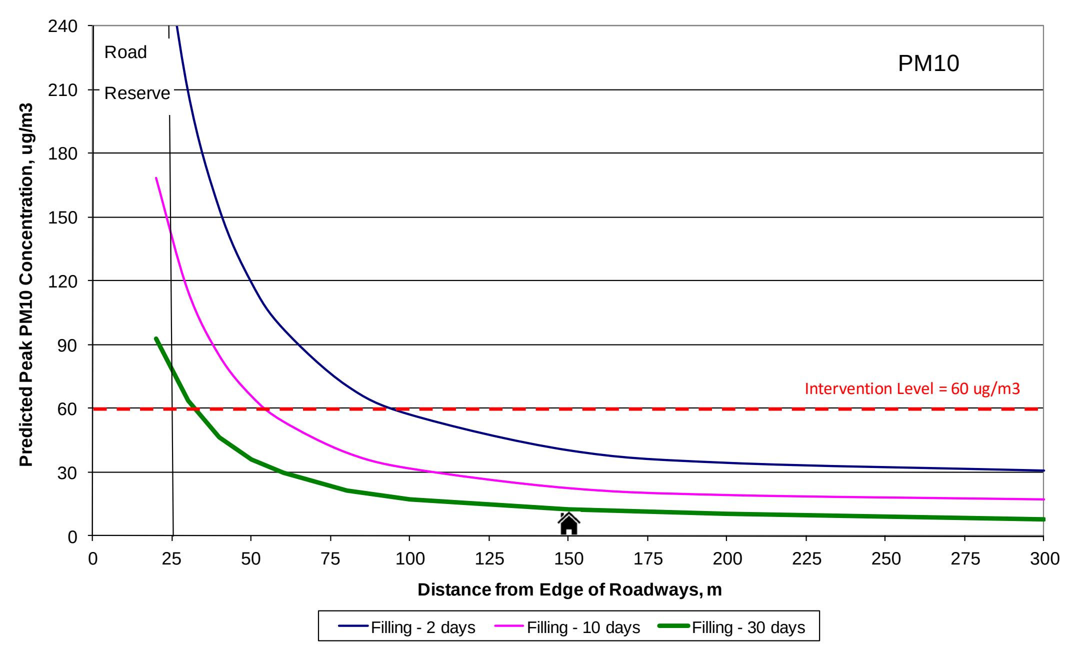

Figure 9-3. Predicted Peak PM10 Concentration Distribution

The concentrations shown in Figure 9-3 represent the worst days and month in the year 2017. Hot dry conditions, with blustering northerly winds, are worst for erosion and transport of dust and lead to higher PM_{10} levels near construction sites. On the other hand, for many days there will be cool conditions or some recent rain, and dust erosion and transport will be well-controlled, so there will not be the elevated dust conditions as depicted in Figure 9-3. Mitigation measures recommended in Section 10 will limit the extent and duration of nuisance dust conditions.

9.1.1 Dustfall

Calculations show that the increment in monthly average dustfall from the Bypass project will be 2 mg/m^2/month at the nearest sensitive receptor and 1.1 mg/m^2/month at a receptor at 100 m distance. The fill material to be used in embankments has little fine particles and is mostly medium to coarse particles that settle out close to the construction zone.

9.1.2 Household Water Supplies

There are approximately 15 rural residences within 300 m of the route that collect rainwater from their roof for domestic use. Calculations show that the monthly average dustfall from the Bypass project will be less than 14 mg/m^2/month at all of these houses (based on the 30-day TSP concentration distribution shown in Figure 9-3). Nonetheless, there will be higher dust at these residences for the two years of the construction period and a proportion of the extra dust will settle on the roof. A first-flush device, readily available from plumbing supply shops, would divert the majority of all dust away from the tank. Most houses should already have such a device as it is useful to divert leaves, trigs and bird detritus away from the tank, as well as rural and construction dust. The project should advise the households that do not have them of the potential benefits, but not take responsibility for installing them.

Emissions from vehicles are principally gases and fine particles. They are unlikely to deposit on roofs in significant amounts. Particle emissions from cars are largely controlled by catalytic converters and particle emissions from trucks (diesel engines) are very fine and slow to settle. Emissions from operations are not expected to cause problems in roof water supplies.

9.1.3 Vineyard

There is a vineyard in the area of the proposed routes, however, the site is well away from route C2. The dust and PM_{10} predictions in Figures 9-1 and 9-2 show that there will not be a significant increase in dust or dustfall at the vineyard.

9.1.4 Conclusion on Dust

The predicted 1-hour TSP levels shown in Figures 9-1 and 9-2, and the peak PM_{10} levels shown in Figure 9-3, are interpreted as follows:

1. For the 2 receptors within 100 m of the roadway, there will be elevated dust levels on about 30 days per year during the period of construction. High concentrations will occur on a few hot days each year, with a moderate impact on those days, but otherwise a minor impact for the large part of the construction period;
2. For the 4 receptors within 100 m to 200 m of the roadway, there will be elevated dust levels on a few days per year during the period of construction. Elevated concentrations will occur on a few hot days each year, with a minor impact on those days, but otherwise a low impact for the large part of the construction period);
3. For the 9 receptors within 200 m to 300 m of the roadway, there will be increased dust levels on a few days per year during the period of construction, with a minor impact on those days, but otherwise a low impact for the large part of the construction period;
4. There will be a minor effect on roof water quality for roof water systems within 100 m of the roadway, during the construction period.

9.2 Vehicle Emission Assessment for Option C2

Modelling of vehicle emissions after the Bypass is in operation was carried out for the year 2031 using the *Ausroads* dispersion model, to predict the concentrations of the four Class 1 contaminants on a typical cross section. This is the standard model used to predict near-road concentrations of contaminants. The predictions were checked using the *Aermod* line model, which gave the same results.

The roadway was modelled as four rows of sources (two rows for the westbound lanes and the two rows for the eastbound lanes). Emissions varied each hour in accordance with the directional traffic volumes.

The concentration profiles across the roadway and adjacent land are plotted in the figures that follow. The background concentration is included in the predicted concentrations. Highest concentrations occur on the roadway and the concentrations decrease with distance from the roadway.

For the 1-hour modelling scenarios, the results of the emission modelling are summarised in the following figures:

- Figure 9.4 shows the distribution of 1-hour CO concentration;
- Figure 9.5 shows the distribution of 1-hour NO2 concentration;
- Figure 9.6 shows the distribution of 1-hour PM10 concentration; and
- Figure 9.7 shows the distribution of 1-hour PM2.5 concentration.

For longer averaging periods, the results of the emission modelling are summarised for various parameters in the following figures:

- Figure 9.8 shows the distribution of 8-hour CO concentration;
- Figure 9.9 shows the distribution of 24-hour PM10 concentration;
- Figure 9.10 shows the distribution of 24-hour PM2.5 concentration.
- Figure 9-11 shows the distribution of annual NO2 concentration;
- Figure 9-12 shows the distribution of annual PM10 concentration; and
- Figure 9-13 shows the distribution of annual PM2.5 concentration.

The 1-hour, 8-hour and 24-hour plots of concentration refer to the 99.9 percentile level, which is the 8^{th} highest hour each year, the 8^{th} highest 8-hour level each year and the highest 24-hour period in a year. The annual average refers to the arithmetic average of the 8,760 hourly concentrations over a year, at each particular receptor.

As listed above, Figure 9-4 shows the predicted peak 1-hour CO concentration distribution (99.9 percentile) including the background level. The peak CO concentration is well below the design criteria in the SEPP(AQM).

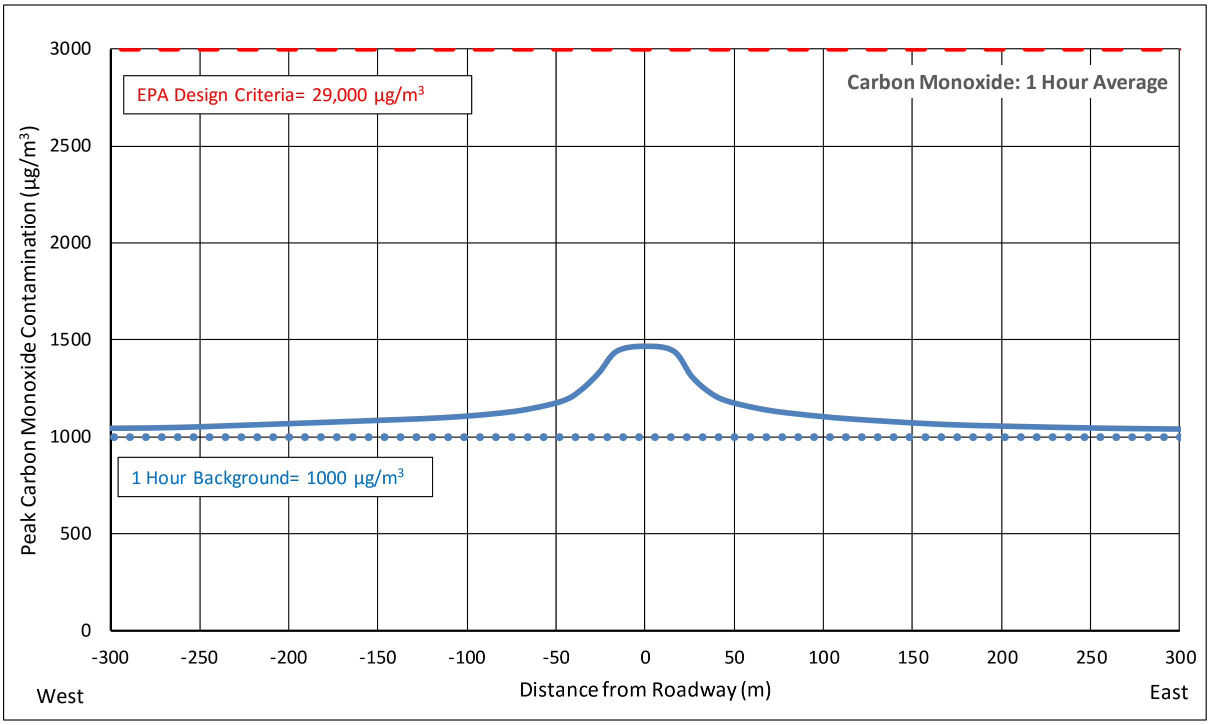

Figure 9-4 Predicted Distribution of Carbon Monoxide

Figure 9-5 shows the predicted peak 1-hour NO_2 concentration distribution (99.9 percentile) including the background level. The peak NO_2 concentration is well below the intervention level and the design criteria in the SEPP(AQM).

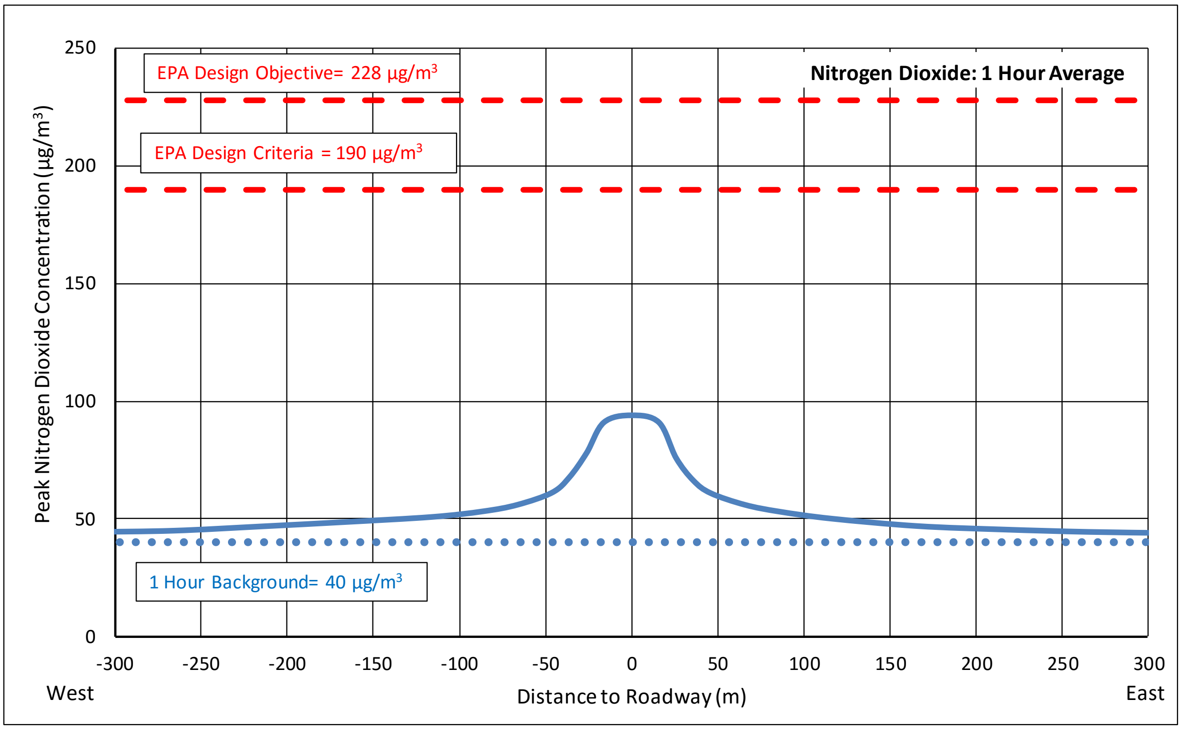

Figure 9-5 Predicted Distribution of Nitrogen Dioxide

Figure 9-6 shows the predicted peak 1-hour PM_{10} concentration distribution (highest day per year) including the background level. The peak PM_{10} concentration is well below the 1-hour SEPP design criteria.

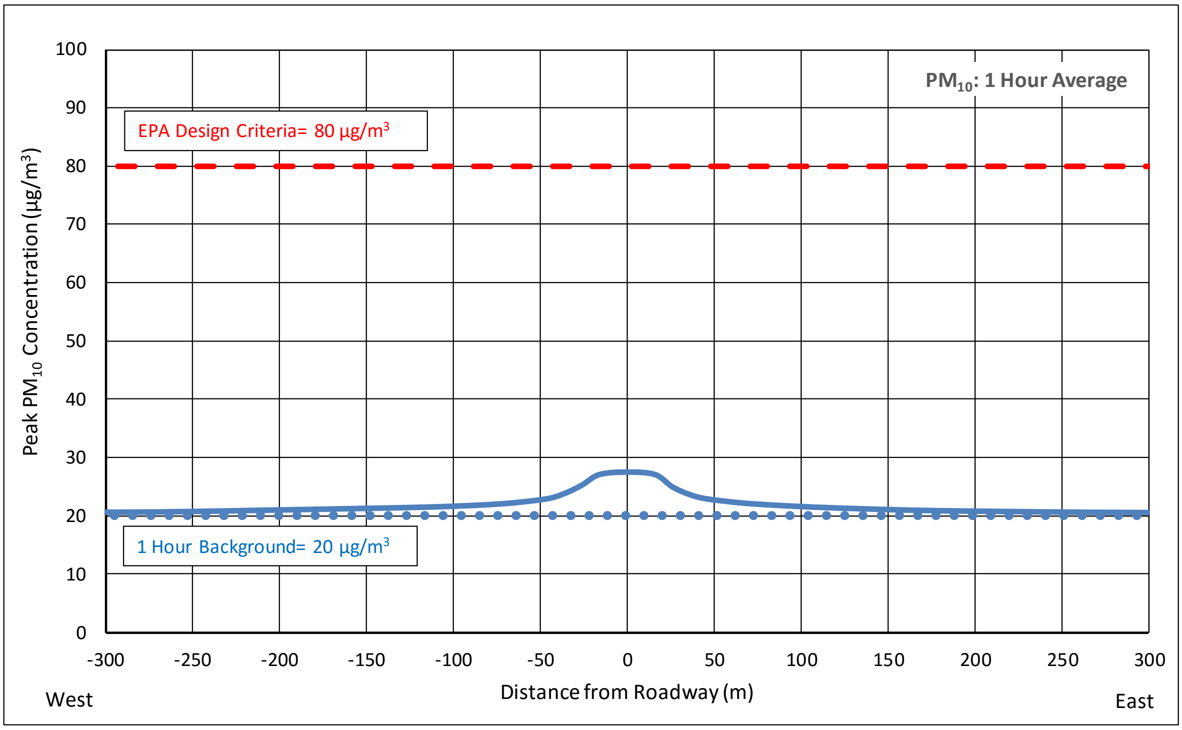

Figure 9-6 Predicted Distribution of PM10 Concentration

Figure 9-7 shows the predicted peak 1-hour $PM_{2.5}$ concentration distribution (highest day per year) including the background level. The peak $PM_{2.5}$ concentration is well below the 1-hour SEPP design criteria.

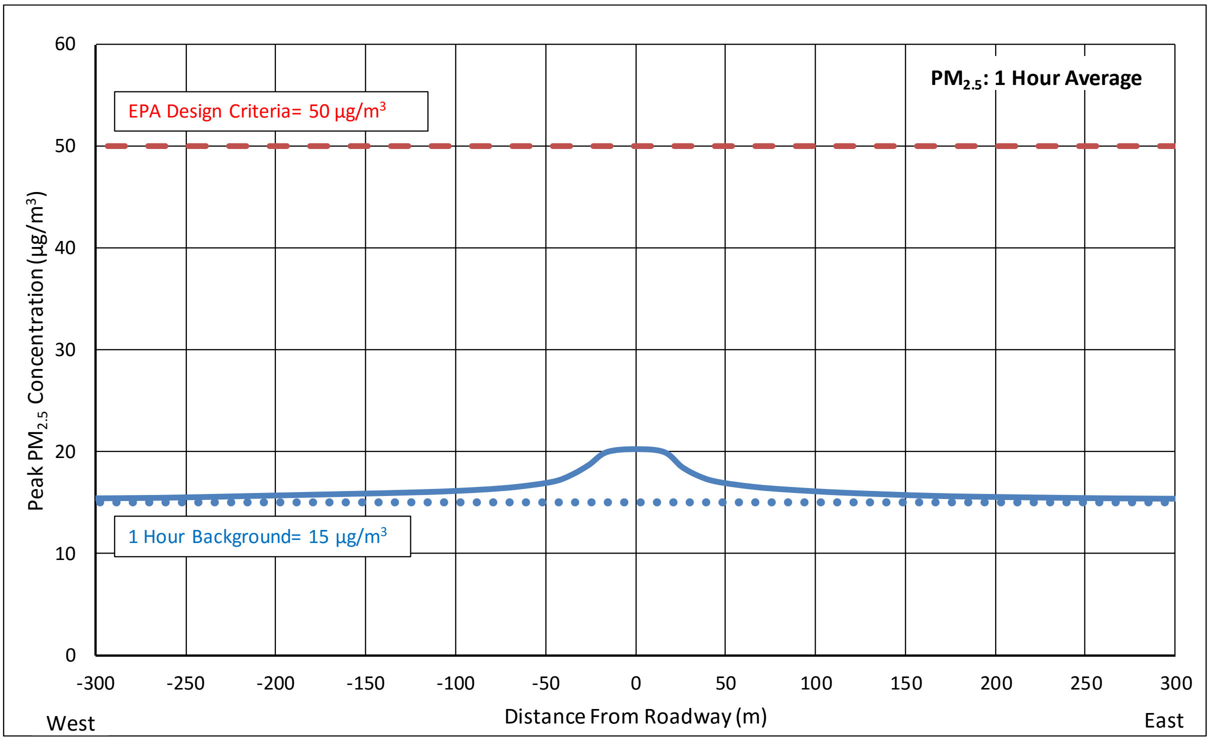

Figure 9-7 Predicted Distribution of PM2.5 Concentration

9.2.1 Results for Longer Averaging Periods

The results of the emission modelling for longer averaging periods are summarised for various parameters in the following figures:

- Figure 9-8 shows the distribution of 8-hour CO concentration;
- Figure 9-9 shows the distribution of 24-hour PM10 concentration;
- Figure 9-10 shows the distribution of 24-hour PM2.5 concentration;
- Figure 9-11 shows the distribution of annual NO2 concentration;
- Figure 9-12 shows the distribution of annual PM10 concentration; and
- Figure 9-13 shows the distribution of annual PM2.5 concentration.

Figure 9-8 shows the predicted peak 8-hour CO concentration distribution including the background level. The predicted peak 8-hour CO concentration is well below the design objective in the SEPP(AAQ).

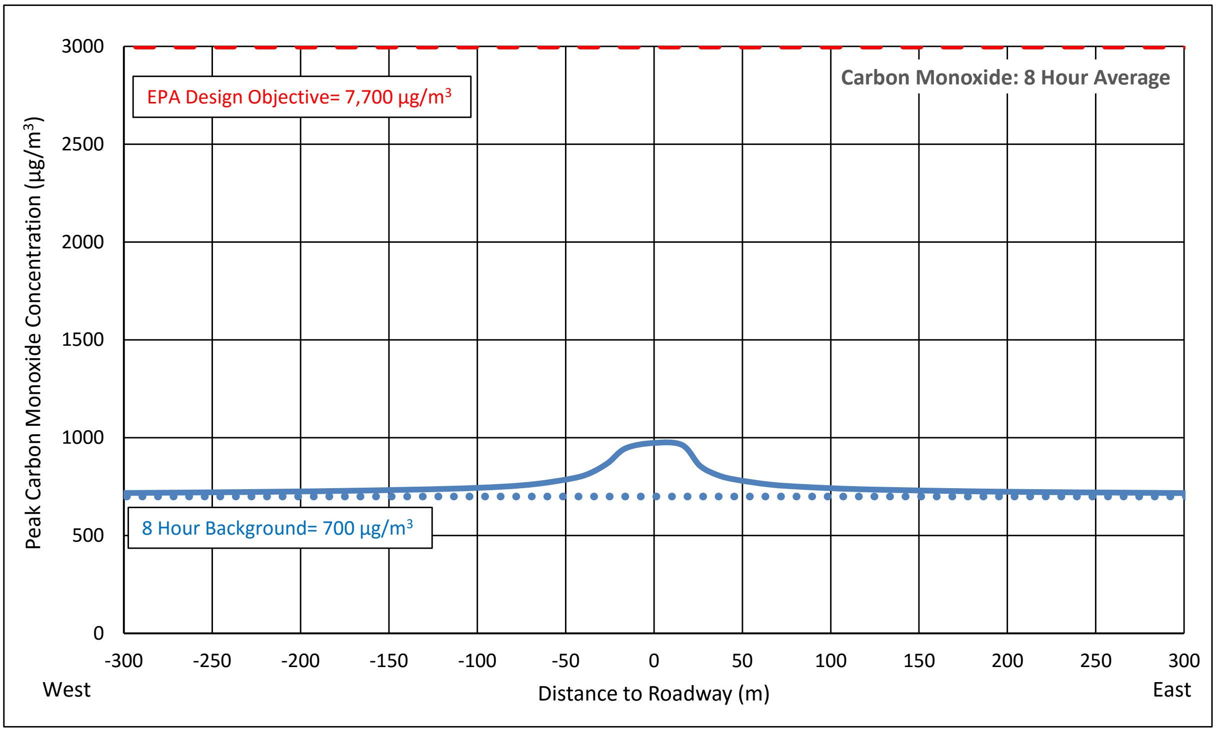

Figure 9-8 Predicted Distribution of 8-hour Carbon Monoxide

Figure 9-9 shows the predicted peak 24-hour PM_{10} concentration distribution (highest day per year) including the background level. The peak PM_{10} concentration is well below the design objective in the SEPP(AAQ).

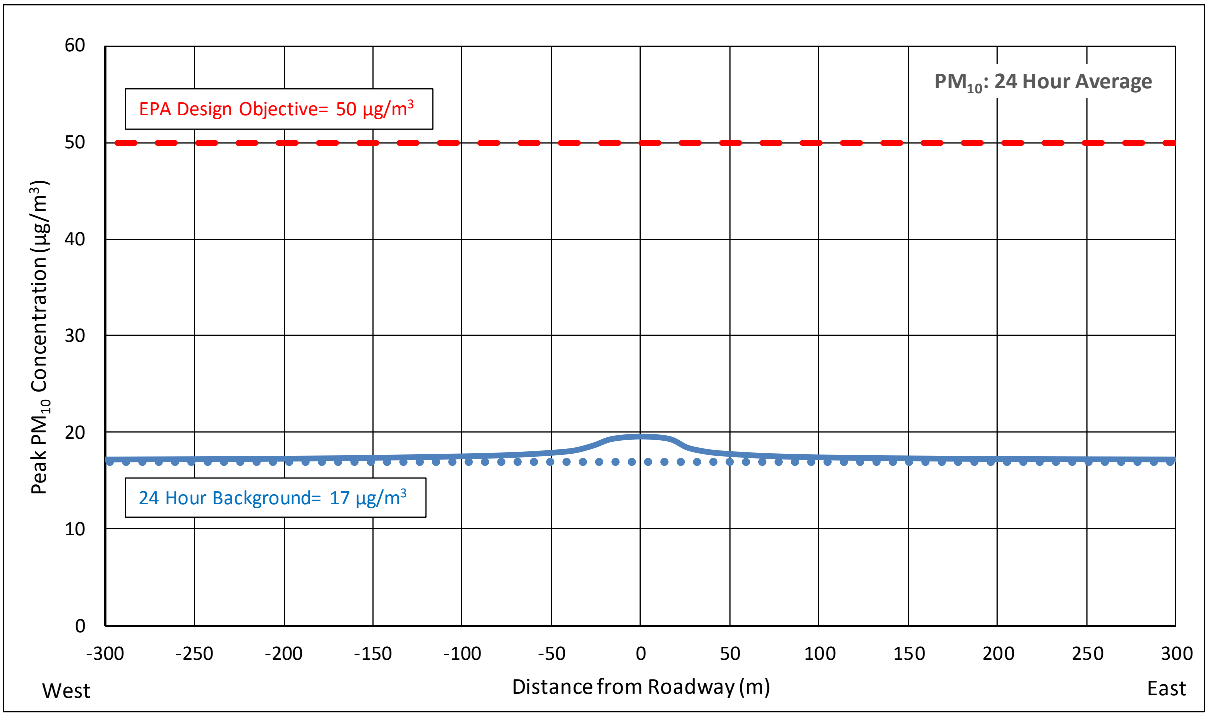

Figure 9-9 Predicted Distribution of 24-hour PM10 Concentration

Figure 9-10 shows the predicted peak 24-hour $PM_{2.5}$ concentration distribution (highest day per year) including the background level. The peak $PM_{2.5}$ concentration is well below the design objective in the SEPP(AAQ).

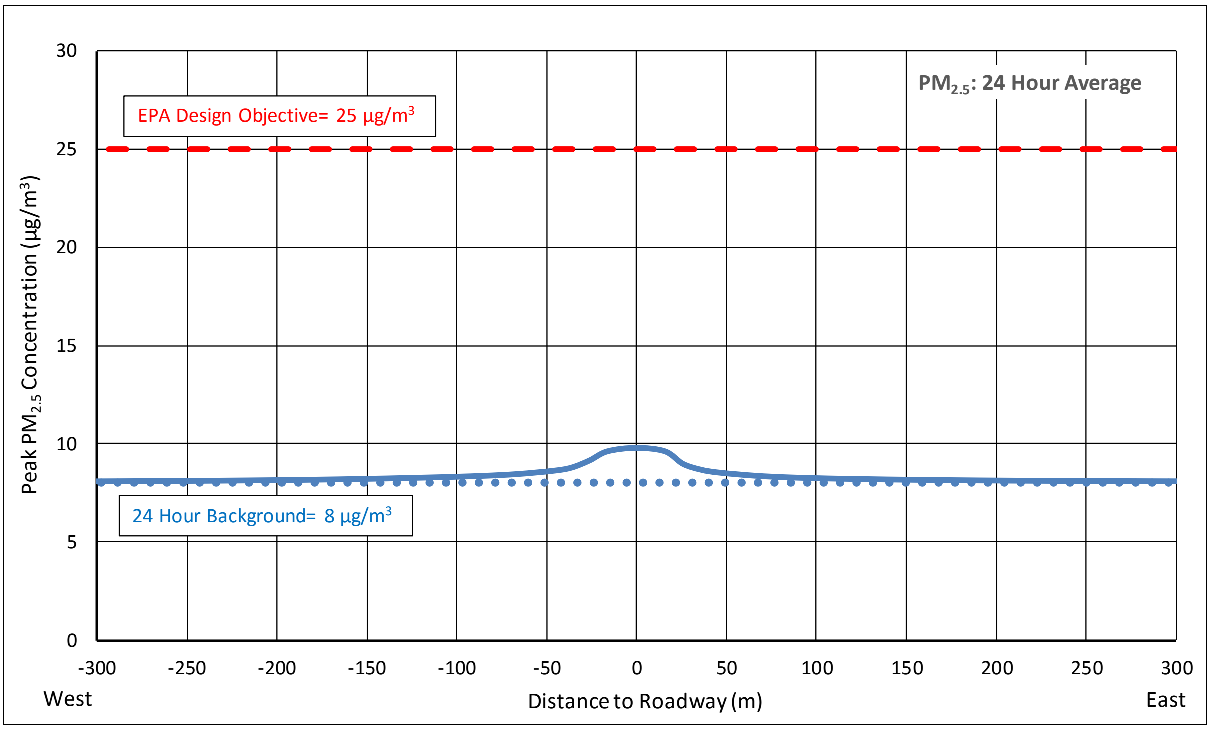

Figure 9-10 Predicted Distribution of 24-hour PM2.5

Figure 9-11 shows the predicted peak annual NO_2 concentration distribution (99.9 percentile) including the background level. The annual NO_2 concentration is well below the design objective in the SEPP(AAQ).

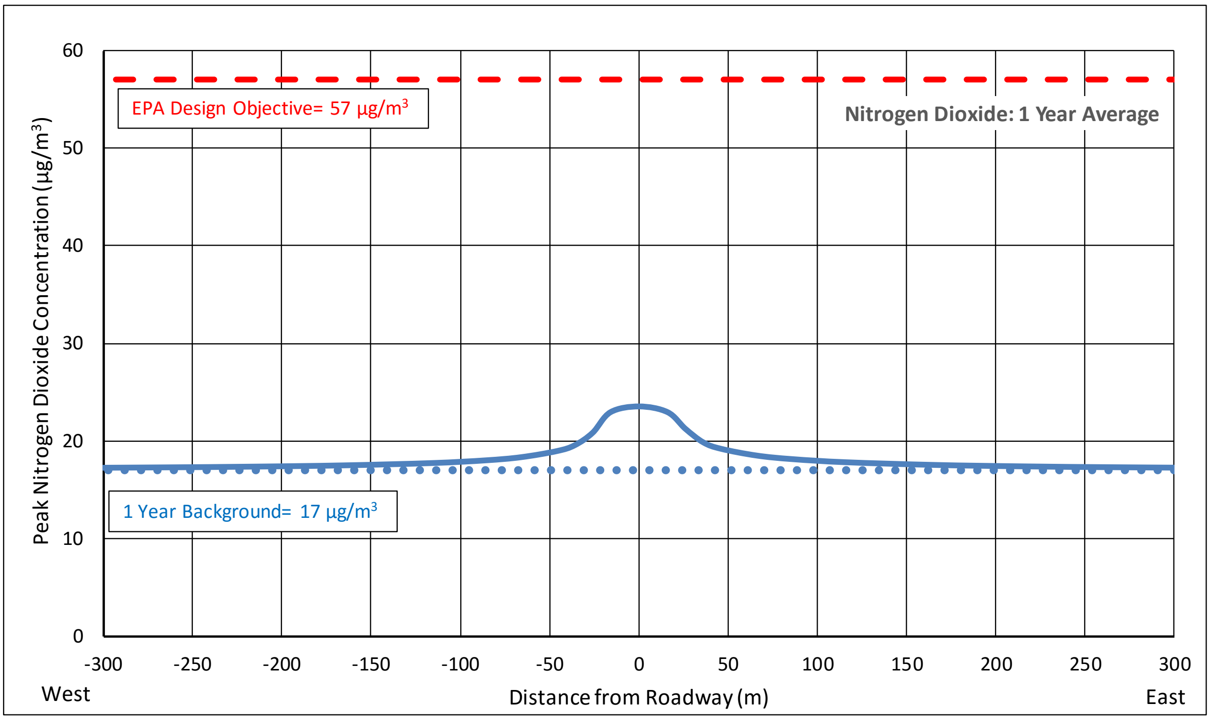

Figure 9-11 Predicted Annual Nitrogen Dioxide Concentration Distribution

Figure 9-12 shows the predicted annual PM_{10} concentration distribution including the background level. The annual PM_{10} concentration is well below the design objective in the SEPP(AAQ).

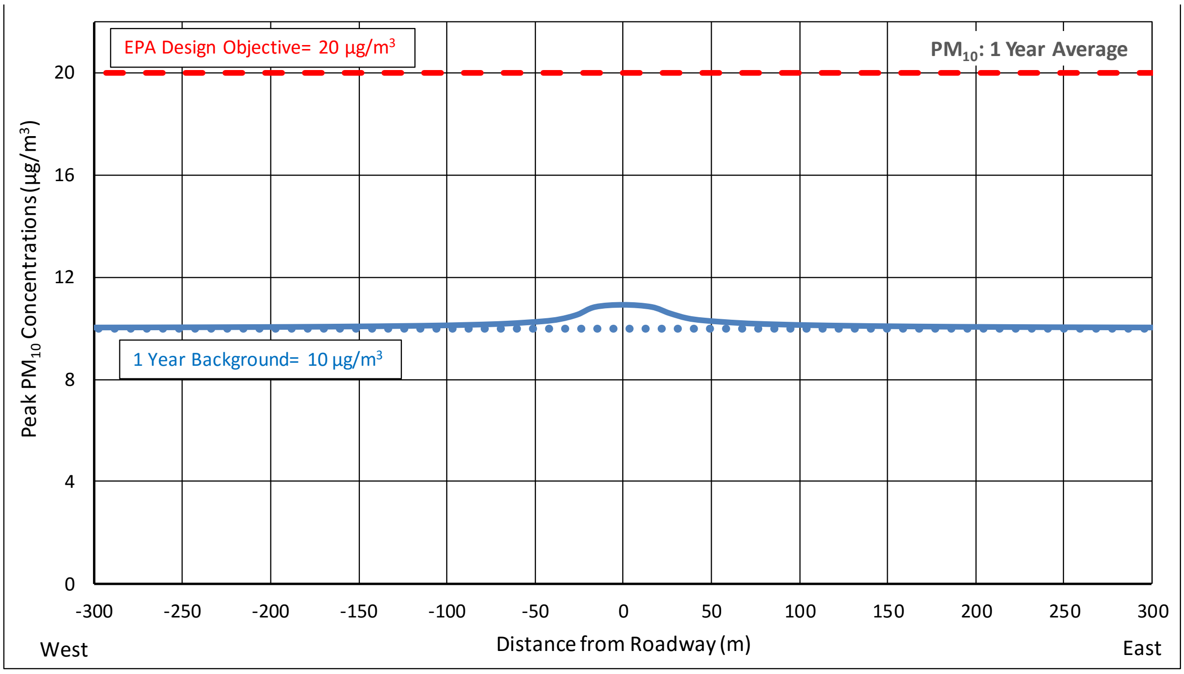

Figure 9-12 Predicted Annual PM10 Concentration Distribution

Figure 9-13 shows the predicted annual $PM_{2.5}$ concentration distribution including the background level. Note that the assumed background concentration of 6 ug/m^3 is a substantial proportion of the current environmental objective of 8 ug/m^3. The annual $PM_{2.5}$ concentration is within the design objective in the SEPP(AAQ).

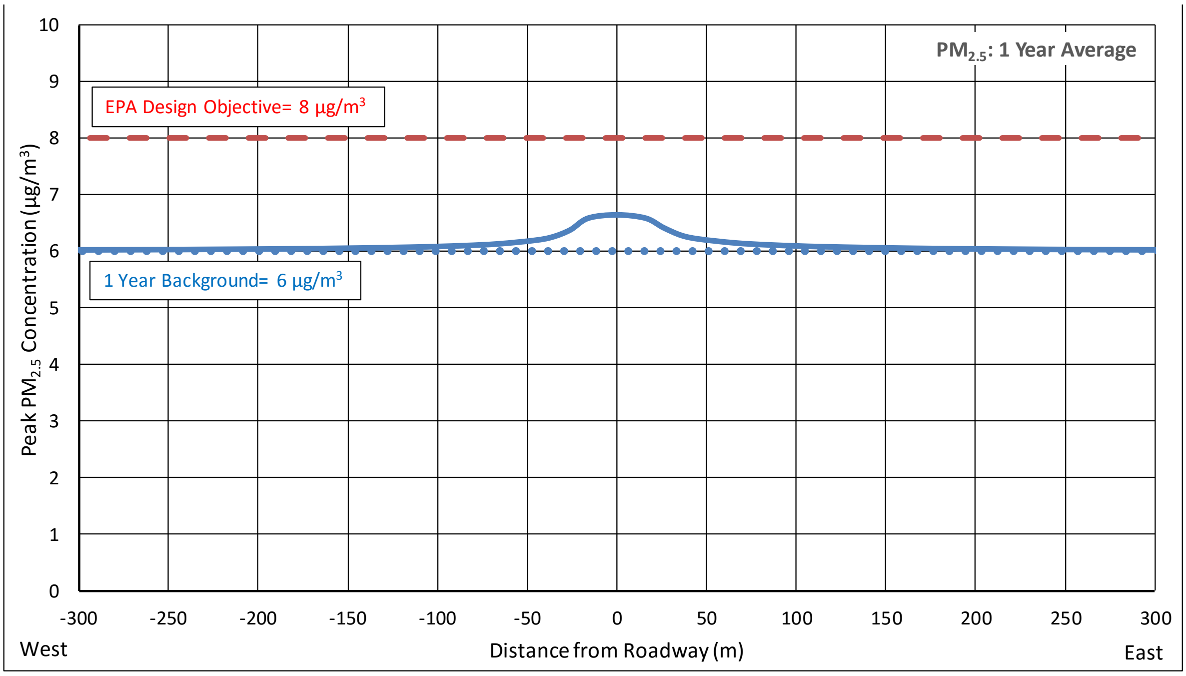

Figure 9-13 Predicted Annual PM2.5 Concentration Distribution

9.2.2 Summary of Findings for Vehicle Emissions

In summary, for all constituents and all averaging periods, the concentrations of air contaminants at all receptors during operation of the Bypass are predicted to satisfy the SEPP(AQM) Intervention Levels and Design Criteria, and the SEPP(AAQ) Environmental Objectives. The air quality predictions for vehicle emissions show that, owing to the small number of vehicles and the separation between the roadway and the nearest receptors, there will be negligible impact of vehicle emissions at all receptors, even those within 100 m of the roadway (but outside the defined road reserve). Therefore, no mitigation measures are proposed for operational impacts.

9.3 Greenhouse gas assessment for Option C2

There would be slightly higher fuel consumption on the average vehicle journey through Beaufort compared to the journey on the Bypass. Calculations of fuel use for typical vehicle journeys on the Bypass route C2 and through the main street of Beaufort will result in a small (about 3 per cent) reduction in greenhouse gas emissions on the Bypass compared to travel through Beaufort.

10 Mitigation Measures

10.1 Standard Dust Mitigation Measures

The standard measures for dust mitigation in VicRoads Contracts are set out below.

(a) General

All work under the Contract shall comply with the following requirements:

- *Emissions of odorous substances or particulates shall not create or be likely to create objectionable conditions for the public;*
- *Materials of any type shall not be disposed of through burning;*
- *Material that may create a hazard or nuisance dust shall be covered during transport; and*
- *Dust generated from road construction activities shall not create a hazard or nuisance to the public, shall not disperse from the site or across roadways, nor interfere with crops, stock or any other dust-sensitive receptors.*

(b) Plant and Equipment

All work under the Contract shall comply with the following requirements:

- *Emissions of visible smoke to the atmosphere from construction plant and equipment shall not be for periods greater than 10 consecutive seconds;*
- *Where practicable all heavy-duty diesel engines must be fitted with Selective Catalytic Reduction (SCR) and diesel particulate filters.*

(c) Monitoring

Monitoring shall comply with the following requirements:

- *Insoluble solids from any air quality monitoring station, as measured by a dust deposit gauge in accordance with the requirements of AS 3580.10.1, shall not exceed 4 g/m²/month or 2 g/m²/month above the background measurement, whichever is the lesser;*
- *Directional dust gauges that comply with the equipment requirements of AS 2724.5 shall be installed alongside each air quality monitoring station. Directional dust gauges shall be orientated such that one of the collecting cylinders is directed towards the construction activities;*
- *Directional dust shall be measured as insoluble solids in accordance with AS 3580.10.1 for each of the four collecting cylinders. Directional dust gravimetric results shall be expressed as the percentage of the total directional dust gauge catch for each cylinder;*
- *Dust deposition and directional dust monitoring shall be supplemented with continuous monitoring using a portable laser light scattering instrument to allow changes to dust control measures if the PM_{10} 1-hour average concentration exceeds 120 µg/m³;*
- *Portable laser light scattering instruments shall be operational daily while undertaking construction activities,*
- *Portable laser light scattering instrument(s) shall provide a visible and logged alarm and SMS notification if the 1-hour average criterion of 120 µg/m³ is exceeded;*

- *The portable light scattering instrument shall be calibrated and maintained in accordance with manufacturer's instructions with calibration and maintenance records.*

10.2 Summary of Additional Mitigations

As construction dust is the air quality issue that poses the highest potential risk, extra dust mitigation measures are recommended to limit, as far as practicable, prolonged adverse impacts on sensitive receptors during the construction period, while acknowledging that some local increase in dust is inevitable. These extra dust mitigation measures should be incorporated into the construction air quality management plan that would form part of the environmental management plan developed for the project. The recommended extra measures are as follows.

- *Reduce activities with high dust generating potential (including heavy excavations and drilling) when strong winds are blowing towards the town.*
- *Restrict speeds of construction vehicles (e.g. to 20 from 40 km/hr, depending on surface travelled) to minimise wheel-generated dust on unsealed routes.*
- *Locate haulage routes for rock and soil away from sensitive receivers as much as practicable.*
- *Water exposed surfaces, including exposed stockpiles and unsealed roadways, regularly to suppress dust generation, with extra watering on days with hot northerly winds.*
- *Cover truck loads where there is potential for dust emissions during transport.*
- *Install appropriate emission control mechanisms (e.g. fabric filter on crushers, concrete batchers) to minimise air emissions.*
- *Install truck tyre cleaning stations at site boundaries for earth moving vehicles to minimise off-site transport of material, which could cause dust emissions.*
- *Develop a construction traffic management plan and advise all truck drivers, contractors and vehicular machinery operators of designated access routes.*
- *Locate stockpiles away from sensitive receivers, as far as practicable.*
- *On stockpiles of topsoil, use mulch or surfactants (eg, polymer based crusting agents) to agglomerate soil particles and increase the threshold erosion velocity.*
- *On other stockpiles or temporary soil surfaces lasting more than three weeks, use surfactants (eg, polymer based crusting agents if there is low traffic flow or vegetable oil-based agents is there is heavy traffic flow) to reduce dust emissions.*
- *Install three portable dust monitoring stations as per the VicRoads specification between the work site and sensitive receptors within 200 m of the roadway. Take action promptly in response to high readings of dust on portable monitoring stations. The dust monitoring stations should be sited as advised by an air quality expert.*

A summary of mitigation measures is provided in Table 10-1 and will require incorporation into the EMF for the management of residual impacts.

Table 10.1 Summary of Mitigation Measures

NO.	MITIGATION	PROJECT PHASE
AQ1	Implement a site-specific dust management plan that incorporates the VicRoads standard measures and the following additional measures: • Install 3 portable dust monitoring stations near receptors • Extra precautionary watering on days with hot north winds • Extra requirements for locating and covering stockpiles • Extra controls for trucks moving construction materials.	Construction

10.3 Residual Impacts

Assuming the extra mitigation measures listed above are implemented, the residual impacts from dust during construction are assessed as follows.

1. For the 2 receptors within 100 m of the roadway, there will be elevated dust levels on a few days during the period of construction with a moderate impact on those days and otherwise a minor impact for the large part of the construction period.
2. For the 4 receptors within 100 m to 200 m of the roadway, there will be elevated dust levels on a few hot days per year during the period of construction with a minor impact, but otherwise a negligible impact.
3. For the 9 receptors within 200 m to 300 m of the roadway, there will be increased dust levels on a few days per year during the period of construction with a low impact on those days, but otherwise are negligible.
4. If dust diversions systems are installed on the roof water systems within 100 m of the roadway, there will be low impact on water quality.

The concentrations of all air contaminants at all receptors during operation of the Bypass are predicted to satisfy the SEPP(AQM) Intervention Levels and Design Criteria, and the SEPP(AAQ) Environmental Objectives. The air quality predictions for vehicle emissions show that, owing to the small number of vehicles and the separation between the roadway and the nearest receptors, there will be negligible impact of vehicle emissions at all receptors, even those within 100 m of the roadway (but outside the defined road reserve). Therefore, no mitigation measures are proposed for operational impacts.

11 Conclusion

This report assesses the effects of the Beaufort Bypass on air quality during the construction and long-term operation of the bypass project.

Four alternative routes for the Bypass across the north of Beaufort were developed for assessment. The two routes (A0 and A1) are further from the town and marginally longer. The two routes (C0 and C2) are closer to the town and marginally shorter. The Bypass routes traverse rural residential and rural land across the north of Beaufort. Depending on the route, there are 3 to 4 residences within 100 m of the Bypass and 9 to 12 residences within 300 m of the Bypass roadways.

A detailed assessment was made of dust during construction and the extent of vehicle emissions from Option C2, which is the preferred route.

The extent of dust raised during construction depends on the weather and stage of construction. There will be more dust on days with high temperatures and strong winds. To address this, dust management procedures have been strengthened.

Air quality impacts during construction are expected to extend a short distance beyond the construction corridor on dry days with moderate to strong winds. Construction dust concentrations are predicted to be highest during filling operations and to be less during later stages of construction. The zone of nuisance dust is predicted to extend up to about 200 m from the edge of construction on days of unfavourable weather, although generally the nuisance zone should be less than 150 m for most of the construction period.

The construction period is expected to be two years, and dust impacts will generally be localized in extent and limited to summer where warmer weather predominates. A range of management measures have been recommended to limit the extent of dust and adverse effects on sensitive receptors

Air quality impacts during operations are expected to be negligible at sensitive receptors adjoining the Bypass because there are only a small number of vehicles using the Bypass (traffic is predicted to be 8,970 vehicles per day in 2031). Significant changes in air quality near roadways generally occur with more than 50,000 veh/day. Outside the road reserve, the concentrations of air contaminants from vehicles on the Bypass are predicted to be within the SEPP requirements for air quality.

When operating, the Bypass will result in an improvement in air quality along the main street of Beaufort because the majority of through traffic will have been diverted to the Bypass.

12 Limitations

The atmosphere is a complex hydrodynamic system, and the movement of air at Beaufort depends on many parameters including air and ground temperature, topography and land use, as well as larger-scale synoptic processes.

Dispersion modelling simulates the movement of dust and air pollutants in the atmosphere using mathematical equations. The model equations necessarily involve some level of simplification of these very complex processes, based on our understanding of the major processes involved and their interactions, available input data and processing time limitations.

These simplifications limit the accuracy that can be achieved, particularly during low wind speed conditions or for low-level, non-buoyant sources, where the topography of stockpiles and road embankments creates extra local topography and roughness. To accommodate these known limitations, model outputs tend to provide conservative estimates of pollutant concentrations at particular locations.

Dust modelling is influenced by sequences of wet and dry days, by variability in the fine constituents of the materials excavated, stockpiled and used in embankment construction. Thus, dispersion models, provide good estimates of the extent of dust concentrations but cannot predict the dust concentrations at a particular point at a particular hour.

The air quality impact assessment reflects the vehicle numbers and operational speeds provided by WSP, which were used to determine emissions for dispersion modelling.

Existing background concentrations and wind conditions were estimated from observations at other locations in Victoria due to the unavailability of a representative monitoring station at Beaufort. The adopted background concentrations have been chosen conservatively and actual background concentrations at the Project site may be lower than the adopted concentrations. However, background concentrations will vary over time, depending on agricultural activities (ploughing, harvesting stocking rates) and seasonal weather (drought or otherwise). Local bushfires can substantially increase background fine particle concentrations.

13 References

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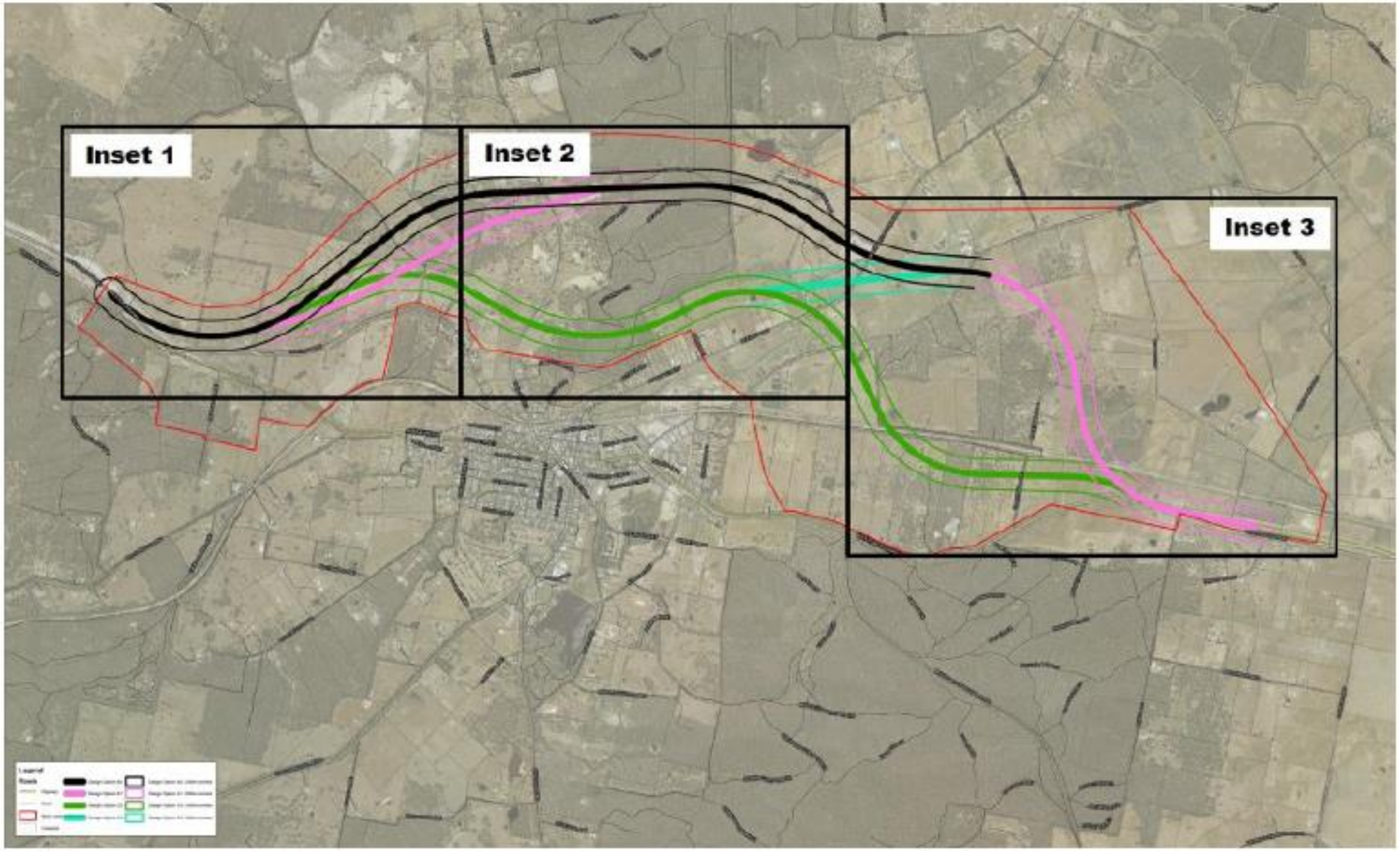
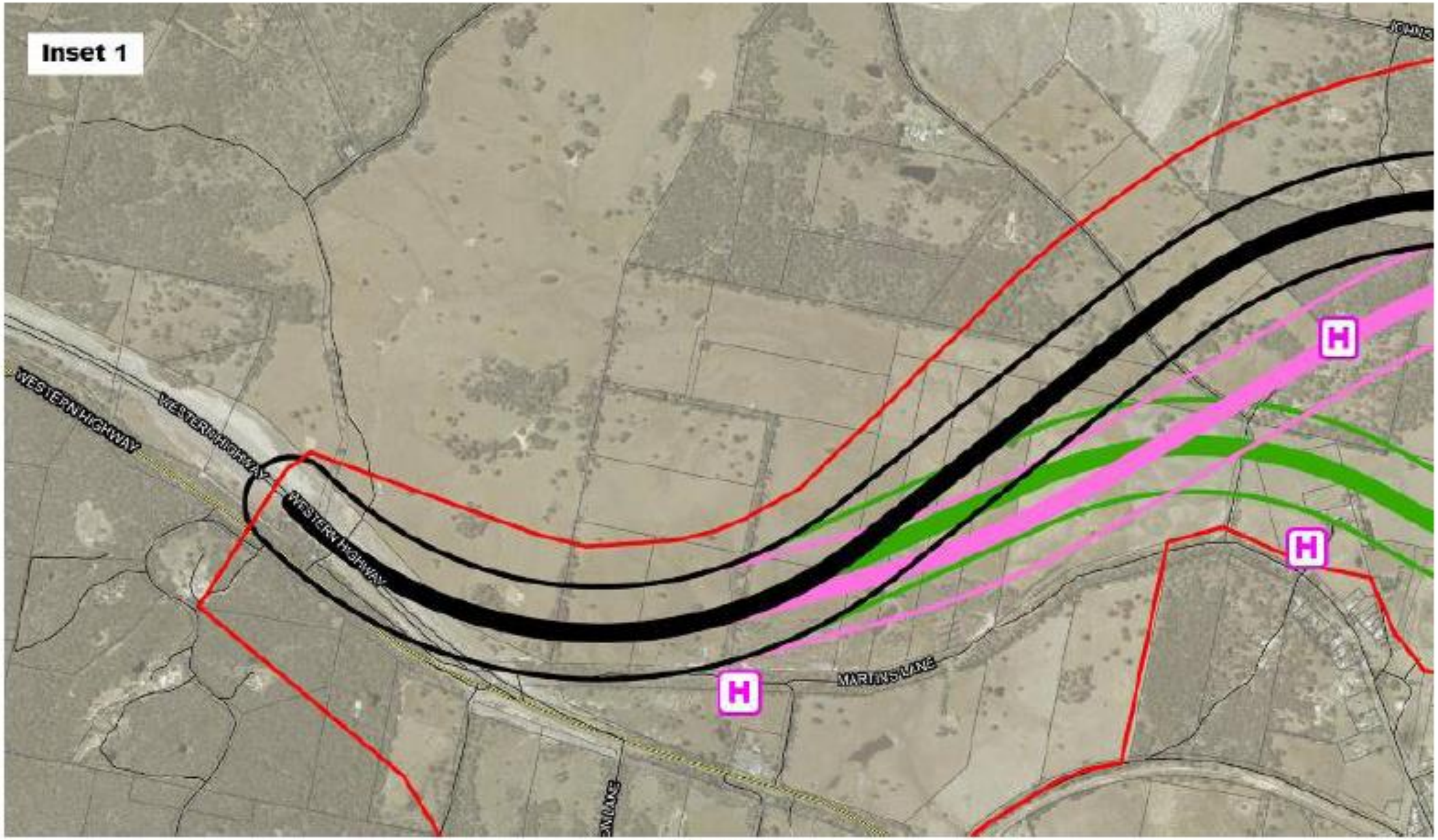
Appendix A – Sensitive Receptors

The plans on the following pages show the location of sensitive receptors in the vicinity of the alignment options. The key for the three plans is shown in Figure A-1, where the route options are divided into three sections to retain a readable scale. The symbol "H" on the plans depicts the location of a house (rural or edge of town area) while the symbol "V" depicts the location of a vineyard.

Appendix A-1. Key Map for Location of Sensitive Receptors on Route Options for Beaufort Bypass

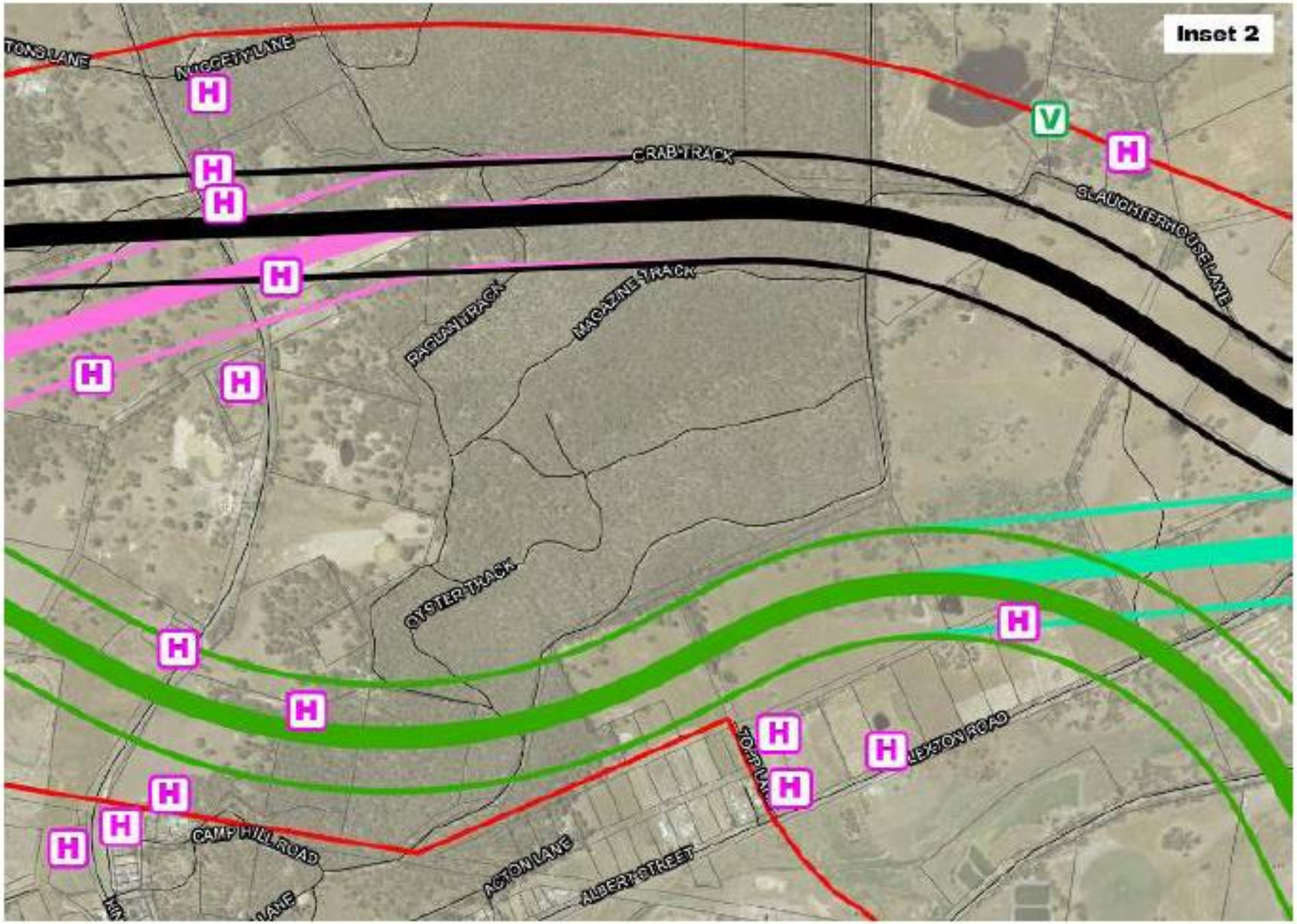


Appendix A-2. Location of Sensitive Receptors (subject to final alignments being selected) – West



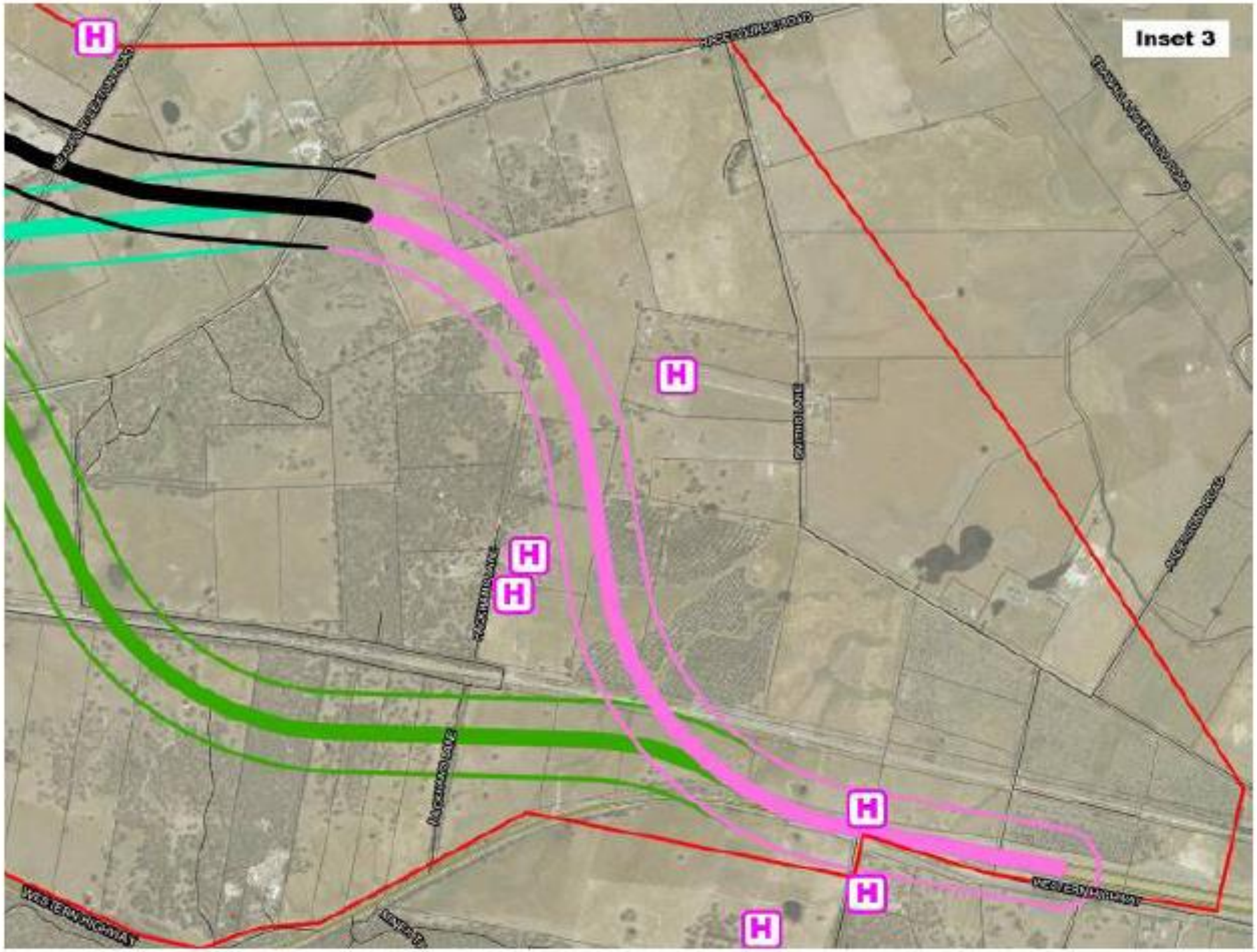
Note: H = house

Appendix A-3. Location of Sensitive Receptors (subject to final alignments being selected) – Central



Note: H = house; V = vineyard

Appendix A-4. Location of Sensitive Receptors (subject to final alignments being selected) – East

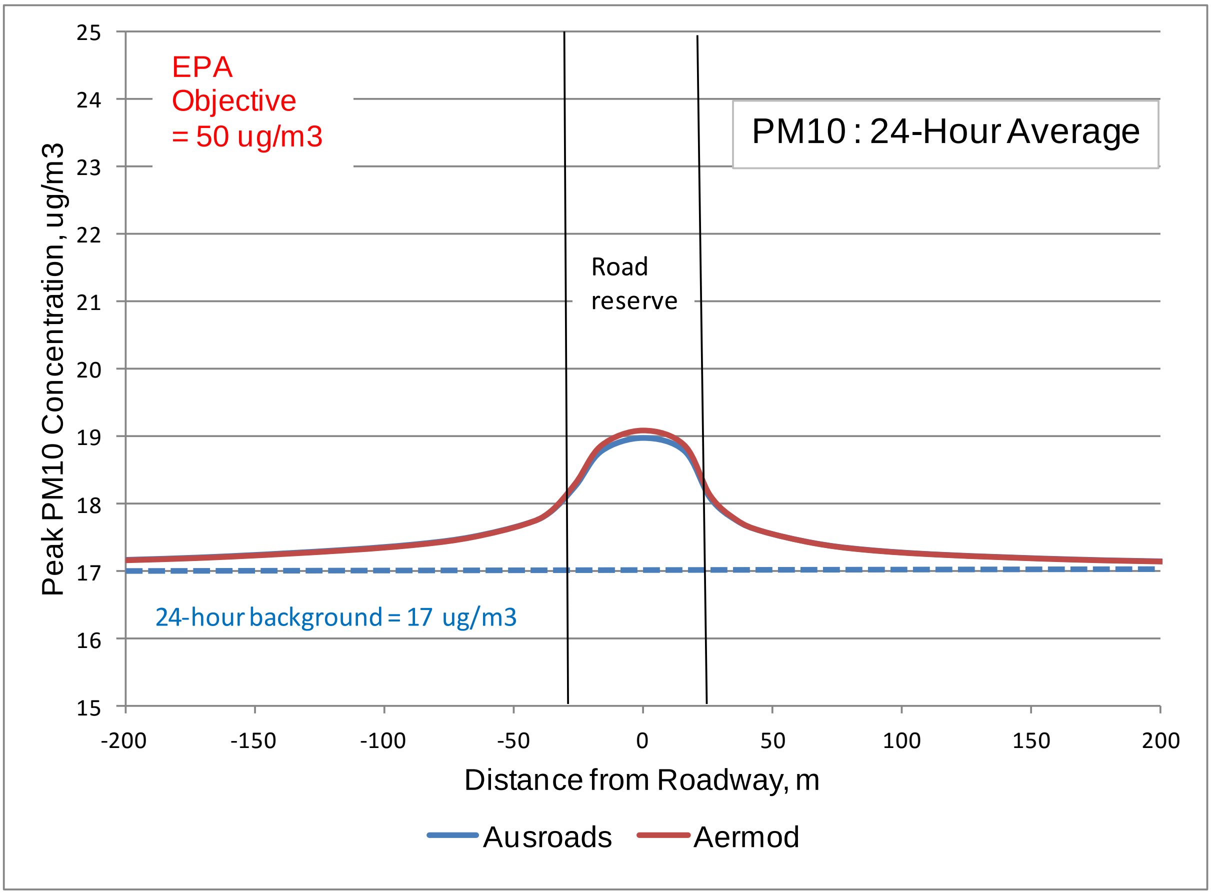


Note: H = house

Appendix B – Comparison of Ausroads and Aermod

A comparison of the Ausroads and Aermod predictions is shown in Figure B-1, which shows the west-to-east distribution of peak 24-hour PM_{10} concentration from vehicle emissions. The plot is at an expanded scale (compared to figure in Chapter 8) to emphasise the comparison of the two models.

Figure B-1 Predicted PM10 Concentration by Two Models



Both models predict essentially the same PM_{10} concentrations at all receptors. On and close to the roadway, Aermod predicts slightly higher concentrations. Beyond about 60 m from the road, Aermod predicts slightly lower concentrations (but the difference is very small, as can be seen in Figure B-1).

The background concentration has a major influence on the peak concentrations of PM_{10} near the Beaufort Bypass. The contribution from vehicles on the road is considered relatively small at the edge of the road reserve and minor beyond about 100 m from the road.

Both models predicted essentially the same concentrations at receptors. This confirms that the air quality model predictions presented in the Report are valid.

Appendix C – Air Quality Risk Assessment