IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications for resource consents and notices of requirement in relation to the Ōtaki to North of Levin Project
BY	**WAKA KOTAHI NZ TRANSPORT AGENCY**
	Applicant

ŌTAKI TO NORTH OF LEVIN HIGHWAY PROJECT

TECHNICAL ASSESSMENT C: AIR QUALITY

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Glossary of Terms

Table C.1: Glossary of Terms	
Term	**Definition**
2005 WHO AQG	2005 World Health Organisation Air Quality Guidelines.
2021 WHO AQG	2021 World Health Organisation Air Quality Guidelines.
AADT	Annual Average Daily Traffic.
Background Air Quality	Background refers to existing air quality 'Without Project'.
CAQMP	Construction Air Quality Management Plan.
CASANZ	Clean Air Society of Australia and New Zealand.
CO	Carbon Monoxide, an air pollutant produced from incomplete combustion of fuels, eg, diesel and petrol used in transport. CO can cause health effects such as asphyxia.
Design year	The year in which traffic volumes are anticipated to reach a preselected level, usually taken to be 10 years after the completion of the State Highway improvement.
Designation	A provision made in a district plan to give effect to a requirement made by a requiring authority (eg, Waka Kotahi New Zealand Transport Agency) for public work, project, or work.
Emission	The release of a substance (eg, an air pollutant) from a source, (eg, transport, industry or domestic fires). Emissions are often expressed in units per activity (eg, grams per kilometre driven g/km or grams per kilogram fuel burnt g/kg).
ESR	Environmental and Social Responsibility.
EWS	Electronic Weather Station.
Exceedance	An occasion when the concentration of an air pollutant exceeds a standard or permissible measurement.
Existing Air Quality	Existing air quality is the air quality now. The sum of the background air quality and the nearby road contribution.
FIDOL	Frequency, Intensity, Duration, Offensiveness and Location.
GWRC	Greater Wellington District Council.
HCV	Heavy Commercial Vehicles.
HDC	Horowhenua District Council.
Horizons	Manawatū Whanganui Regional Council.
IAQM	Institute of Air Quality Management.

Table C.1: Glossary of Terms	
Term	**Definition**
KCDC	Kāpiti Coast District Council.
LCV	Light Commercial Vehicles.
Link	In a road network, a portion of a road between two intersections, junctions, interchanges, or nodes. Its basic characterises are length, vehicle speeds, travel times and number of lands.
MetService	Meteorological Service of New Zealand.
MfE	Ministry for the Environment.
MfE GPG ADM	Ministry for the Environment, Good Practice Guide for Atmospheric Dispersion Modelling.
MfE GPG Dust	Ministry for the Environment, Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emissions.
MfE GPG LT	Ministry for the Environment, Good Practice Guide for Assessing Discharge to Air from Land Transport.
NES-AQ	National Environmental Standards for Air Quality, which sets standards for ambient air quality for key air pollutants to protect health. The NES-AQ apply to any location outdoors where people are likely to be exposed. The full title is Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins, and Other Toxics) Regulations 2004.
NIMT	North Island Main Trunk. The main rail line in the North Island.
NIWA	National Institute of Water and Atmospheric Research.
NO_2	Nitrogen Dioxide, an air pollutant produced from the combustion of fossil fuels used in transport. NO_2 can cause health effects such as increased susceptibility to lung infections.
NoR	Notice of Requirement for a Designation.
NRP	Greater Wellington Natural Resources Plan.
NZAAQG	Ministry for the Environment New Zealand Ambient Air Quality Guidelines.
NZUP	New Zealand Upgrade Programme.
O_3	Ozone. Ozone is a very reactive gas that can absorb Ultra Violet (UV) radiation. Ozone can cause serious health effects, such as mortality, respiratory and cardiovascular disease at high concentrations. Short term health effects also include irritation to eye, nose and throat, coughing and headaches.

Table C.1: Glossary of Terms	
Term	**Definition**
Opening Year	The year in which the State Highway improvement is completed and opened for use.
PDP	Pattle Delamore Partners.
PM_{10}	Fine particulate Matter with an aerodynamic diameter < 10 µm, an air pollutant produced from the combustion of fossil fuels, primarily diesel, used in transport. PM_{10} can cause serious health effects such as increased cardio-respiratory illness and premature death.
$PM_{2.5}$	Fine particulate Matter with an aerodynamic diameter < 2.5 µm, an air pollutant produced from the combustion of fossil fuels, primarily diesel, used in transport. $PM_{2.5}$ relates more directly with adverse health effects when compared to PM_{10}.
PP2Ō	Peka Peka to Ōtaki.
The Ō2NL Project	Ōtaki to North Levin Highway Project.
RMA	Resource Management Act 1991.
Sensitive Receptor	A location where people or surroundings may be particularly sensitive to the effect of air pollution eg, retirement villages, aged care facilities, hospitals, schools, early childhood education centres, marae, other cultural facility and sensitive ecosystems.
SH	State Highway.
SO_2	Sulphur Dioxide. Sulphur dioxide is a colourless, soluble gas with a characteristic pungent smell which forms sulphuric acid when combined with water. Sulphur dioxide can cause respiratory problems.
Stage 1 Assessment	Environmental and social responsibility screen. This consists of a simple checklist of questions that is carried out for all projects during the indicative business case.
Stage 2 Assessment	Preliminary technical assessment. The purpose of this assessment is to establish whether the predicted Project or cumulative air quality impact is likely to result in the relevant air quality criteria being exceeded. This stage includes the screening assessment (tier 2 from MfE GPG LT).
Stage 3 Assessment	Technical assessment. This level of assessment is based on detailed atmospheric dispersion modelling techniques and reliance on site-specific input data. This stage is designed to evaluate in detail the likely effects of air quality risks or opportunities arising from the Project and feed this information back into the detailed design process. The assessment also aims to provide information on how any effects can be mitigated.

Table C.1: Glossary of Terms	
Term	**Definition**
SUP	Shared Use Path.
TAPM	The Air Pollution Model.
TSP	Total Suspended particulate, a measure of likely dust nuisance.
UTM	Universal Transverse Mercator.
VEPM	Vehicle Emissions Prediction Model.
VOC	Volatile Organic Compounds, these are a group of air pollutants. In transport applications, VOCs are produced by the evaporation or combustion of fossil fuels and include a wide range of compounds.
Waka Kotahi	Waka Kotahi New Zealand Transport Agency is responsible for the building and operation of New Zealand's State Highway network amongst other duties since July 2008.
Waka Kotahi Guide	Waka Kotahi Guide to assessing air quality impacts from state highway projects[1] (Waka Kotahi Guide).
WHO	World Health Organization.
With Project	The predicted air quality contribution for each link affected by the Project at both the predicted opening year and the design year, with the Project implemented.
Without Project	The predicted air quality risk for each link affected by the Project at both the predicted opening year and the design year, assuming no alterations are made to the existing road.
WRAQMP	Wellington Regional Council Air Quality Management Plan.
µm	Unit of Length (micron).
m	Unit of Length (metre).
km	Unit of Length (kilometre).
km/hr	Unit of speed (kilometres per hour).
m/s	unit of speed (metres per second).
$\mu g/m^3$	Concentration (microgram per cubic metre).
g/km	Emission rate (grams per kilometre).

[1] Waka Kotahi NZ Transport Agency, Guide to assessing air quality impacts from state highway projects, version 2.3, October 2019.

EXECUTIVE SUMMARY

1. This technical assessment assesses the potential effects of discharges to air associated with the construction and operation of a highway between Ōtaki and North Levin ("**Ō2NL Project**"). It has been prepared to support the notices of requirement ("**NoR**") for designations and application of resource consents for the Ō2NL Project.

2. This assessment has been undertaken using best practice methods, best available data, and adopting the recommendations of the relevant good practice guides. For these reasons, the results and conclusions presented in the report can confidently be used to assess the potential air quality impacts of the Ō2NL Project.

Construction Effects of the Ō2NL Project

3. The primary potential air discharge from the construction of the Ō2NL Project will be dust, which has the potential to cause diminished amenity values. Pattle Delamore Partners Limited ("**PDP**") has assumed that construction will not commence until all properties within the designations have been acquired by the Crown, and therefore a qualitative assessment has been undertaken to determine the potential for the approximately 400 properties within 200 metres of the proposed designations to be affected by dust.[2] Overall, the sensitivity of the area to dust effects on people and property is high, due to the short distances between the construction footprint and a relatively large number of potentially sensitive receptors.

4. Approximately 130 properties could be located within 50 m of the proposed designation boundary and the unmitigated dust effects at these properties could result in nuisance effects that have the potential to be considered offensive or objectionable. The assumed 50 m buffer is conservative, as it does not take into account the distance between construction works and the designation boundary.

5. However, approximately 50 of these properties are located outside the designations but within 50 m of the Ō2NL concept design. If the Ō2NL concept design is constructed those properties would be close to construction activities. The best-practice mitigation measures detailed in the proposed consent conditions and the Construction Air Quality Management

[2] The number of properties is based on existing properties and new building platforms, identified in Technical Assessment B.

Plan ("**CAQMP**"), which is required to be prepared per the conditions set (Appendix Five to Volume II), will reduce dust nuisance effects at those properties. Despite these measures, in my opinion it is likely that the residual dust effects at these properties will be such that residents are likely to notice increased dust levels and potentially be annoyed.

6. For the 270 properties (approximately) located more than 50 m (but less than 200 m) from the designation boundary, the unmitigated dust nuisance effects are unlikely to be considered offensive or objectionable. Regardless, these dust emissions will be mitigated through the consent conditions and the CAQMP to ensure that residents are unlikely to notice any changes in dust levels.

7. Overall, based on PDP's experience, the number of properties that could be affected by nuisance dust is not unusual for a construction project of this scale.

8. The overall construction dust effects of the Ō2NL Project on ecological areas are considered to be "low" to "very low" based on the information provided in Table J.3 in Technical Assessment J (Terrestrial Ecology).

9. There will also be minor emissions (exhaust fumes) from construction vehicles. The potential air quality effects from these emissions are considered to be negligible due to the relatively small number of vehicles that will be operating during the construction period.

Measures to Mitigate Construction Effects from the Ō2NL Project

10. A number of mitigation measures have been recommended to reduce the potential for construction dust emissions, given the high-risk rating[3] for air quality effects on residential properties. These measures will be required through the conditions to be contained in a CAQMP and includes (but is not limited to):

    (a) speed restrictions on construction vehicles operating on unsealed surfaces near sensitive receptors;

    (b) ensuring appropriate mitigation measures are in place to minimise dust effects in areas where construction activities are occurring such as:

[3] Based on the IAQM Criteria in Assessment of Effects section.

(i) the use of water tankers to dampen surfaces that have the potential to create dust; and

(ii) finished cut batters are vegetated or covered with hydroseed or mulch as soon as practicable;

(c) having a community engagement and liaison team, which meets with potentially affected property owners and develops specific mitigation packages, as well as promptly addressing concerns or complaints (using the comprehensive complaints procedure); and

(d) having a team dedicated to monitoring environmental effects.

11. The proposed mitigation measures for ecological areas (as described in Technical Assessment J (Terrestrial Ecology)) are:

(a) monitoring the settlement of construction dust on indigenous vegetation that will be retained; and

(b) where necessary implementing dust suppression and control measures.

Operational Effects of the Ō2NL Project

12. The operational assessment was undertaken using the methodology set out in Waka Kotahi New Zealand Transport Agency's ("**Waka Kotahi**") guidance and included a Stage 2 assessment using the Waka Kotahi Air Quality Screening model and a Stage 3 assessment using the CALPUFF atmospheric dispersion model.

Stage 2 Assessment

13. The Waka Kotahi screening model was used to assess the potential operational air quality effects for the southern portion of the proposed designations from Taylors Road to Ohau. This screening model has been used to predict annual nitrogen dioxide ("**NO_2**"), concentrations and 24-hour particulate matter smaller than 10 µm ("**PM_{10}**") concentrations from vehicle emissions for the opening year (2029) with and without the Ō2NL Project.

14. The screening model results show that sensitive receptors alongside the existing State Highway 1 ("**SH1**") will see an improvement, or at worst no change, in air quality with the Ō2NL Project. The receptors located near the proposed alignment will see either no change or a small increase in

concentration with the Project, with all concentrations being below the relevant health assessment criteria.

Stage 3 Assessment

15. A detailed Stage 3 assessment using the CALPUFF dispersion model was undertaken for Ō2NL between Ohau and North of Levin. This assessment has predicted ambient concentrations of NO_2, PM_{10}, and particulate matter smaller than 2.5 µm ("**$PM_{2.5}$**") from vehicle emissions using the Ō2NL highway and existing state highway network for the opening year (2029) and the design year (2039) with and without the Ō2NL Project. The assessment results indicate low concentrations of pollutants for all scenarios with no exceedances of the relevant ambient air quality standards.

16. NO_2 and $PM_{2.5}$ concentrations decreased for all averaging periods in 2039 when compared to 2029 for both scenarios, while PM_{10} concentrations (all averaging periods) increased in 2039 when compared to 2029 (both scenarios). However, the predicted increases are not considered significant, and all concentrations are below the relevant air quality guidelines.

17. All modelled scenarios result in a reduction in concentrations for the 'With Project' scenario when compared to the 'Without Project / Do Minimum' for the corresponding year. The reduction in concentrations reflect the decrease in vehicle numbers through Levin town centre, the predicted changes in vehicle emission technologies and a move away from fossil fuelled vehicles.

18. The small, predicted increase in 24-hour PM_{10} concentrations in 2039 compared to 2029 in Levin town centre can be attributed to the increase in vehicle numbers outweighing the benefits of enhanced vehicle emission technologies.

19. The Shared Use Path ("**SUP**") is located within 200 m of the Ō2NL highway at different points along the route. Users along the SUP are closer to the Ō2NL highway when compared to the sensitive receptors and therefore will experience higher concentrations compared to the residences. However, these concentrations are still predicted to be below relevant air quality assessment criteria and unlikely to result in any adverse health effects.

20. Overall, the Ō2NL Project will improve air quality within the Ō2NL Project area as a result of improved traffic flows, which corresponds to reduced

traffic emissions which is shown in both the Stage 2 and Stage 3 assessment methods.

Measures to mitigate Operational Effects of the Ō2NL Project

21. For both years assessed, with the Ō2NL Project constructed, it is predicted that minor increases in concentrations will generally occur in areas located within 200 m of the proposed carriageway. Regardless of the scale of any increase, predicted concentrations will remain well below relevant air quality assessment criteria and therefore the implementation of any operational mitigation measures is not required.

INTRODUCTION

22. This report has been prepared by Andrew Curtis, a Technical Director at Pattle Delamore Partners Limited. I am the primary author of this report. I have been assisted by:

    (a) Tara Hutchins who is an Air Quality Scientist at PDP and was responsible for undertaking the dispersion modelling and assisted with drafting of the report.

    (b) Jonathan Harland who is an Air Quality Service Leader at PDP and was responsible for the ambient monitoring of air pollutants and review of the dispersion modelling.

    (c) Jeff Bluett who is a Technical Director at PDP amd who is the primary peer reviewer of the work undertaken.

Qualifications and experience

23. I have the following qualifications and experience relevant to this assessment:

    (a) Bachelor’s Degree in Chemical and Material Engineering from the University of Auckland.

    (b) Post Graduate Diploma in Toxicology with Distinction from RMIT University, Melbourne.

    (c) Post Graduate Certificate in Sustainable Management from the Open Polytechnic.

(d) Some recent or current projects where I have provided air quality advice include:

(i) Primary author of the air quality assessment for the PP2Ō expressway, and preparation of evidence for the Board of Inquiry.

(ii) Primary author of the air quality assessment associated with an assessment of options for an alternate crossing of the Waitemata Harbour.

(iii) Author of the Construction Air Quality Management Plan for Te Ara Nui o Te Rangihaeata / Transmission Gully.

(iv) Co-author on the Clean Air Society of Australia and New Zealand ("**CASANZ**") "*Good Practice Guide for the Assessment and Management of Air Pollution from Road Transport*" (2021) for assessing impacts of roadway projects.

Code of conduct

24. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014. This assessment has been prepared in compliance with that Code, as if it were evidence being given in Environment Court proceedings. In particular, unless I state otherwise, this assessment is within my area of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Purpose and scope of assessment

25. Waka Kotahi is giving NoRs for designations to the Horowhenua District Council ("**HDC**") and the Kāpiti Coast District Council ("**KCDC**") and is applying for the necessary resource consents from Manawatū-Whanganui Regional Council ("**Horizons**") and the Greater Wellington Regional Council ("**GWRC**") for the Ō2NL Project. The Ō2NL Project is part of the New Zealand Upgrade Programme ("**NZUP**") and has the purpose to "*improve safety and access, support economic growth, provide greater route resilience, and better access to walking and cycling facilities*". This assessment considers air quality effects associated with the construction and operation of the Ō2NL Project.

26. This technical assessment is one of a suite of technical assessments prepared for the Ō2NL Project and assesses the actual and potential environmental effects of the Ō2NL Project on air quality.

27. Specifically, it presents an assessment of:

(a) the potential effects of air discharges, primarily dust, from the construction of the Ō2NL Project on ‘sensitive receptors’ (defined later) along the proposed route, together with mitigation measures to minimise any potential effects; and

(b) the potential effects (both positive and negative) of vehicle emissions associated with the Ō2NL Project once it is operational on a number of representative sensitive receptors along the proposed route.

PROJECT DESCRIPTION

28. The Ō2NL Project involves the construction, operation, use, maintenance, and improvement of approximately 24 kilometres of new four-lane median divided state highway (two lanes in each direction) and a SUP between Taylors Road, Ōtaki (and PP2Ō) and SH1 north of Levin. The Ō2NL Project includes the following key features:

(a) a grade separated diamond interchange at Tararua Road, providing access into Levin;

(b) two dual lane roundabouts located where Ō2NL crosses State Highway 57 ("SH57") and where it connects with the current SH1 at Heatherlea East Road, north of Levin;

(c) four lane bridges over the Waiauti, Waikawa and Kuku Streams, the Ohau River and the North Island Main Trunk ('**NIMT**") rail line, north of Levin;

(d) a half interchange with southbound ramps near Taylors Road and the new PP2Ō expressway to provide access from the current SH1 for traffic heading south from Manakau or heading north from Wellington, as well as providing an alternative access to Ōtaki;

(e) local road underpasses at South Manakau Road and Sorenson Road to retain local connections;

(f) local road overpasses to provide continued local road connectivity at Honi Taipua Road, North Manakau Road, Kuku East Road, Muhunoa East Road, Tararua Road (as part of the interchange), and Queen Street East;

(g) new local roads at Kuku East Road and Manakau Heights Road to provide access to properties located to the east of the Ō2NL Project;

(h) local road reconnections connecting:

  (i) McLeavey Road to Arapaepae South Road to the west side of the Ō2NL Project;

  (ii) Arapaepae South Road, Kimberley Road and Tararua Road on the east side of the Ō2NL Project;

  (iii) Waihou Road to McDonald Road to Arapaepae Road / SH57;

  (iv) Koputaroa Road to Heatherlea East Road and providing access to the new northern roundabout;

(i) the relocation of, and improvement of, the Tararua Road and current SH1 intersection, including the introduction of traffic signals and a crossing of the NIMT;

(j) road lighting at conflict points, that is, where traffic can enter or exit the highway;

(k) median and edge barriers that are typically wire road safety barriers with alternative barrier types used in some locations, such as bridges that require rigid barriers or for the reduction of road traffic noise;

(l) stormwater treatment wetlands and ponds, stormwater swales, drains and sediment traps;

(m) culverts to reconnect streams crossed by the Ō2NL Project and stream diversions to recreate and reconnect streams;

(n) a separated (typically) 3 m wide SUP, for walking and cycling along the entire length of the new highway (but deviating away from being alongside the Ō2NL Project around Pukehou (near Ōtaki)) that will link into the shared path facility that are part of the PP2Ō expressway (and further afield to the Mackays to Peka Peka expressway SUP);

(o) spoil sites at various locations along the length of the Project; and

(p) five sites for the supply of bulk fill / earth material located near Waikawa Stream, the Ohau River and south of Heatherlea East Road.

29. The Ō2NL Project passes through the management areas of two regional councils and two district councils: GWRC, Horizons, KCDC, and HDC.

ASSESSMENT METHODOLOGY

30. This air quality assessment has been undertaken in accordance with accepted best practice in New Zealand as set out in the following guidance documents:

(a) Ministry for the Environment ("**MfE**") Good practice Guide for Assessing and Managing Dust ("**MfE GPG Dust**");[4]

(b) MfE Good Practice Guide for Assessing Discharges to Air from Land Transport ("**MfE GPG LT**");[5]

(c) MfE Good Practice Guide for Atmospheric Dispersion Modelling ("**MfE GPG ADM**");[6] and

(d) Guide to assessing Air Quality Impacts from State Highway Project v2.3 ("**Waka Kotahi Guide**").[7]

Construction Assessment

31. This assessment has qualitatively determined the air quality effects associated with the construction of the Ō2NL Project in accordance with the recommendations detailed in the MfE GPG Dust and Waka Kotahi Guide.

32. This assessment has involved reviewing the activities that will be undertaken at a particular location and determining the potential for these activities to generate nuisance dust that might affect sensitive receptors. In determining whether there is the potential for nuisance to occur, consideration has been made of:

(a) the nature of the activity being undertaken;

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[4] Ministry for the Environment, *Good Practice Guide for Assessing and Managing Dust*, November 2016.
[5] Ministry for the Environment, Good Practice Guide for Assessing Discharge to Air from Land Transport, June 2008.
[6] Ministry for the Environment, *Good Practice Guide for Atmospheric Dispersion Modelling*, June 2004.
[7] Waka Kotahi NZ Transport Agency, *Guide to assessing air quality impacts from State Highway projects,* version 2.3, October 2019.

(b) how long the activities are likely to occur;

(c) the volume and nature of the soils or other material being cut or placed;

(d) mitigation measures implemented to control the potential for effects (eg, use of water carts, covering stockpiles etc);

(e) how close receptors are to the work areas;

(f) the nature of the receptors and their sensitivity to dust; and

(g) the prevailing meteorological conditions; and

(h) effectiveness of mitigation measures.

Operational Assessment

33. The operational effects of the Ō2NL Project have been assessed using a methodology based on that set out in Waka Kotahi Guide, and the MfE GPG LT.[8] Both documents set out an approach to determine the appropriate level of assessment required, when assessing the environmental effects from a specific roading project.

34. The Waka Kotahi Guide sets out a staged assessment as follows:

(a) Stage 1 - Environment and Social responsibility screen. This consists of a simple checklist of questions that is carried out for all projects during the indicative business case.

(b) Stage 2 – Preliminary technical assessment. The purpose of this assessment is to establish whether the predicted project or cumulative air quality impact is likely to result in the relevant air quality criteria being exceeded.

(c) Stage 3 - Technical assessment. This level of assessment is based on detailed atmospheric dispersion modelling techniques and reliance on site-specific input data. This stage is designed to evaluate in detail the likely effects of air quality risks or opportunities arising from a project and feed this information back into the detailed design process. The assessment also aims to provide information on how potential effects can be mitigated.

[8] Ministry for the Environment, *Good Practice Guide for Assessing Discharge to Air from Land Transport,* June 2008 (MfE GPG LT).

35. Whereas the MfE GPG LT[9] sets out a three-tiered assessment, as follows:

(a) Tier 1 – Preliminary assessment, to identify whether there are likely to be significant air quality effects.

(b) Tier 2 – Screening assessment.

(c) Tier 3 – Full assessment, within increased complexity in modelling and reliance on site-specific data.

36. A combination of the Waka Kotahi staged approach and MfE GPG LT tiered approach has been used for this operational assessment, although it is primarily based on the Waka Kotahi staged approach. However, the MfE tiered approach is incorporated in the Waka Kotahi Stages 2 and 3. The Stage 2 assessment incorporates Tier 1 and Tier 2, and the Stage 3 assessment incorporates Tier 3. Further details of the methodology adopted for the Stage 2 and 3 assessments is provided in the sub-sections below.

37. The Ō2NL Project operational assessment utilises a combination of Stage 2 (preliminary technical assessment) and Stage 3 (detailed technical assessment). A Stage 2 assessment undertaken for the area from Taylors Road to Ohau River and a Stage 3 assessment undertaken for the area from Ohau River to North Levin. A Stage 3 assessment is required due to a relatively large number of sensitive receptors being located in Levin and in the surrounding area.

Operational Assessment - Criteria Pollutants

38. The following vehicle-related air pollutants have been identified in the Waka Kotahi guide as having the potential to cause adverse health effects:

(a) gases – eg, NO_2, carbon monoxide ("**CO**") and volatile organic compounds ("**VOCs**") such as benzene; and

(b) particulate matter in different size fractions – eg, PM_{10} and $PM_{2.5}$.

39. From these pollutants the majority of ambient air quality health effects result from three indicator pollutants (NO_2, PM_{10}, and $PM_{2.5}$). Therefore, the guidance suggests that if the levels of the indicator pollutants are less than ambient air quality criteria (refer to assessment criteria section) then the

[9] Ministry for the Environment, *Good Practice Guide for Assessing Discharge to Air from Land Transport,* June 2008 (MfE GPG LT).

levels of other pollutants (VOCs, ozone ("**O_3**"), and CO) would be likely to be below the relevant assessment criteria.

40. If NO_2, PM_{10}, and $PM_{2.5}$ concentrations are found to exceed the relevant air quality assessment criteria, then an assessment of the additional pollutants may be required.

41. In addition to effects on human health there is also the potential for air pollutants to have adverse effects on ecosystems. However, these effects generally only occur when concentration levels are higher than those used as assessment criteria[10] for determining adverse human health effects. Therefore, providing that pollutants are below the heath-based effects assessment criteria, then there are unlikely to be effects on the environment or ecosystems.[11]

Assessment scenarios

42. As required by the Waka Kotahi assessment method, the potential effects of the Ō2NL Project on the surrounding environment are predicted for three scenarios - the current situation (base year, 2018), the opening year (2029) and 10 years after opening (2039). Future scenarios are referred to as either 'Without Project' / 'Do Minimum' or 'With Project'.

43. The scenarios reflect the effect the Ō2NL Project will have on air quality, taking into consideration improvements in vehicle emissions over time and changes to the composition of the vehicle fleet. These scenarios also allow a 'With Project' and 'Without Project' / 'Do Minimum' comparison of air quality.

Sensitive Receptors

44. A 'sensitive receptor' is defined by Horizons as a location where people or surroundings may be particularly sensitive to the effects of air pollution. This type of receptor includes (but is not limited to) residential buildings, hospitals, education facilities, rest homes, motels, public places, public roads, surface water bodies, marae, water supply catchments and intakes, rare, threatened and at-risk habitats and sensitive crops.[12]

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[10] Set out in the Assessment Criteria section of this Assessment.
[11] Ministry for the Environment, *Good Practice Guide for Assessing Discharges to Air from Land Transport,* June 2008 - Section 3.1.2.
[12] Policy 15-2, Horizons One Plan, 2014.

45. During the preliminary stages of the assessment, areas were identified following a site visit, where there was the potential for air quality impacts to occur, and a number of representative sensitive receptors were selected in each of those areas (for the operational assessment). Not all of the sensitive receptors have been included as discrete receptors for practical purposes, but instead, a number of locations that are representative of likely worst-case potential impacts have been selected.

46. The location of these selected sensitive (discrete) receptors are shown in Figure C.1 to Figure C.5 and Appendix C.1, presented in the traffic and emission modelling section.

47. The predicted air quality impacts at R1 to R16 (Figures C.1 and C.2) are assessed using the Stage 2 assessment and the remaining receptors (Figure C.3 to Figure C.5) using the Stage 3 assessment.

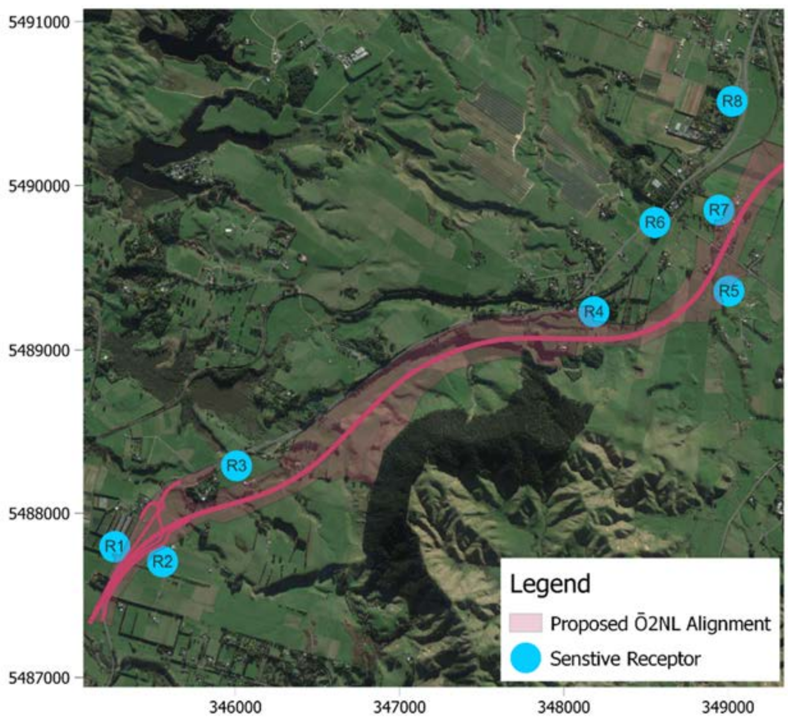


Figure C.1: Sensitive Receptor Locations (R1-R8) (Chainage 34,900 to 29,000)

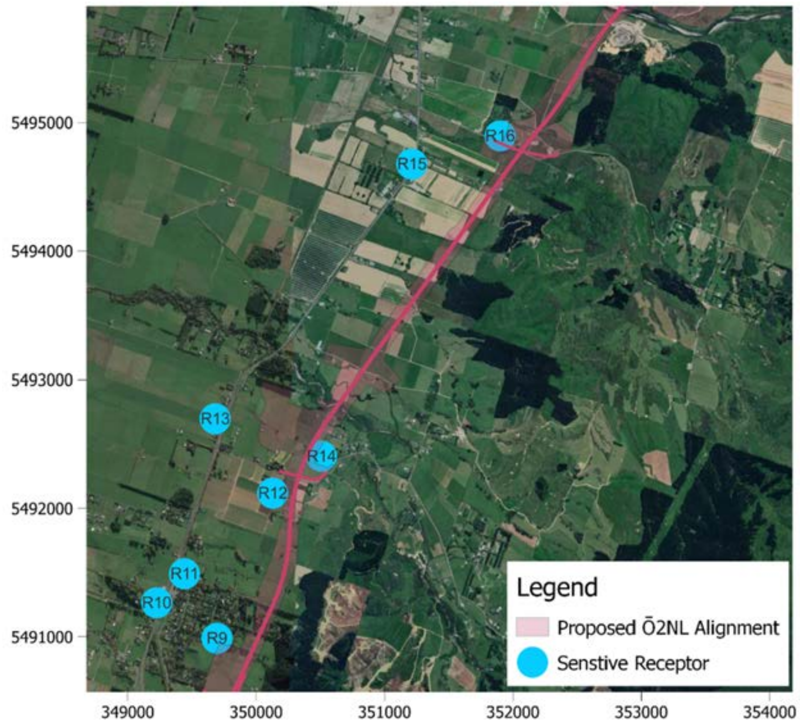


Figure C.2: Sensitive Receptor Locations (R9-R16) (Chainage 29,000 to 22,600)

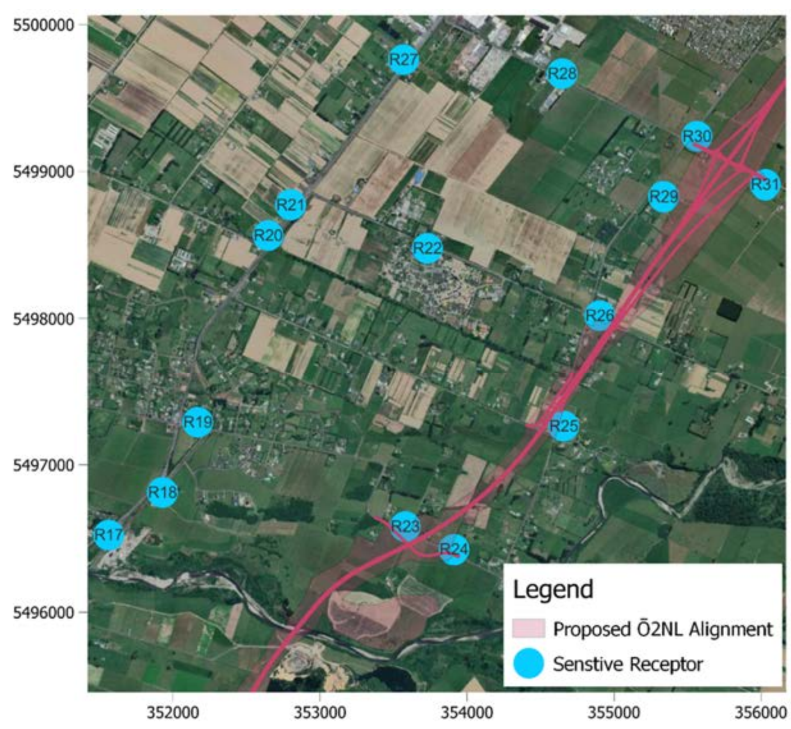


Figure C.3: Sensitive Receptor Locations (R16-R31) (Chainage 22,600 to 18,200)

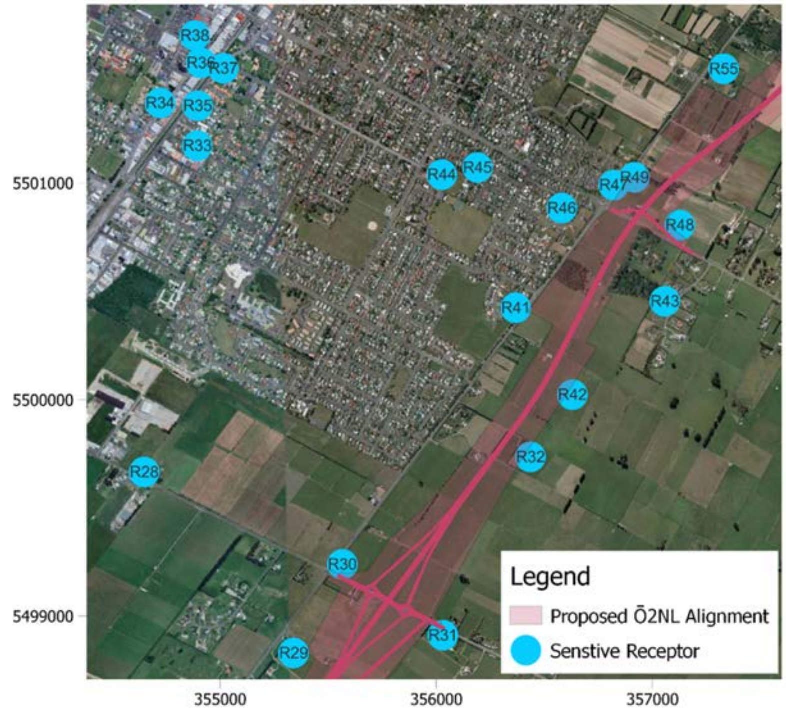


Figure C.4: Sensitive Receptor Locations (R27-R49) (Chainage 18,200 to 15,000)

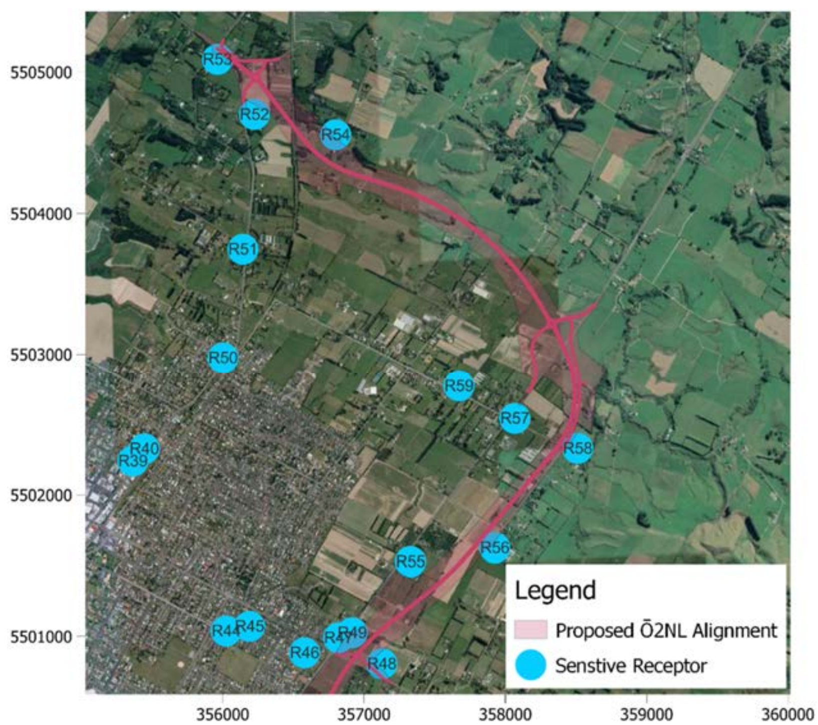


Figure C.5: Sensitive Receptor Locations (R49-R59) (Chainage 15,000 to 10,000)

Stage 2 Assessment – Preliminary Technical Assessment Methodology

48. The Stage 2 assessment has been undertaken using the Waka Kotahi air quality screening model.[13] This model predicts if Project or cumulative (Project emissions combined with background) air quality impacts at the sensitive receptors presented in Figures C.1 and Figure C.2 are likely to result in an exceedance of the relevant air quality criteria. This assessment method has been used for the section of road spanning North Ōtaki to Ohau River (approximate chainage 34,450 to 22,700).

49. Because the screening model only runs up to the year 2030, the base year (2018) and the Project completion year (2029) With and Without the Project have been assessed.[14] Given the general reducing trend in vehicle emissions; the Government's stated objective of increasing the uptake of electric vehicles;[15] and an increase in vehicle numbers, any emissions beyond 2030 have been assumed to be similar to or less than those assessed in 2029.

50. As the screening model uses a high-level approach, the road has been split into three sections to correspond with the change in speed limits, with multiple sensitive receptors chosen for each section. These sections are:

    (a) Section 1: Taylors Road to Manakau (approximate chainage 34,450 to 29,000).

    (b) Section 2: Manakau (approximate chainage 29,000 to 27,100).

    (c) Section 3: Manakau to Ohau (approximate chainage 27,100 to 22,700.)

51. The screening model has been set up in accordance with the guidance from Waka Kotahi[16] with the following information being included:

    (a) average daily vehicle count (rounded to the nearest 500);

    (b) percentage of heavy vehicles, and vehicle speeds;[17,18]

[13] Please note that this model is currently being updated, and the results might need to be updated once the new model is released.
[14] It was not possible to model the Project completion year plus 10 (2039).
[15] Ministry for the Environment, *Towards a productive, sustainable and inclusive economy – Aotearoa New Zealand's First Emissions Reduction Plan*.
[16] As stated in Metcalfe, J., and Kuschel G. (2014). Air quality screening model v2.0 users' notes, prepared for NZ Transport Agency, June 2014.
[17] Technical Assessment A (Transport).
[18] QTP Limited, SATURN, FreeSpeeds_OL2Oa_18_AM_00a_00, FreeSpeeds_OL2Oa_39_AM_00a_00_M1, FreeSpeeds_OL2Oa_39_AM_2DIs_M1, January 2021.

(c) distances to receptors from the roadway (measured on aerial imagery and rounded to the nearest 5 m);

(d) background annual NO_2 concentrations (Table C.20); and

(e) background 24-hour PM_{10} concentrations from the Waka Kotahi recommended background concentrations (Table C.20) (Rural area).

52. The roading dataset consists of a series of nodes for each direction of traffic. The data from the node closest to the receptor has been taken and both directions of traffic added together to get the annual average daily traffic count for that stretch of road. For the percentage of heavy vehicles, the average of each direction was taken (and rounded to the nearest whole number).

53. The vehicle speed entered is based on the provided SATURN dataset, with the following used:

(a) 2018: 80 km/h for the Manakau Town Centre and 94 km/h elsewhere.

(b) 2029 ‘Without Project’ / ‘Do Minimum’: 80 km/hr for all sections.

(c) 2029 ‘With Project’: 65 km/hr for all existing road sections and 94 km/hr for the proposed highway.

54. Data from the screening model is provided in Appendix C.2 and summarised in the operational effects section later in this report, where it is used to indicate whether the cumulative concentrations have a positive ("+ve"), negative ("-ve"), or no change ("NC") effect when compared to the base year, with the percentage of change in brackets.

Stage 3 Assessment – Air Dispersion Model Methodology

55. Following the Stage 2 assessment heading north, for the remaining section of road (Ohau River to North Levin) a more detailed technical assessment has been undertaken (Stage 3 assessment).

56. A traffic emission and pollution dispersion model was set up and used to predict the concentration of the indicator pollutants at specific locations along the current SH1 and at locations near the Ō2NL Project. The results of modelling were then used to assist in the assessment of air quality effects from the operation of the Project.

57. The atmospheric dispersion modelling assessment was conducted using CALPUFF (Version 7), which has been extensively used in New Zealand and Australia and is a recommended model in the MfE GPG ADM,[19] particularly for sites surrounded by complex terrain and/or in complex settings. It is considered that this is the most appropriate model for the Ō2NL Project given the varying terrain along the route. The CALPUFF model was set up, run and data analysed in accordance with the guidance contained in the MfE GPG ADM.

58. To run the dispersion model, a two-year meteorological dataset running from 1 January 2019 to 31 December 2020 was developed in line with current best practice. This time period, particularly 2019, includes El Niño climatic conditions, with the latter half of 2020 trending towards La Niña conditions. Given this, the choice of 2019 and 2020 provides a suitably wide range of meteorological conditions appropriate for the dispersion modelling assessment.

59. Appendix C.3 provide details on the steps taken to create the meteorological dataset, which was incorporated into the CALPUFF model and the model configuration.

60. A copy of the CALMET and CALPUFF input files are provided in Appendices C.4 and C.5, respectively.

Traffic Assumptions

61. The following assumptions on roadway traffic have been made as part of the modelling assessment:

   (a) hourly traffic flows have been calculated based on the vehicle count percentages provided in Table C.2 (below);

   (b) the vehicle fleet profile has been calculated as a ratio of the default Waka Kotahi Vehicle Emission Prediction Model ("**VEPM**") version 6.3;

   (c) fleet compositions are based on the % Heavy Commercial Vehicles ("**HCV**") data provided by Stantec's traffic forecasting model;[20] and

   (d) vehicle speeds have been based on SATURN data.

[19] Ministry for the Environment, *Good Practice Guide for Atmospheric Dispersion Modelling*, June 2004.
[20] Stantec, Technical Assessment A Assessment of Effects on the Transport Network.

62. Where a link has two speed predictions, the link was separated so that the emissions for the change in speeds could be modelled. No account has been made for variability encountered during peak traffic flow period.

63. The SATURN data was provided for 2018 (base year) and 2039 (‘Without Project’ / ‘Do Minimum’ and ‘With Project’). It is assumed that vehicle speeds in 2029 will be the same as in 2039.

TRAFFIC AND EMISSION MODELLING

64. The number, age and type of vehicles have a critical impact on the type and volume of contaminants discharged from the vehicle fleet. This section details the approach taken and data used to model the vehicle fleet’s emissions.

Road Links inputted into the model

65. The existing SH1, SH57 and the Ō2NL Project have been modelled to assess the potential for cumulative effects. For the Stage 3 assessment, the arterial roads that link Levin and SH57 have been included in the model (Kimberley Road, Tararua Road, Queen Steet East, and Roslyn Road). However, given low traffic volumes on other local roads the emissions from these have not been assessed as their contribution to this assessment would be insignificant. Appendix C.6 contains figures showing the road links incorporated into the model for the air dispersion model. For the air quality screening model, the road link adjacent to the receptor was chosen.

66. The road link data was provided by Stantec as a series of nodes. The number of nodes has been rationalised where there was no or minimal change in vehicle numbers recorded between nodes, as the dispersion model is not able to handle the number of nodes provided by Stantec.

Traffic Flow

67. The road traffic flow data[21] was provided by Stantec for 2018 (base year), 2029, 2039, and 2049. For all future years, 25 percentile, 75 percentile and 95 percentile growth rates were provided. For this assessment the 2018, 2029 (95 percentile) and 2039 (95 percentile) data was used on a conservative (worst-case) basis.

[21] Technical Assessment A (Transport).

68. The daily traffic count for each direction and daily percentage of heavy vehicles for each section of road was also provided by Stantec. The 2029 and 2039 data was provided by Stantec for two scenarios; 'Without Project'/ 'Do Minimum' and 'With Project'.

69. A summary of the traffic data used in this assessment is presented in Appendix C.7.

70. An hourly count report was provided for Ohau – Telemetry Site 56 from 1 January 2017 to 31 December 2017 for all vehicles. This count provided a breakdown of the number of vehicles for each hour on a weekday, weekend and on average. The average count has been used and applied across the dispersion model to provide a realistic diurnal pattern of hourly traffic flows. Table C.2 provides the percentage of the annual average daily traffic present on each hour of a weekday.

Table C.2: Hourly Traffic Count

Hour	Percentage of Vehicles (%)	Hour	Percentage of Vehicles (%)
0:00 – 1:00	0.505	12:00 – 13:00	6.965
1:00 – 2:00	0.394	13:00 – 14:00	7.318
2:00 – 3:00	0.429	14:00 – 15:00	7.794
3:00 – 4:00	0.582	15:00 – 16:00	8.252
4:00 – 5:00	0.782	16:00 – 17:00	8.517
5:00 – 6:00	1.740	17:00 – 18:00	7.629
6:00 – 7:00	2.886	18:00 – 19:00	5.131
7:00 – 8:00	4.878	19:00 – 20:00	3.656
8:00 – 9:00	5.889	20:00 – 21:00	2.527
9:00 – 10:00	6.289	21:00 – 22:00	1.763
10:00 – 11:00	6.865	22:00 – 23:00	1.211
11:00 – 12:00	7.171	23:00 – 0:00	0.829

71. Neither weekend nor holiday traffic patterns have been included in this assessment. It is likely that the vehicle numbers will decrease in the weekends and fluctuate over the holiday period, therefore, using weekday traffic numbers provides a more conservative assessment and best represents daily traffic volumes.

Vehicle Speed

72. Modelled vehicle speed data was provided from the SATURN model, the vehicle speeds were split into five bands, with the average speed within each band used:

    (a) 0 – 44 km/hr Modelled: 22 km/hr (light commercial vehicle ("**LCV**") and HCV.

    (b) 45 – 54 km/hr Modelled: 50 km/hr (LCV and HCV).

    (c) 55 – 74 km/hr Modelled: 65 km/hr (LCV and HCV).

    (d) 75 – 85 km/hr Modelled: 80 km/hr (LCV and HCV).

    (e) 85 – 102 km/hr Modelled: 94 km/hr (LCV) 86 km/hr (HCV).

73. The predicted vehicle speeds were provided for 2018, 2039 With Project and 2039 Do Minimum. It has been assumed that the vehicles in 2029 will be travelling at the same speed as those in 2039.

Vehicle Fleet Profile

74. HCV data for the base year of 2018, and the projected HCV data for 2029 and 2039 was provided.[22] Detailed fleet composition was not available for this assessment and is required in VEPM. Therefore, the default fleet profile in VEPM was used to obtain the proportion of vehicles within each category including cars, LCV, HCV, and buses against the overall percentage of HCV provided by Stantec.

Road Gradients

75. The majority of the Ō2NL Project is at-grade with a gradient between -0.5% and 0.5%. The highest gradient recorded along the proposed carriageway is 5.2%, however, this change in gradient is for a short distance (chainage 9,380 to 9,540) and deemed not significant with respect to the potential for increased vehicle emissions. Therefore, no gradient adjustment has been made to vehicle emission estimations.

[22] Technical Assessment A (Transport).

Emission Modelling Methodology

76. The VEPM6.3 model was used in conjunction with the traffic data[23] to determine emission rates for NO_2, PM_{10} and $PM_{2.5}$ for the scenarios modelled.

77. VEPM6.3 was selected in accordance with current industry best practice. VEPM provides emission factors for various pollutants for a range of vehicle fleet categories including passenger cars, LCV and HCV. VEPM uses these emission factors in combination with a fleet profile to obtain a fleet average emission factor. The emission factors consider a number of variables including:

   (a) assessment year;

   (b) vehicle speed;

   (c) impact of cold engine operation;

   (d) impact of catalytic converter removal;

   (e) impact of fuel properties;

   (f) impact of emission degradation due to vehicles accumulated distance; and

   (g) fleet profile.

78. The following VEPM values have been used as inputs into the model (all inputs except for the ambient temperature which has decreased, are VEPM default values):

   (a) average trip Length = 9.1 km;

   (b) ambient temperature = 9°C;

   (c) cold start = Yes;

   (d) degradation = Yes;

   (e) percentage of catalytic converters not working on old cars = 0%;

   (f) percentage of catalytic converters not working on new cars = 0%; and

[23] Technical Assessment A (Transport).

(g) heavy vehicle load = 50%.

79. Short distance journeys create more emissions on a per kilometre basis due to the engine running when cold, therefore leaving the average trip length as the default value is deemed to be conservative. It is likely that vehicles travelling on the Ō2NL roads will be running hot. The VEPM emission factors and vehicle flow numbers are presented in Appendix C.8.

AIR QUALITY ASSESSMENT CRITERIA

80. To determine the adverse effects of the contaminants discharged for the Project's construction and operational scenarios, the predicted pollutant impacts and concentrations are compared against the relevant amenity and health effect assessment criteria.

Statutory Considerations - Construction

81. The following assessment criteria has been identified in the MfE GPG Dust[24] (alongside guidance in the MfE GPG Dust) as being relevant to the construction assessment:

(a) National Environmental Standards for Air Quality ("NES-AQ");

(b) New Zealand Ambient Air Quality Guidelines ("NZAAQG");

(c) objectives and policies in relevant regional plans.

National Environmental Standards and Ambient Air Quality Guidelines

82. The NES-AQ and NZAAQG set out ambient concentration limits for PM_{10}, as this assessment is a qualitative assessment these standards do not apply.

Regional Guidelines

83. Greater Wellington proposed Natural Resources Plan[25] ("**NRP**") sets out the following objectives that relate to the construction dust assessment criteria.

> "*Objective O39*
>
> *Ambient air quality is maintained or improved to the acceptable category or better in Schedule L1 (ambient air).*
>
> *Objective O41*

[24] Ministry for the Environment, *Good Practice Guide for Assessing and Managing Dust*, November 2016.
[25] Greater Wellington Regional Council, Proposed Natural Resources Plan, August 2021.

The adverse effects of odour, smoke and dust on amenity values and people's well-being are minimised".

84. Horizons One Plan[26] sets out guidelines when managing overall dust emissions. This is provided in Table C.3.

Table C.3: Horizons Regional Ambient Air Quality Guidelines for Construction

Pollutant	Regional Standard
Dust	A discharge must not cause any noxious, offensive or objectionable dust beyond the property boundary

MfE GPG Dust

85. The MfE GPG Dust sets out suggested mitigation trigger levels for total suspended particulates ("**TSP**"), PM_{10} and deposited dust and these have been outlined in Table C.4, Table C.5 and Table C.6, respectively.

Table C.4: Suggested mitigation trigger levels for total suspended particulate (TSP)

Trigger	Averaging Period	Sensitivity of receiving environment		
		High	Moderate	Low
Short term	5 min	250 µg/m³[27]	n/a	n/a
Short term	1 hour	200 µg/m³	250 µg/m³	n/a
Daily	24 hours (rolling average)	60 µg/m³	80 µg/m³	100 µg/m³
Wind warning	1 minute	10 m/s (during two consecutive 10-minute periods)		
Rain warning	12 hours	There has been no rain in the previous 12 hours		
Visible dust	Instantaneous	Visible dust crossing the boundary		

[26] Horizons Regional Council, One Plan, *The Consolidated Regional Policy Statement, Regional Plan and Regional Costal Plan for the Manawatu-Wanganui Region,* 19 December 2014.
[27] Micrograms per cubic metre.

Table C.5: Suggested mitigation trigger levels for PM_{10}				
Trigger	Averaging Period	Sensitivity of receiving environment		
		High	Moderate	Low
Short term	1 hour	150 µg/m³	n/a	n/a

Table C.6: Recommended mitigation trigger levels for deposited dust		
Trigger	Averaging Period	Trigger levels (above background concentration)
Monthly	30 days	4 g/m²/30 days

Statutory considerations - operational

86. The following assessment criteria have been identified as being relevant to the operational assessment:

(a) NES-AQ;

(b) NZAAQG;

(c) World Health Organisation ("**WHO**") Air Quality Guidelines 2005 ("**2005 WHO AQG**") $PM_{2.5}$ and PM_{10}, O_3, NO_2, SO_2 and CO;

(d) WHO Air Quality Guidelines 2021 ("**2021 WHO AQG**") (Particulate matter ($PM_{2.5}$ and PM_{10}), ozone (O_3), NO_2, Sulphur Dioxide ("**SO_2**") and CO;

(e) Regional Ambient Air Quality Guidelines (under the NRP and One Plan);

(f) Waka Kotahi Ambient and significance criteria (from the Waka Kotahi Guide); and

(g) MfE Significance Criteria for Incremental Analysis.

National Environmental Standards

87. MfE gazetted the NES-AQ,[28] as regulations under the Resource Management Act 1991 ("**RMA**") on 6 September 2004, which are based on the potential for health effects. These health effects are described in the

[28] Ministry for the Environment, *Resource Management (National Environmental Standards for Air Quality,* Regulations, 2004.

NZAAQG.[29] The NES-AQ applies standards to five air pollutants: PM_{10}, CO, NO_2, SO_2, and O_3. MfE has also proposed a new NES-AQ[30] for $PM_{2.5}$.

88. While these standards and guidelines were not intended to become air quality assessment criteria, they have become the de facto assessment criteria because regional authorities are required to ensure air quality within their jurisdiction is maintained at or below these levels.

89. Table C.7 presents the NES-AQ assessment criteria relevant to this assessment.

Table C.7: National Environmental Standards for Ambient Air Quality

Pollutant	Air Quality Criteria (µg/m^3)	Averaging Period
PM_{10}	50	24-hr
$PM_{2.5}$	25	24-hr
NO_2	200	1-hr

New Zealand Ambient Air Quality Guidelines

90. The NZAAQG were published by MfE in 2002 following a comprehensive review of international and national research and are widely accepted among New Zealand air quality practitioners. The NZAAQG criteria provide the minimum requirements that ambient air quality should meet in order to protect human health and the environment.

91. NZAAQG levels for pollutants and averaging periods not superseded by the NES-AQ are still applicable, and the relevant guidelines for the protection of human health are presented in Table C.8.

Table C.8: New Zealand Ambient Air Quality Guidelines Relevant to Assessment

Pollutant	Threshold Concentration (µg/m^3)	Averaging Period
PM_{10}	20	Annual
NO_2	100	24-hr

[29] Ministry for the Environment, *Ambient Air Quality Guidelines* (2002 update).
[30] Ministry for the Environment, *Proposed amendments to the National Environmental Standards for Air Quality: particulate matter and mercury emissions – consultation document.* February 2020.

92. The NZAAQG also contains critical levels for protecting ecosystems. The guidelines specific for agricultural crops are provided in Table C.9.

Table C.9: NZAAQG Critical levels for protecting ecosystems

Contaminant	Critical Level (µg/m³)	Averaging period
NO_2	30	Annual

World Health Organisation

93. The NES-AQ and NZAAQG are essentially the same as the 2005 WHO Air AQG[31] with respect to air quality assessment criteria. In addition, 2021 WHO AQG[32] has promulgated 24-hr and annual guidelines for $PM_{2.5}$ and an annual guideline for NO_2, both of which are relevant to this assessment. Both sets of guidelines are presented in Table C.10.

94. As Table C.10 indicates the 2021 WHO AQG are more stringent than those previously reported in 2005 WHO AQG. The AQG are presented as interim targets and a final AQG. The contaminants covered by the 2021 WHO AQG are $PM_{2.5}$, PM_{10}, O_3, NO_2, SO_2 and CO. The 24-hour $PM_{2.5}$, PM_{10}, NO_2, SO_2 and CO guidelines are the 99th percentile value (ie 3 – 4 exceedance days per year). At this stage the 2021 WHO AQG have not been adopted in New Zealand and therefore the current NES-AQ and NZAAQG has been used in preference.[33]

Table C.10: WHO Guidelines

Pollutant	2005 WHO AQG	2021 WHO AQG	Averaging Period
	(µg/m³)		
PM_{10}	50	45	24-hr
	20	15	Annual
$PM_{2.5}$	25	15	24-hr
	10	5	Annual
NO_2	-	25	24-hr
	40	10	Annual

[31] World Health Organisation, *Air Quality Guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide,* Global update, 2005.
[32] World Health Organisation, *Particulate Matter ($PM_{2.5}$ and PM_{10}), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide,* 2021.
[33] MfE have indicated that they will be issuing a document about the new guidelines and how these will affect the current criteria.

95. The NRP contains regional ambient air quality targets for a number of pollutants relevant to the Ō2NL Project. The NRP guidelines are presented in Table C.11.

Table C.11: NRP Ambient Air Quality Guidelines

Pollutant	Concentration (µg/m³)				Averaging Period
	Alert[1]	Acceptable[2]	Good[3]	Excellent[4]	
PM_{10}	50	33	17	No target	24-hr
	20	13	7	No target	Annual
$PM_{2.5}$	25	17	8	No target	24-hour
	10	7	3	No target	Annual
CO	30,000	20,000	10,000	3,000	1-hr
	10,000	7,000	3,000	1,000	8-hr
NO_2	200	132	66	20	1-hr
	100	66	33	10	24-hr

Notes:

1. *Alert is a warning level, which can lead to exceedances if not curbed*
2. *Acceptable is where the maximum values might be of concern in some locations but are generally at a level that does not warrant action*
3. *Good is where peak measurements are unlikely to affect air quality*
4. *Excellent are values of little concern.*

<u>Horizons One Plan</u>

96. Chapter 7 of the Horizons One Plan sets out regional ambient air quality guidelines for a number of pollutants relevant to the Ō2NL Project. The One Plan states that the NES-AQ must be adopted as ambient air quality guidelines for the region alongside the regional standard set out in Table C.12.

Table C.12: Horizons Regional Ambient Air Quality Guidelines for the operation of the Project

Pollutant	Regional Standard
Gases and other airborne contaminants	A discharge must not result in noxious or dangerous levels of gasses or other contaminants beyond the property boundary.

Waka Kotahi Ambient Air Quality Criteria

97. Waka Kotahi has determined ambient air quality criteria for key indicator pollutants – PM_{10}, $PM_{2.5}$ and NO_2. The most relevant assessment criteria that apply to these pollutants is shown in Table C.13. The Waka Kotahi recommended assessment method assumes that if the levels for the indicator pollutants are below those shown in Table C.13, then levels of other pollutants are also likely to meet the relevant assessment criteria.

98. A set of significance criteria is also provided in the Waka Kotahi Guide, and these have been provided in Table C.14. These criteria are used to determine the risk of an adverse air quality impact associated with the Project.

Table C.13: Key Ambient Air Quality Criteria for Road-Transport Related Air Pollutants

Pollutant	Threshold Concentration (µg/m³)	Averaging Period
NO_2	200	1-hr
	100	24-hr
	40	Annual
PM_{10}	50	24-hr
	20	Annual
$PM_{2.5}$	25	24-hr
	10	Annual

Table C.14: Waka Kotahi Air Quality Significance Criteria

Air Pollutant	Limit (µg/m³)	Averaging Time	Project Contribution [1]	Cumulative Contribution [2]
NO_2	40	Annual	10%	90%
PM_{10}	50	24-hr	10%	90%

Notes:

1. *The project contribution is the concentration predicted for only the road/link under consideration as a percentage of the relevant guideline*
2. *The cumulative contribution is the concentration predicted for the project plus the estimated background air quality at that location as a percentage of the relevant guideline*

MfE Significance Criteria for Incremental Analysis

99. MfE has recommended a set of criteria to determine whether the predicted concentrations of road traffic pollutants are likely to be 'significant' (MfE GPG LT[34]). MfE state that these are absolute criteria and are not related to the existing air quality and are to be used for incremental analysis only. The significance criteria relevant to this assessment are presented in Table C.15. The significance of changes in air quality, is discussed in the Operational effects section, later in this report.

Table C.15: MfE Ambient Air Quality Significance Criteria

Pollutant	Significant Criteria Concentration ($\mu g/m^3$)	Averaging Period
PM_{10}	2.5	24-hr
	1.0	Annual
$PM_{2.5}$	1.3	24-hr
NO_2	20	1-hr
	5	24-hr

Relevant Planning and Statutory matters

100. In addition to the assessment criteria set out above, there are various other matters that require consideration when undertaking an assessment of this type. Those that are most relevant to this assessment are set out below. These matters are not considered in this assessment but are presented for the sake of completeness. The relevant planning and statutory matters are considered in detail in the Ō2NL AEE.[35]

Greater Wellington Regional Council Air Quality Management Plan

101. The Greater Wellington Regional Council Air Quality Management Plan ("**WRAQMP**")[36] identifies air emissions from mobile transport as a significant source of air pollution within the region, particularly in the Wellington urban area. The WRAQMP Objectives 4.1.1 and 4.1.2 cover emissions associated with the construction of roads. In addition to this, policies 4.2.22 and 4.2.23 address the air quality impacts from these sources of air pollution. The

[34] Ministry for the Environment, *Good Practice Guide for Assessing Discharge to Air from Land Transport,* June 2008 (MfE GPG LT).
[35] Refer to Volume II documents.
[36] Wellington Regional Council, Air Quality Management Plan for the Wellington Region, May 2000.

WRAQMP contains no specific rules relating to discharges from mobile transport sources.

"Objective 4.1.1

High quality air in the Region is maintained and protected, degraded air is enhanced, and there is no significant deterioration in ambient air quality in any part of the Region.

Objective 4.1.2

Discharges to air in the Region are managed in a way, or at a rate which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while ensuring that adverse effects, including any adverse effect on:

- *local ambient air quality;*
- *human health;*
- *amenity values;*
- *resources or values of significance to tangata whenua;*
- *the quality of ecosystems, water and soil; and*
- *the global atmosphere;*

Are avoided, remedied or mitigated.

Policy 4.2.22

To avoid, remedy, or mitigate the adverse effects of discharges to air from mobile transport sources and to promote:

1) *To use of transport fuel which are low or non-polluting;*
2) *The use of fuel-efficient and well maintained vehicles; and*
3) *Driving habitats which minimise the production of harmful emission.*

Policy 4.2.23

To promote improved air quality in the Region through regional and district transport planning practices which:

1) *Encourage the development of an efficient and effective public transport system;*

> 2) *Promote the use of non-motorised forms of transport such as walking and cycling; and*
>
> 3) *Aim to reduce the growth in motor vehicles numbers and motor vehicle congestion in urban areas."*

Wellington Regional Land Transport Plan

102. The Wellington Regional Land Transport Plan[37] contains the following policies that relate to air quality within the region:

> *"Ensure carbon emission reduction is a key objective underpinning regional transport planning and investment policies;*
>
> *Ensure best practice design, construction and maintenance standards are used during the implementation of transport infrastructure projects, to avoid or minimise adverse effects on the environment; and*
>
> *Advocate for and support initiatives that contribute to ongoing improvement of the vehicle fleet to reduce greenhouse gas emissions and improve air quality, including update of electric vehicles, alternative fuel options and improved fuel efficiency."*

Operative Kāpiti Coast District Plan

103. The operative Kāpiti Coast District Plan[38] became operative on 30 June 2021 and identified Ō2NL as one of the four Waka Kotahi projects currently in development. The specific policy relating to air quality is TR-P4.

> "*TR-P4 Effects of Transport on Land Use/Development*
>
> *The potential adverse effects of developments, operation, maintenance and upgrading of the transport network on land use and development will be avoided, remediated or mitigated by:*
>
> 1) *Ensure that new habitable building and future noise sensitive activities within close proximity to roads identified as a transportation noise effect route and the rail corridor as identified on the District Plan Maps are protected from the adverse effects of road traffic and rail noise;*
>
> 2) *Avoiding the significant adverse effects of earthworks associated with the transport network;*

[37] Wellington Regional Land Transport Plan, June 2021.
[38] Kāpiti Coast District Council, Operative Kāpiti Coast District Plan 2021, June 2021.

3) Ensuring that the development will:

h) Avoid unacceptable levels of emissions to air"

Horizons One Plan

104. The Horizons One Plan[39] became operative on 25 November 2014 and has an overall objective of:

> "*Objective 7-1 Ambient Air Quality*
>
> *A standard of ambient air quality is maintained which is not detrimental to amenity values, human health, property or the life-supporting capacity of air and meets the national ambient air quality standards."*

Horizons Regional Land Transport Plan 2021-2031

105. The Horizons Regional Land Transport Plan[40] was published in 2021 and Objective 4 relates to the impact of transport on the environment. The relevant section is as follows:

> *"Objective 4: Environment*
>
> *The impact of transport on the environment, and the transport system's vulnerability to climate change, is minimised.*
>
> *P4.6: Advocate for and support initiatives that contribute to ongoing improvement of the vehicle fleet to reduce greenhouse gas emissions to reduce climate impacts and improve air quality, including the uptake of electric vehicle technology, alternative fuel options and improved fuel efficiency."*

Operative Horowhenua District Council Plan

106. The Horowhenua District Council District Plan[41] became operative on 3 June 2015 and states that Horizons will control discharges to air, land and water under the provision of the One Plan.

107. The District Plan does however contain information on Land Transport (chapter 10) and identified Oxford Street in Levin as a key area for traffic congestion which has led to adverse effects on the community. The plan identified that the Wellington Northern Corridor requires upgrading to reduce

[39] Horizons Regional Council, Manawatu-Wanganui Regional Council One Plan, April 2016.
[40] Horizons Regional Council, Regional Land Transport Plan 2021-2031, 2021.
[41] Horowhenua District Council, Horowhenua District Council District Plan, June 2015.

traffic congestion, improve safety and support economic growth in New Zealand.

> *"Policy 10.2.2*
>
> *Requires all extensions and upgrades to the land transport infrastructure, including roads to avoid, remedy, or mitigate any adverse effects on the natural and physical resources, sensitive areas, and amenity and landscape values of the district.*
>
> *Policy 10.2.4*
>
> *Adopt techniques to discourage high volume and heavy traffic use in the area where it would have adverse environmental effects on the local community."*

EXISTING ENVIRONMENT

108. The following section provides a description of the surrounding land use and topography and provides an overview of the meteorology and air quality environment between Ōtaki and North Levin, the area in which the Ō2NL Project will be constructed.

Land Use and Topography

109. The proposed designations are located to the east of the existing SH1 through land that is zoned Rural Production Zone (KCDC District Plan), Rural or versatile land (HDC District Plan). The designations pass through the township of Levin and the settlements of Manakau and Ohau. The rural land is mainly used for market gardening activities as well as beef and sheep farming.

110. Figures showing the land use of the area along the proposed designations are presented in the Ōtaki to North of Levin, General Arrangement Plan, 310203848-01-100-C1000’s, 20.04.22. The topography is relatively flat with heights increasing from west to east and a number of small rolling hills from south to north with the overall elevation being similar.

Meteorology

111. The Meteorological Service of New Zealand ("**MetService**") and the National Institute of Water and Atmospheric Research ("**NIWA**") both operate electronic weather stations ("**EWS**") in Levin. The data has been reviewed

from the MetService site (April 2016 to April 2021[42]) located at Universal Transverse Mercator ("**UTM**") 352,781.93 m E and 5,501,978.10 m S, Zone 60S and the NIWA site (1 January 2019 to January 2021) located at UTM 353,001.22 m E and 5,501,197.23 m S.

112. The windrose for the MetService site is presented in Figure C.6 for a 5-year period, and the windrose for NIWA is presented in Figure C.7 for a 2-year period.

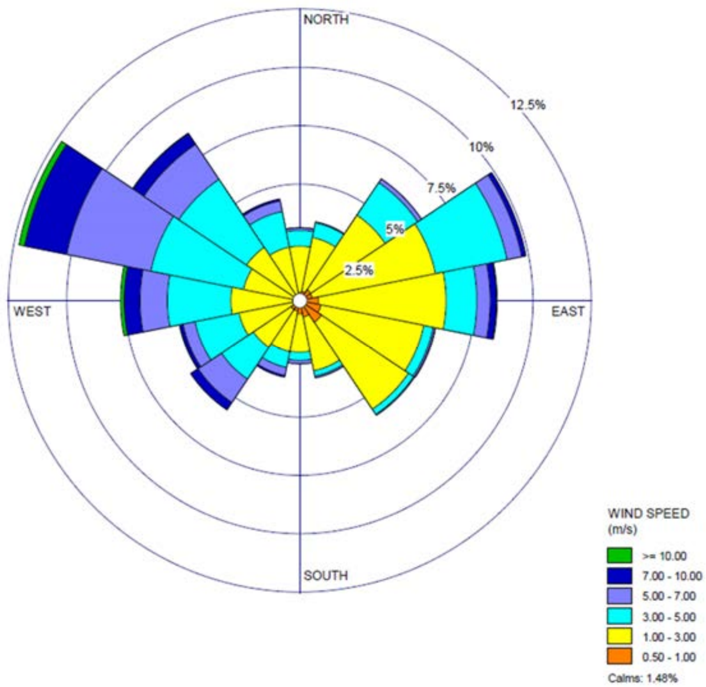


Figure C.6: Levin MetService Windrose April 2016 to April 2021

[42] The site was installed on 3 February 2016 and the first data recorded in April 2016.

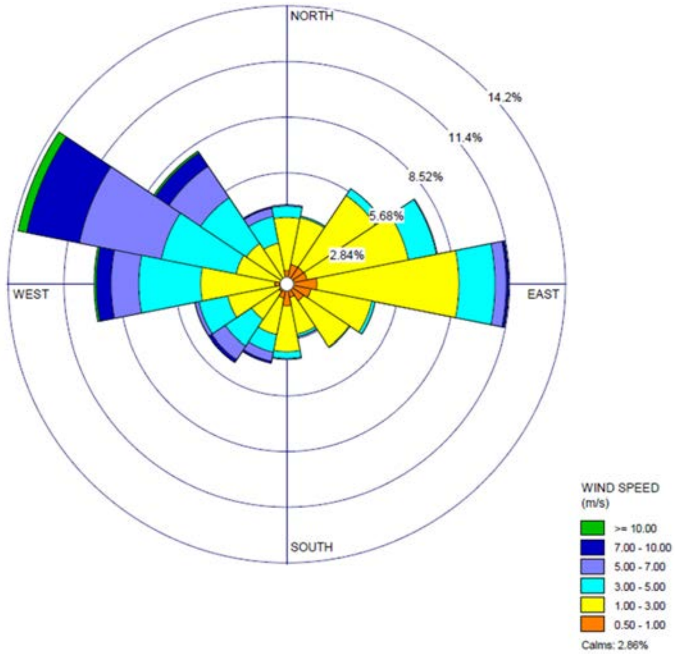


Figure C.7: Levin NIWA windrose January 2019 to December 2020

113. Due to the close proximity of the two sites, the windroses have similar wind directions and wind speeds. The NIWA site did experience slightly more calms, but the low wind speeds are from a similar direction. The average windspeed recorded by MetService was 3.0 metres per second and the average windspeed recorded by NIWA was 2.7 m/s.

114. A meteorological monitoring station for the Ō2NL Project was established in Manakau as there is no meteorological monitoring available for this area. The monitoring station is located near 46 Tame Porati Street, Manakau and is illustrated in Figure C.8. The windrose for 1 August 2021 to 1 August 2022 is presented in Figure C.9.

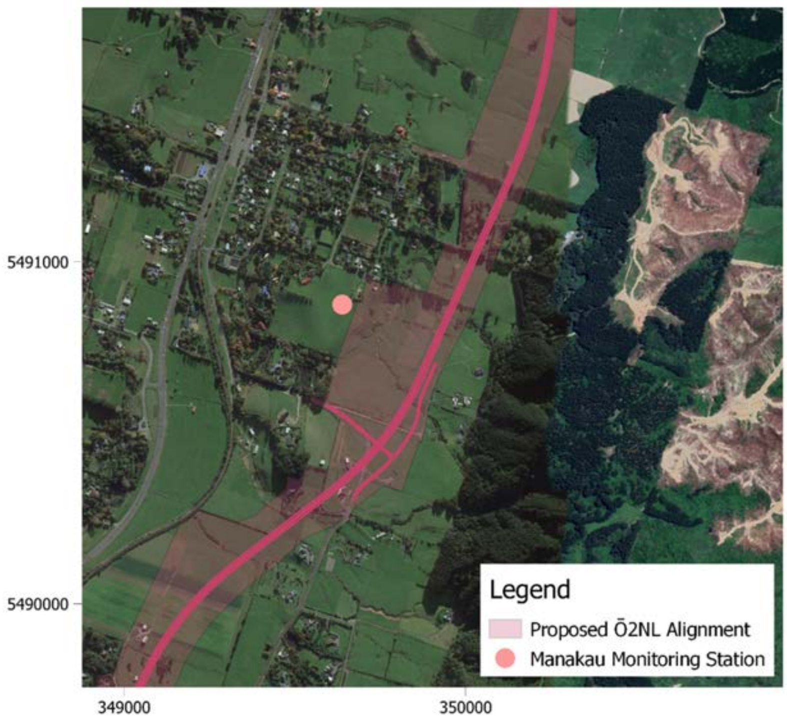


Figure C.8: Manakau Monitoring Location

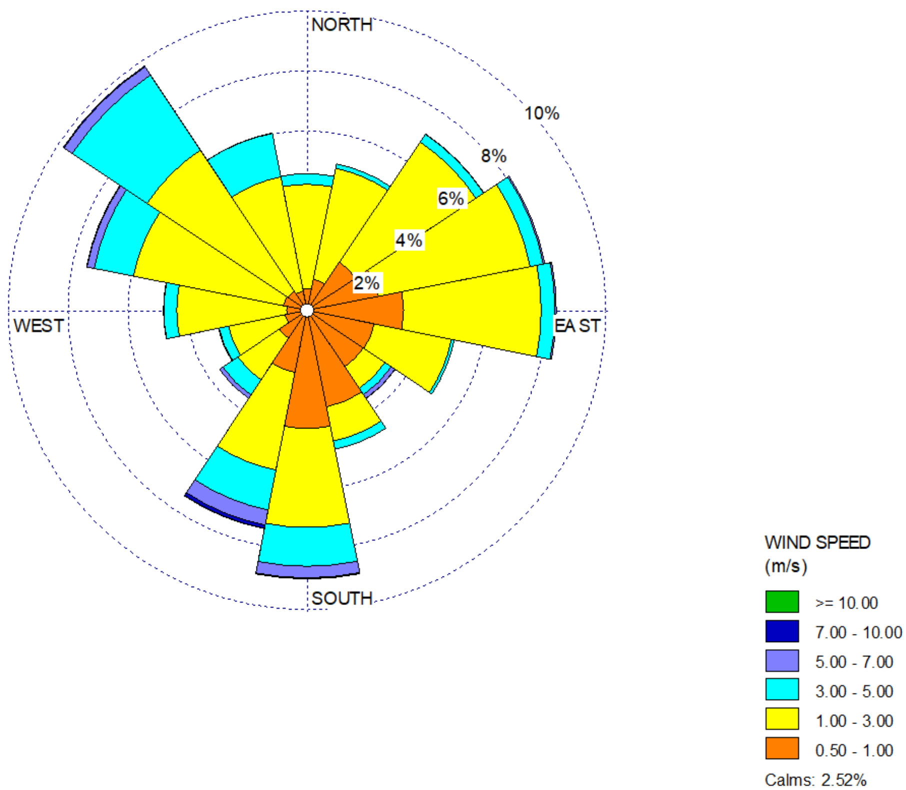


Figure C.9: Manakau Windrose (1 August 2021 to 1 August 2022)

115. The windrose from Manakau shows a higher percentage of winds coming from the east, south, and northwest, and lower percentage of winds from the southeast, this is reflective of the surrounding topography.

116. Overall, the difference between the wind conditions in Levin and Manakau will not result in a large impact on the assessment findings as the air dispersion model focuses on the emissions produced in Levin and takes into account the surrounding topography and land use. Both monitoring stations for Levin were input into the meteorological model that drives the air pollution dispersion model.

NO_2 Monitoring Study

117. Waka Kotahi has set up a passive NO_2 monitoring study at various locations across New Zealand, however there are no monitors in the area of the proposed designation. In order to verify that the concentrations at the nearest Waka Kotahi monitoring location (Ōtaki, corner of SH1 and Mill Road) are appropriate to use in this assessment an air quality monitoring site has been established in Levin for the Project.

118. The location of the monitoring site (co-located with the PM_{10} monitor discussed below) is shown in Figure C.10 at the intersection of Queens Street East and SH57.

119. The NO_2 is measured using two passive diffusion tube samplers. The average results from the samplers are recorded in Table C.16. Data is collected as monthly averages (however the time period for these samples has been greater due to COVID restraints in sample retrieval). The samples from July to October were for 79 days and October to November for 44 days.

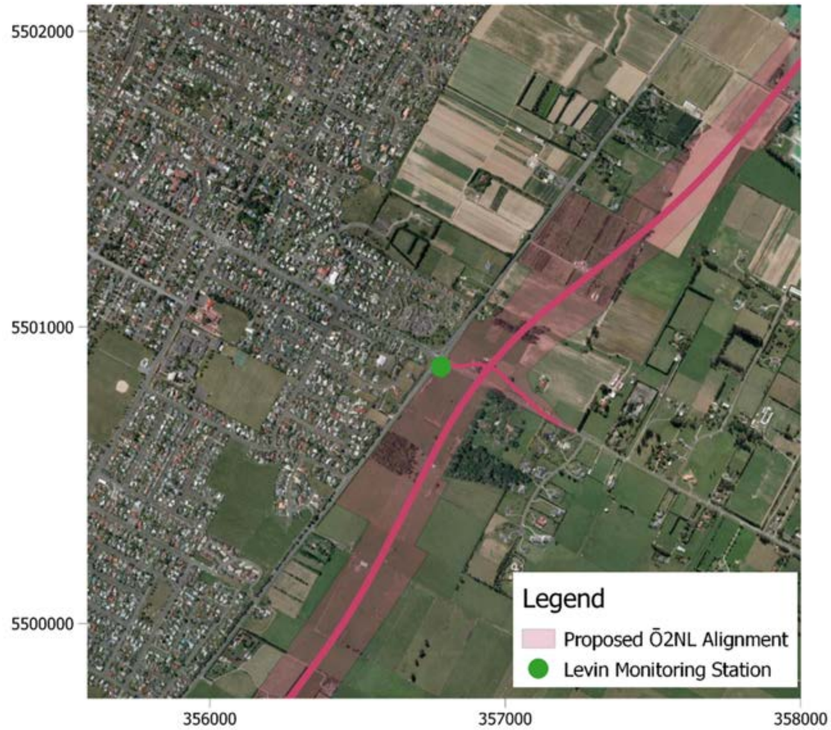


Figure C.10: Levin Monitoring Location

Table C.16: NO_2 Monitoring Results			
Location	July- Oct 2021	Oct – Nov 2021	Average
	µg/m³		
Levin	6.7	9.0	7.8

120. Given the limited site-specific data available, monitoring data has been obtained from the Waka Kotahi[43] monitoring site[44] closest to Levin to provide a comparison to the monitored NO_2 concentrations. Monitoring at this location commenced in March 2010 and data has been obtained up to December 2020.

121. The Waka Kotahi data shows that NO_2 concentrations are lowest during summer months and highest during the winter. This is most likely due to meteorological conditions and the contribution of combustion emissions from fuel burning heaters in the township of Ōtaki in winter. The average concentration for the period January 2010 to December 2020 was 16.1 µg/m³.

[43] Tonkin & Taylor, *Ambient Air Quality (Nitrogen Dioxide) Monitoring Programme Annual Report 2007-2020,* August 2021.
[44] Corner of SH1 and Mill Road, Ōtaki.

122. The relatively high concentrations at the Waka Kotahi site (when compared to monitoring undertaken by PDP) is primarily due to being located on SH1 (PDP monitoring was on SH 57) and close location to the busy intersection where relatively high emissions occur as vehicles have to slow and queue for, and accelerate away from, the roundabout. Figure C.11 presents the monthly NO_2 concentrations measured at this site.

123. Based on the results from both sets of monitoring data, it is not expected that there will be any current chronic adverse effects from NO_2 concentrations, as the concentration near SH1 and SH57 are well below the WHO interim annual average guideline of 40 µg/m^3.

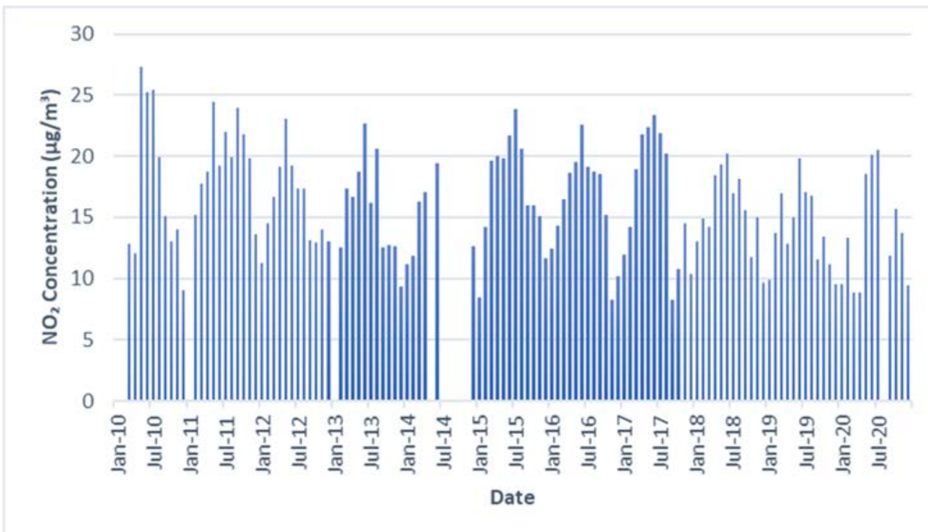


Figure C.11: NO_2 Passive Diffusion Tube Concentrations (Jan 2010 to Dec 2020)

PDP Particulate Monitoring

124. PDP has installed Sersirion SPS30 ("**SPS30**") PM_{10} and $PM_{2.5}$ monitors at both the Manakau and Levin monitoring sites (Figure C.8 and Figure C.10). The period of 1 August 2021 to 31 May 2022 the data has been analysed.

125. A field[45] and laboratory[46] evaluation of the SPS30 monitor was undertaken in 2019. The PM_{10} and $PM_{2.5}$ concentrations were co-located with three reference instruments (MetOne BAM, GRIMM, and Teledyne API T640 ("**T640**")). When comparing the 24-hour concentration the results show strong correlations between the three reference instruments (R^2 between 0.68 and 0.86) for $PM_{2.5}$ concentrations with the $PM_{2.5}$ results being overestimated with GRIMM and MetOne BAM and underestimated when

[45] South Coast AQMD, *Field Evaluation Sersirion SPS30 Evaluation Kit – DRAFT, 2019*.
[46] South Coast AQMD, *Laboratory Evaluation Sersirion SPS30 – DRAFT, 2019*.

compared to the T640. However, PM_{10} concentrations were underpredicted with the SPS30 when compared against all three reference units. It should be noted no sensor calibration was performed prior to the beginning of this test and therefore could affect the results.

126. A colocation study was also undertaken in New Zealand[47] using the SPS30 sensors. This study compared the SPS30 against a Teledyne API T640x. The comparison of the 24-hour PM_{10} and $PM_{2.5}$ concentrations between the SPS30 and T640x monitor showed a good correlation with an R^2 value of 0.97 for $PM_{2.5}$ and 0.96 for PM_{10}. This study indicated that the SPS30 overpredicted 24-hour $PM_{2.5}$ concentrations by 5 percent and underpredicted PM_{10} concentrations by 8 percent.

127. The SPS30 uses a light scattering sensor and the concentrations measured by these sensors are affected by environmental factors and even the type of dust particulate. Given that the colocation study was undertaken in New Zealand conditions, it is expected that the SPS30 monitoring result at Levin and Manakau will provide a similar level of accuracy as seen in the colocation study report.

128. The 24-hour concentrations from the Manakau monitoring station are provided in Figure C.12 and the 24-hour concentrations from Levin are provided in Figure C.13.[48] Both figures show a similar trend in concentration with the highest PM_{10} concentration recorded in both locations occurring on 10 September 2021.

129. The average 24-hour PM_{10} concentration recorded in both Manakau and Levin was 3.3 µg/m^3. However, the average 24-hour $PM_{2.5}$ concentration was higher in Levin being 2.7 µg/m^3 compared to 2.5 µg/m^3 in Manukau. This is most likely due to the proximity of the Levin site to SH57.

[47] GHD Limited, *Laminex Taupo- Air Quality Monitoring Report August 2020-2021,* November 2021.
[48] The Levin Monitoring station stopped working on 6 July and therefore only data up until this data has been analysed.

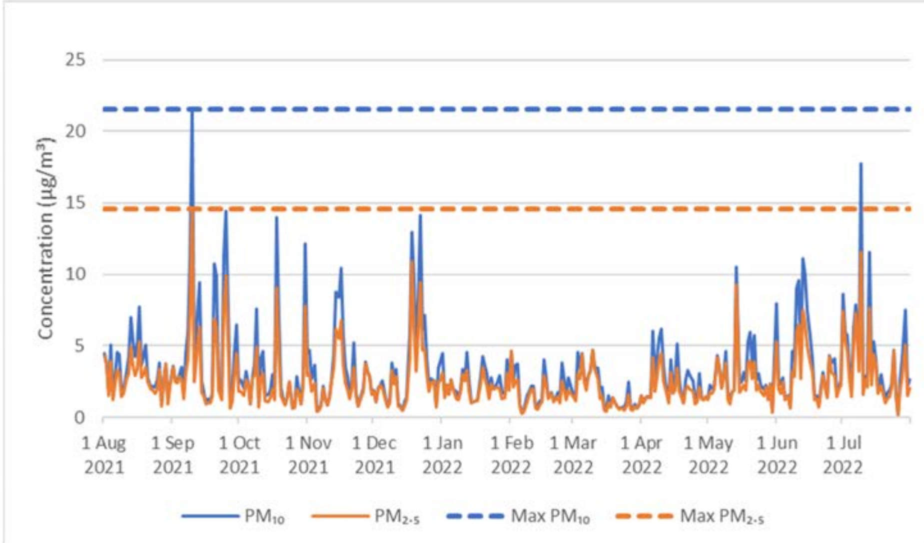


Figure C.12: 24-hour PM_{10} Concentrations in Manakau

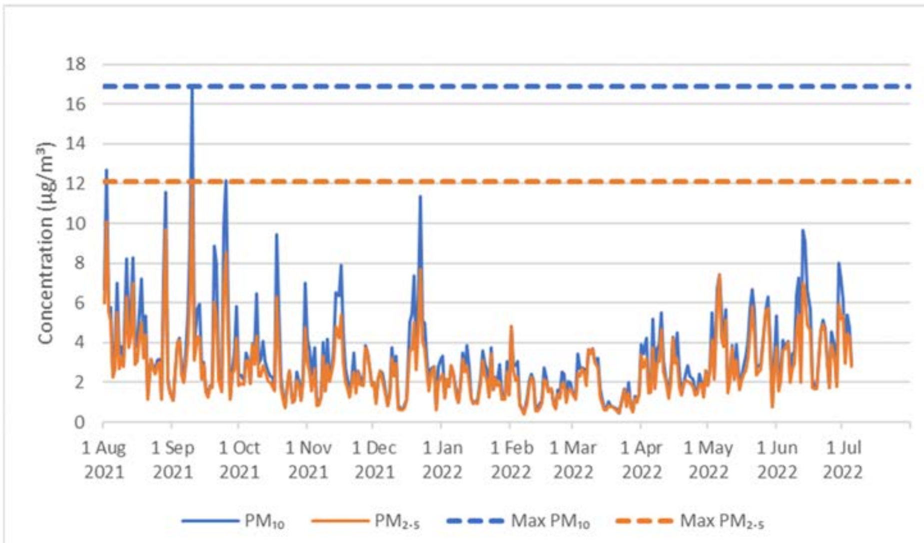


Figure C.13: 24-hour PM_{10} Concentration in Levin

Airsheds

130. In 2005 the regional councils and unitary authorities identified a number of areas throughout New Zealand where ambient concentrations of air pollutants could reach levels higher than the MfE promulgated NES-AQ.[49] These areas have been called airsheds. Airsheds serve as a management tool for regional councils to assist with controlling levels of pollutants within that area. Regional councils have the responsibility to monitor concentrations of air pollutants within these airsheds and must implement

[49] Ministry for the Environment, *Resource Management (National Environmental Standards for Air Quality,* Regulations, 2004.

rules and regulations to ensure that air quality is maintained at levels below the relevant NES-AQ standard.

131. A small section of one of the proposed designations is located within the gazetted Kāpiti Coast Air Quality Management Area SO 355936. This area is not considered a polluted airshed by GWRC and no air quality monitoring has been undertaken by the GWRC.

132. The remainder of the proposed designations sits within the Manawatū-Whanganui region and is not located within an airshed which is defined as polluted.

Background Ambient Air Quality

133. The following section presents the ambient air quality monitoring data available for the assessment area and explains how this was used to estimate background concentrations employed in the assessment process.

134. Background data has then been used in this assessment to assess cumulative concentrations, ie road contribution plus background contributions, from all other activities. These predominantly arise from activities such as domestic home heating and industrial processes. There are also natural background sources of PM_{10} such as sea salt and alluvial dust.

135. The predicted air quality impacts from a road project are combined with the background air quality to determine whether the air quality criteria are likely to be exceeded.

NO_2

136. 1-hour, 24-hour and annual NO_2 background concentrations need to be estimated for this assessment, in order to do this a number of data sources need to be used.

137. The 1-hour and 24-hour background NO_2 concentrations that have been used in this assessment are provided in Table C.17,[50] these values are recommended to be used in the absence of monitoring data.

[50] https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/planning-and-assessment/background-air-quality/.

Table C.17: Background Concentrations		
Area	1-hour NO_2	24-hour NO_2
	($\mu g/m^3$)	
Levin	58.0	38.0

138. An annual concentration for NO_2 has been conservatively estimated to be 9.0 $\mu g/m^3$, this the highest concentration recorded in the PDP monitoring study.

Particulate Matter

139. Waka Kotahi has updated its background concentration dataset to include $PM_{2.5}$.[51]

140. The Ō2NL Project encompasses multiple area units[52] included in the Waka Kotahi set of default background air quality values. The annual PM_{10}, 24-hour $PM_{2.5}$, and annual $PM_{2.5}$ background concentrations are presented in Table C.18, and Figure C.14 shows these areas graphically.

Table C.18: Background Concentrations			
Area	Annual PM_{10}	24-hr $PM_{2.5}$	Annual $PM_{2.5}$
	($\mu g/m^3$)		
Rural	8.2	4.3	2.5
Levin	12.9	20.9	6.6

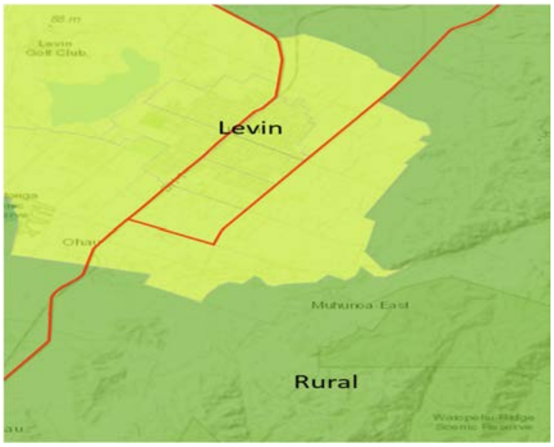


Figure C.14: NZTA Background Concentrations[53]

[51] Tonkin + Taylor, *Particulate Matter Background Air Quality Maps, Summary of Methodology*, June 2020 and Tonkin + Taylor, *Background Annual Average Nitrogen Dioxide Concentrations,* December 2020.
[52] The value from the area unit with the highest concentration has been used as representative of Levin.
[53] Levin is represented by the light green shaded area and the rural area is represented by the green shaded area.

141. No 24-hour PM_{10} background concentrations have been developed by Waka Kotahi, therefore, the annual concentration has been calculated based on the 24-hour $PM_{2.5}$ concentration. Table C.19 provides the 24-hour and annual $PM_{2.5}$ background concentrations derived for the two area units based on Auckland Council guidance.[54] Comparing these values to those recorded by the Ō2NL Projects monitoring station, the values Waka Kotahi provide are greater than the averaged monitored concentrations. For example, the monitored 24-hour PM_{10} concentration was 3.5 µg/m³, which is 11.2% of the Waka Kotahi concentration. Therefore, using the Waka Kotahi values as the background concentration is considered highly conservative.

Table C.19: 24 hour PM_{10} and $PM_{2.5}$ background Concentration

Area	Area Classification	24-hr PM_{10} (µg/m³)	24-hour $PM_{2.5}$ (µg/m³)
Rural	Rural	11.6	4.3
Levin	Urban	31.2	20.9

142. The background concentration used in this assessment, is provided in Table C.20.

Table C.20: Background Concentrations used in this Assessment

Contaminants	Averaging Period	Levin (µg/m³)	Elsewhere (µg/m³)
NO_2	1-hour	58.0	
	24-hour	38.0	
	Annual	9.0	
PM_{10}	24-hour	31.2	11.6
	Annual	12.9	8.2
$PM_{2.5}$	24-hour	20.9	4.3
	Annual	6.6	2.5

[54] Auckland Council, *Use of Background Air Quality Data in Resource Consent Applications,* July 2014.

ASSESSMENT OF EFFECTS

Construction Effects

Dust Generating Activities

143. During the construction phase of the Ō2NL Project, there is potential for nuisance dust from construction activities, and combustion emissions from construction vehicles, to affect properties (and the surrounding environment) that are in close proximity to the construction areas.

144. Construction activities have the potential to result in the generation of dust if not appropriately controlled or mitigated, including:

(a) stripping and stockpiling of topsoil;

(b) excavation of cut material;

(c) placement of fill;

(d) stockpiling of soil / cut material;

(e) traffic movements on the haul roads; and

(f) rehabilitation of completed areas.

145. The current design of the Ō2NL Project relies on a significant quantity of fill, which is greater than is able to be provided by the earthwork cut activities. Therefore, four material supply sites have been selected (15, 19, 34a and 36), with the proposed methodology for extracting material from these sites, as follows:

(a) removal of vegetation;

(b) set up on site – access and laydown area preparation including the establishment of erosion and sediment controls; parking; haul roads; boundary fencing, etcetera;

(c) removal and stockpiling of topsoil;

(d) extraction of materials to agreed contours using the methodology provided below:

(i) motor scrapers will be used to cut and transport material over short haul distances and using excavators and dump trucks over longer haul distances;

(ii) cut material will be transported to fill areas placed and recompacted in layers to the underside of the pavement formation;

(iii) excess and unsuitable material will be transported to spoil sites, placed in layers and track rolled with bulldozers; and

(iv) blasting is not anticipated at any of the sites;

(e) re-contouring of the material supply site to finished levels; and

(f) rehabilitation of material supply site area where materials removed – topsoil; planting.

146. The location of the four material supply sites and any potential implications have been incorporated into the assessment of dust impacts presented in the scale of dust effects section below.

Scale of Dust Effects

147. The potential effects of dust from these activities will depend on a range of factors, including the scale of the activity and the location of any receptors in the vicinity of the works. Generally, receptors more than 200 m from construction activities are unlikely to experience any construction dust related nuisance as the dust settles within this distance. However, with the mitigation measures recommended the potential distance within which nuisance related effects might occur reduces to 50 m.

148. The Waka Kotahi Guide requires projects to undertake an environmental and social responsibility ("**ESR**") screen to determine potential air quality risk. Table C.21 outlines the questions which make up the ESR screen. Using this criteria, the Ō2NL Project has the potential to generate adverse construction air emissions due to the duration of the Project and the location of sensitive receptors. Therefore, a more detailed construction assessment has been undertaken in the following sections.

149. The Waka Kotahi Guide also contains an environment and social responsibility screening test to determine construction air quality risk of the Project. For the Ō2NL Project the construction air quality risk has been

assessed as high due to the surrounding land use, distances between the project and sensitive receptors, and the length of the project.

Table C.21: ESR Screening Questions	
Question	**Answer**
What is the zoning of adjacent land?	Primarily Rural
What is the construction timeframe?	>18 Months
What is the One Network Road Classification?	National
Is the area of interest designated as a non-complaint airshed?	No
Are there medical sites, rest homes, schools, residential properties, maraes or other sensitive receivers located within 200 m of the area of interest?	Yes
Does land use within 200 m of the area of interest include industrial sites, chemical manufacturing or storage, petrol station, vehicles maintenance, timber processing/treatment, substations, rail yards, landfills or involve other activities that may result in ground contamination? OR Are there HAIL or SLUR (contaminated) sites within 200 m of the area of interest?	No

Sensitivity of the Receiving Environment

150. Using the assessment method and criteria detailed in the Waka Kotahi Guide, the potential for air quality risk associated with the construction of the Ō2NL Project is largely dependent on the number of sensitive receptors located within 200 m of the proposed route. The MfE GPG dust recommends two risk-based assessment tools for assessing dust which are dust risk index and the Institute of Air Quality Management ("**IAQM**")[55] assessment of risk. The IAQM method was chosen due to the limited construction information that is available at this stage in the Project.

151. The MfE GPG Dust also recommends explicit consideration of all FIDOL factors for any qualitative dust assessment. These factors are as follows:

    (a) Frequency –how often an individual is exposed to dust. Factors determining this include the frequency of the source releasing dust; prevailing meteorological conditions; and topography.

[55] Institute of Air Quality Management, Guidance on the assessment of dust from demolition and construction, Version 1.1, February 2014.

(b) Intensity – the concentration of dust at the receptor location.

(c) Duration – the amount of time that a receptor is exposed to dust. The duration of dust emissions, like its frequency, is related to the source type and discharge characteristics, meteorology, and location. The longer dust detection persists in an individual location, the greater the level of complaints that may be expected.

(d) Offensiveness – a subjective rating of the unpleasantness of the effects of nuisance dust. Offensiveness is related to the sensitivity of the receptors to the dust emissions. That is industrial premisses may be more tolerant to dust concentrations than residential properties.

(e) Location – the type of land use and the nature of human activities in the vicinity of a dust source. The same process in a different location may produce more or less dust depending on local meteorological conditions. It is also important to note that some locations may be more accepting of higher concentrations of dust than others.

152. Table C.22 defines the sensitivity of the area for people and property to dust soiling effects based on the number of receptors and the separation distance, which has been adapted by PDP to match Waka Kotahi guidance of 200 m. These factors are relevant as the more receptors you have, and the closer they are to the construction footprint, the more likely receptors are to be affected by dust. The receptor sensitivity of the area on people and property is classed as high due to being an area with high amenity containing residential properties.

Table C.22: Sensitivity of the area to dust soiling effects

Area Receptor sensitivity	Number of receptors	Distance from the construction footprint (m)			
		0<20	21<50	51<100	101<200
High	>100	High	High	Medium	Low
	11-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low

153. Using the assessment method and criteria detailed in the IAQM assessment of risk, the sensitivity of ecological receptors to impacts is classified as detailed in Table C.23. Using these criteria, the sensitivity is classified as low on the basis of the information provided in Technical Assessment J

(Terrestrial Ecology). No significant natural areas or internationally significant wetlands have been identified, however a loss of approximately 3 hectares of wetlands has been identified. The following comments from Technical Assessment J (Terrestrial Ecology) are noted:

(a) All of the wetlands and indigenous vegetation within the proposed designation corridor lie within an area classified as Acutely Threatened.

(b) No significant natural areas were identified within the proposed designation, with the closest being Prouse's Bush located 1.6 km northwest.

(c) The level of terrestrial ecology effects from the Ō2NL Project was determined using the guidelines provided in the EcIAG.[56] This combined the ecological values with the magnitude of effect.

If not appropriately managed, construction activities can generate dust that could have temporary adverse effects on adjacent indigenous habitats. Heavy dust loads can lead to a decrease in photosynthesis and therefore a decrease on plant health.

Table C.23: Sensitivity of receptors to ecological impacts

Classification	Definition	Example
High	Significant ecological area with internationally recognised features	Ramsar sites (internationally significant wetlands)
Medium	Locations with particularly important species with unknown or uncertain dust sensitivity.	Significant natural areas (SNAs)
Low	Local ecological areas with features that may be affected by dust deposition	Areas identified in regional planning maps

154. The overall sensitivity of receptors to ecological impacts has been deemed 'Low', based on the assessment in Table C.23. However, Technical Assessment J (Terrestrial Ecology) states *"For most habitats, indirect effects can be addressed by mitigation actions at the point of impact[57] to result in residual effects that are Low to Moderate"* when referring to just the dust

[56] Environment Institute of Australia and New Zealand (EIANZ) Ecological Impact Assessment Guidelines, (Roper-Linday et al. 2018.

[57] PDP considers that this would be the point of discharge when relating to air quality.

impact this is classified as "Low" to "Very Low". Technical Assessment J (Terrestrial Ecology) also provides advice on mitigation measures to minimise the indirect effects from the construction (using dust suppression techniques identified in this report). Due to the sensitivity of the area to ecological dust impact being assessed as low to very low, the assessment of dust on ecological impacts has not been discussed further.

Assessment of Dust Effects

155. The following sub-sections present the assessment of potential dust effects of the area contained within the proposed designations as assessed using the method and criteria detailed in Tables C.22. An overview assessment of the designations has been undertaken alongside a more detailed assessment of the sensitive receptors, which are located within 200 m of the proposed indicative alignment. The proposed designations have been split into 10 zones (Zone A to Zone J, moving from south to north).[58] The 10 zones and the sensitive receptors are shown in Figures C.15 to C.25.

156. PDP’s construction dust assessment is made on the basis that construction will not commence until all properties within the designations have been acquired by the Crown. Consequently, PDP has not considered the potential effects on properties within the designation on the basis that, as the owner, the Crown will provide affected parties approval, and therefore any potential effects on these properties do not need to be considered.

157. Overall, more than 100 sensitive receptors have been identified along the proposed alignment outside the designation and therefore a high sensitivity rating has been given for the high-level assessment. An individual sensitivity rating for each zone has not been provided. It is considered that the mitigation measures, set out later in this assessment, will ensure that the potential nuisance effects are minimised as far as practicable. However, as stated in the FIDOL assessment below, the effects on the properties located within 50 m of the construction activity has the potential to be more than minor.

158. The receptors considered in the construction dust assessment have been split into two groups, based on the assessment criteria in Table C.22 (above);

[58] There are two designations (one for the Wellington region and the other for Horizons. Zone A is located in the Wellington Region and the remaining zones are located in Horizons.

those within 50 m of the construction footprint and those further than 50 m and less than 200 m from the construction footprint.

159. This methodology is highly conservative as it uses the designation boundary as the location of the construction footprint and assumes worst case activities are occurring adjacent to it. The majority of dust emissions will come from construction works along the alignment of the Ō2NL concept design which is generally well within the designation boundary.

<u>Overall Proposed Designations Construction Dust Assessment (All Zones)</u>

160. As stated above, the proposed designations have been given a high sensitivity rating based on the number of sensitive receptors along the route and using the criteria defined in Table C.22.

161. When considering the FIDOL factors, the intensity, duration, offensiveness, and location will likely be relatively consistent between the 10 zones. This is based on the following:

    (a) Intensity – The intensity that nuisance dust is experienced is likely to be at the same level for the sensitive receptors within 50 m of the proposed designations and at a lower intensity for the sensitive receptors within 50 to 200 m from the proposed designation.

    (b) For the properties located within 50 m of the source, the unmitigated dust nuisance effects are likely to be offensive or objectionable. However, with mitigation measures in place the potential for dust nuisance effects should reduce but are still likely to be considered more than minor.

    (c) For the properties located more than 50 m from the source, the dust nuisance effects can be mitigated so that the dust nuisance effects are less than minor and therefore not considered offensive or objectionable.

    (d) Duration – When works occur within the zone, the time over which these are undertaken will be similar in the order of months but less than a year. However, those located near haul roads will likely have an increased duration due to increased vehicle movement.

(e) Offensiveness – As the same materials are being moved throughout the proposed designations, the type of dust and the offensiveness of that dust will be constant between the zones.

(f) Location - The majority of the sensitive receptors are residential properties and therefore have a high sensitivity to nuisance dust.

162. The effects of dust are relatively independent of the activity generating it. Rather, they are more dependent on the scale of the activity. Therefore, this lack of activity specificity is not considered important as the scale of activity has conservatively been assessed as large. What is more important is that sensitive receptors are identified. Where the assessment identifies the need for appropriate mitigation measures, these will be developed and implemented, to avoid as far as practicable nuisance effects. Where that is not possible dust nuisance effects will be minimised such that they are not offensive or objectionable.

163. Dust nuisance can include effects like:

(a) visual soiling of clean surfaces, such as cars, window ledges, and household washing; and

(b) dust deposits on flowers, fruit, or vegetables.

164. Effective mitigation procedures are presented this assessment below. These measures are recommended to mitigate any adverse effects of dust generated during the construction of the Ō2NL Project.

165. For the areas identified as agricultural, the nature of any mitigation that may be required for these areas or crops will depend on the timing of the works with respect to the growing cycle, and nature of the crops.

166. It is considered unlikely, with the proposed mitigation measures being employed, that dust will result in significant or noticeable reductions in crop yields or plant health. It is possible that some crops, or portions thereof may be downgraded (seen as less desirable) if they are seen to be "dirty", where they are grown extremely close (less than 20 m) to construction activities. Additional mitigation measures to deal with these localised effects will be developed in consultation with affected landowners and incorporated in the CAQMP.

167. The following sections provide a more detailed construction assessment for construction activities specific to that zone and its sensitive receptors.

Zone A: Taylors Road and Forest Lakes Road (Chainage 34,900 to 32,300)

168. Figure C.15 identifies the parcels boundaries where a residential property and commercial / agricultural activities have been identified.[59] The distance from the designation relates to the location of the residential property within the parcel as this is where dust impacts are more likely to be observed.

169. The main sources of dust that could result in nuisance effects in this zone, apart from the general construction activities (assessed above), are likely to come from the significant volumes of cut and fill required, particularly around the construction of the new roundabout and construction of three ponds / wetlands.

170. Figure C.9 shows the most common wind direction in Manakau for winds above 3 m/s is from the northwest (approximately 3.5% of the time) with a small percentage of high wind speeds also coming from the south and south southwest. Based on this, the residential properties located on the south-eastern side of the proposed designation are likely to be downwind for longer periods of time. In particular the property located between SH1 and the Ō2NL Project off-ramp will also be downwind for a significant portion of time.

171. The sensitive receptor located between SH1 and the Ō2NL Project off-ramp (Chainage 33,800), and the sensitive receptors located within 50 m of the proposed designation boundary, have the potential to be exposed to nuisance dust if the specific dust mitigation measures recommended for the CAQMP are not implemented. If the dust mitigation measures are effectively implemented the dust risk impact on these sensitive receptors will be low.

[59] Based on existing properties and new building platforms, identified in Technical Assessment B (Noise and Vibration).

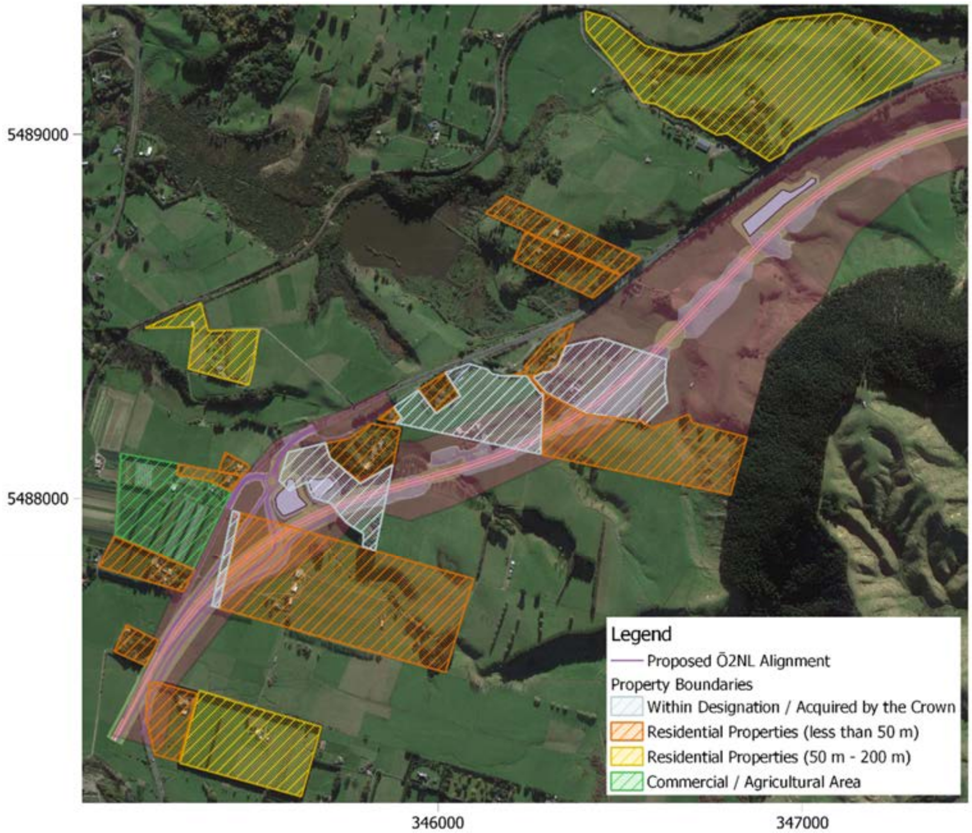


Figure C.15: Sensitive Locations in Zone A (Chainage 34,900 to 32,300)

Zone B: Forest Lakes Road and Manakau Heights Drive (Chainage 32,300 to 29,000)

172. Figure C.16 identifies the parcels boundaries where a residential property and commercial / agricultural activities have been identified.[60] The main sources of dust that could result in nuisance effects in this zone are likely to come from the significant areas of fill and cut required across this zone and the construction of the two ponds/wetlands.

173. This section has over 10 individual sensitive receptors, with the closest being less than 20 m from the proposed designation boundary. A number of residences are located on Mountain View Drive and Manakau Heights Drive and are within 200 m of the proposed designation boundary and overbridge at Manakau Heights Drive.

[60] Based on existing properties and new building platforms, identified in Technical Assessment B (Noise and Vibration).

174. There are also a few residences located along SH1 (near chainage 31,200) to the north of the Ō2NL Project that have the potential to be affected by dust from the construction of the SUP.

175. The sensitive receptors located within 50 m of the proposed designation boundary have the potential to be exposed to nuisance dust if the specific dust mitigation measures recommended for the CAQMP, are not implemented. If the dust mitigation measures are effectively implemented the dust risk impact on these sensitive receptors will be low.

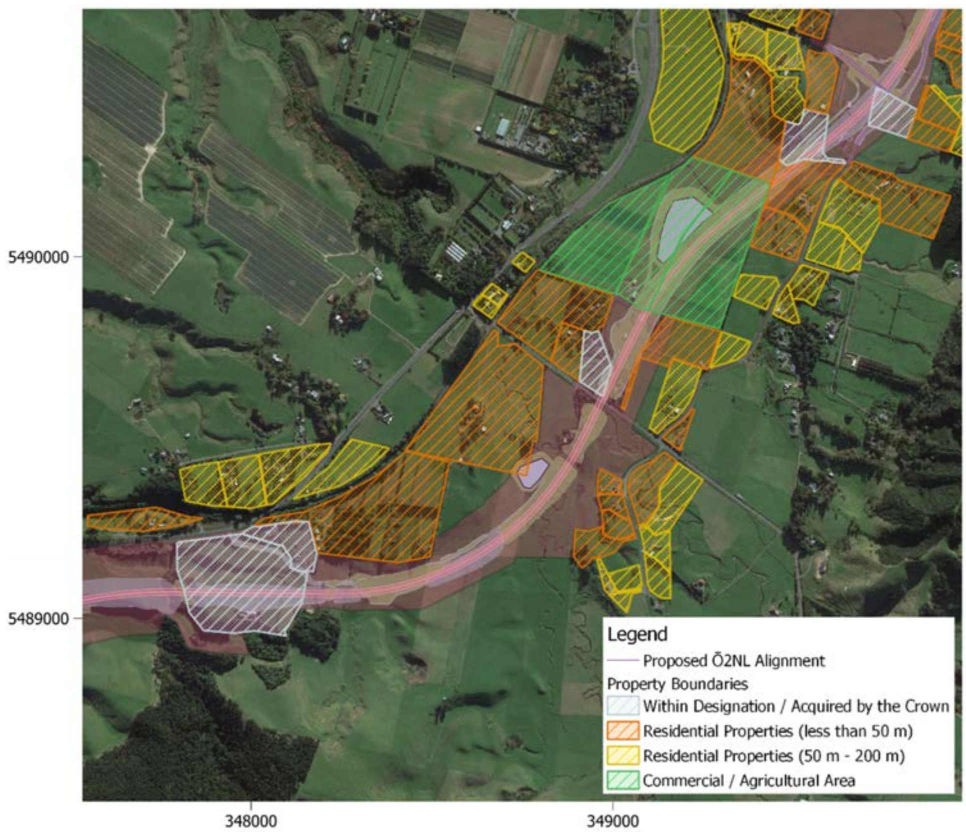


Figure C.16: Sensitive Locations in Zone B (Chainage 32,300 to 29,000)

<u>Zone C: Manakau Heights Drive and North Manakau Road (Chainage 29,000 to 27,100)</u>

176. Figure C.17 identifies the parcels boundaries where a residential property and commercial / agricultural activities have been identified.[61] The main potential for dust nuisance in this zone comes from the fill area along the

[61] Based on existing properties and new building platforms, identified in Technical Assessment B (Noise and Vibration).

route, the creation of a pond / wetland and the general movement of traffic on the haul road.

177. There is an area of crop land close to North Manakau Road, to the east of the Ō2NL Project, which may be sensitive to dust at some times of the year, particularly when within 20 m of construction activities.

178. The majority of residential properties located within 50 m of the designation are located downwind during a northwest wind, and therefore could be exposed to dust for a higher percentage of time, when compared to the other residential properties.

179. The sensitive receptors located within 50 m of the proposed designation boundary have the potential to be exposed to nuisance dust if the specific dust mitigation measures recommended for the CAQMP are not implemented. If the dust mitigation measures are effectively implemented the dust risk impact on these sensitive receptors will be low.

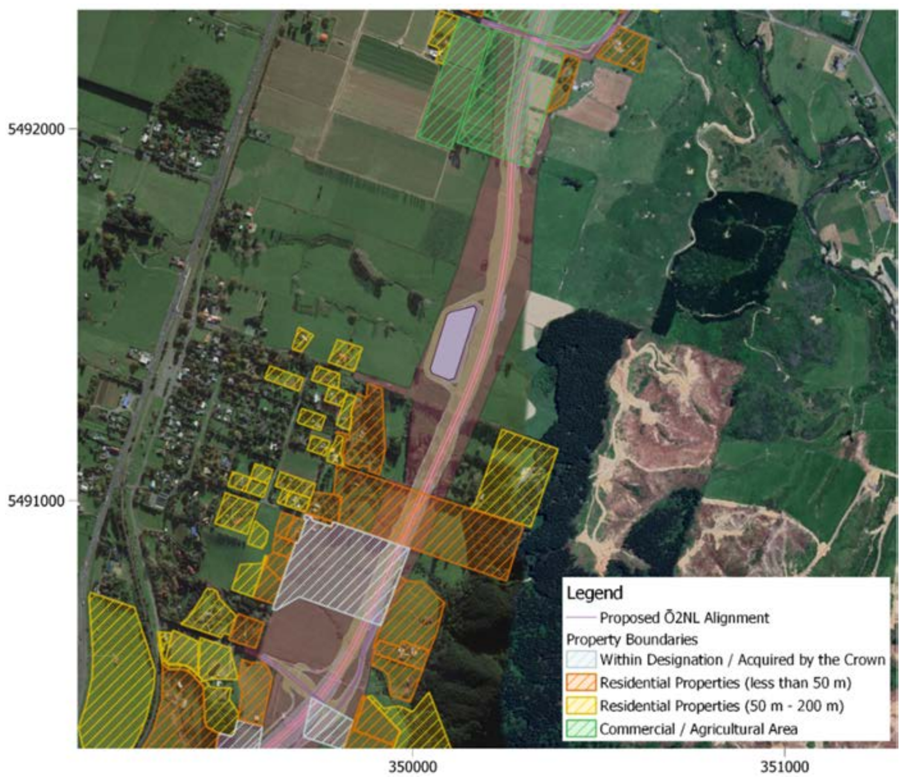


Figure C.17: Sensitive Locations in Zone C (Chainage 29,000 to 27,100)

Zone D: North Manakau Road and Ohau River (Chainage 27,100 to 25,000)

180. Figure C.18 identifies the parcels boundaries where a residential property and commercial / agricultural activities have been identified.[62] The main source of dust that could result in nuisance effects in this zone are likely to come from the cut and fill required, primarily around Kohu East Road and North Manakau Road.

181. The mitigation that may be required for sensitive crop areas in this zone will be the same as that defined in the overall assessment above.

182. The majority of residential properties located within 50 m of the designation are located downwind during a northwest wind, and therefore could be exposed to dust for a higher percentage of time, when compared to the other residential properties.

183. Material Supply Sites 15 and 19 are located within this zone and included in the proposed designation boundary. These sites have the potential to increase the intensity of dust (as the risk of effects from the material is deemed high) and the duration of dust effects. The residential properties around Material Supply Site 15 will likely need additional mitigation measures, especially the property bordering the north of Material Supply Site 15 as this will be downwind during high wind speeds.

184. The sensitive receptors located within 50 m of the proposed designation boundary have the potential to be exposed to nuisance dust if the specific dust mitigation measures recommended for the CAQMP are not implemented. If the dust mitigation measures are effectively implemented the dust risk impact on these sensitive receptors will be low.

[62] Based on existing properties and new building platforms, identified in Technical Assessment B (Noise and Vibration).

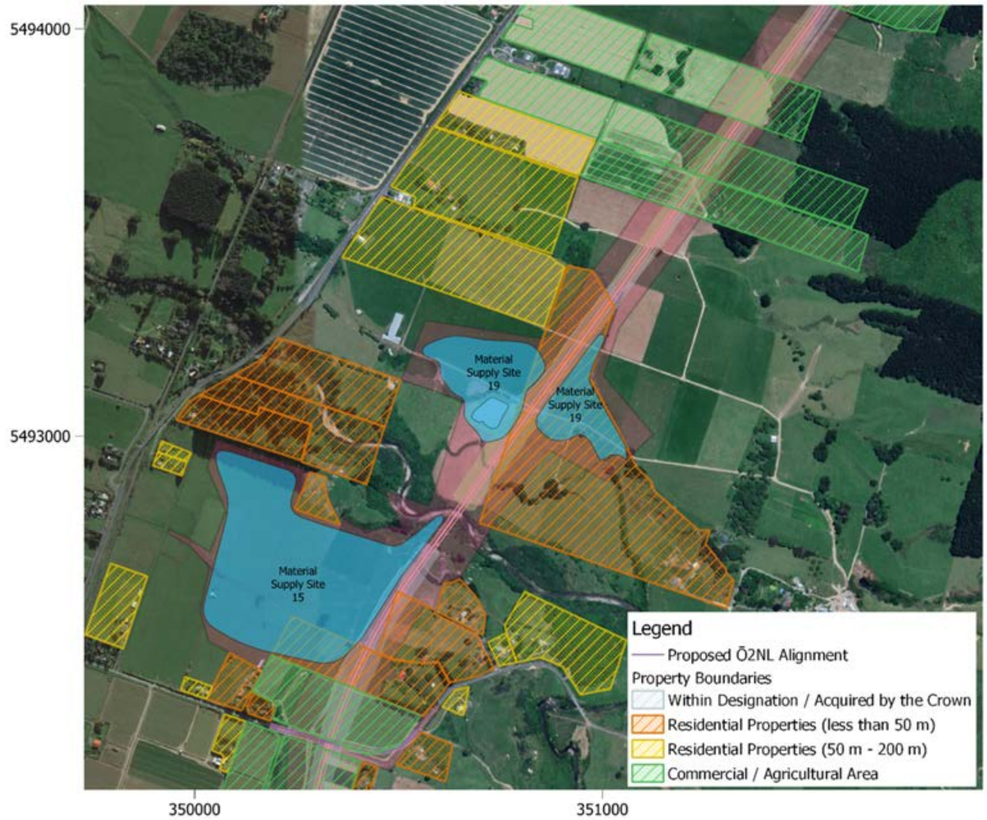


Figure C.18: Sensitive Locations in Zone D (Chainage 27,100 to 25,000)

<u>Zone E: Ohau River and McLeavey Road (Chainage 25,000 to 21,500)</u>

185. Figure C.19 identifies the parcels boundaries where a residential property and commercial / agricultural activities have been identified.[63] The main source of dust that could result in nuisance effects in this zone are likely to come from the amount of fill required, primarily around Muhunoa East Road and the construction of the overbridge along this road.

186. Material Supply Site 36 is located within this zone, but it is unlikely that this will increase the potential for nuisance dust due to the distance between the Material Supply Site and the residential properties.

187. This zone has a small number of sensitive receptors when compared to other zones, however there are a number of sensitive receptors identified as being closer than 50 m from the proposed designation boundary.

188. The sensitive receptors located within 50 m of the proposed designation boundary have the potential to be exposed to nuisance dust if the specific dust mitigation measures recommended for the CAQMP are not

[63] Based on existing properties and new building platforms, identified in Technical Assessment B.

implemented. If the dust mitigation measures are effectively implemented the dust risk impact on these sensitive receptors will be low.

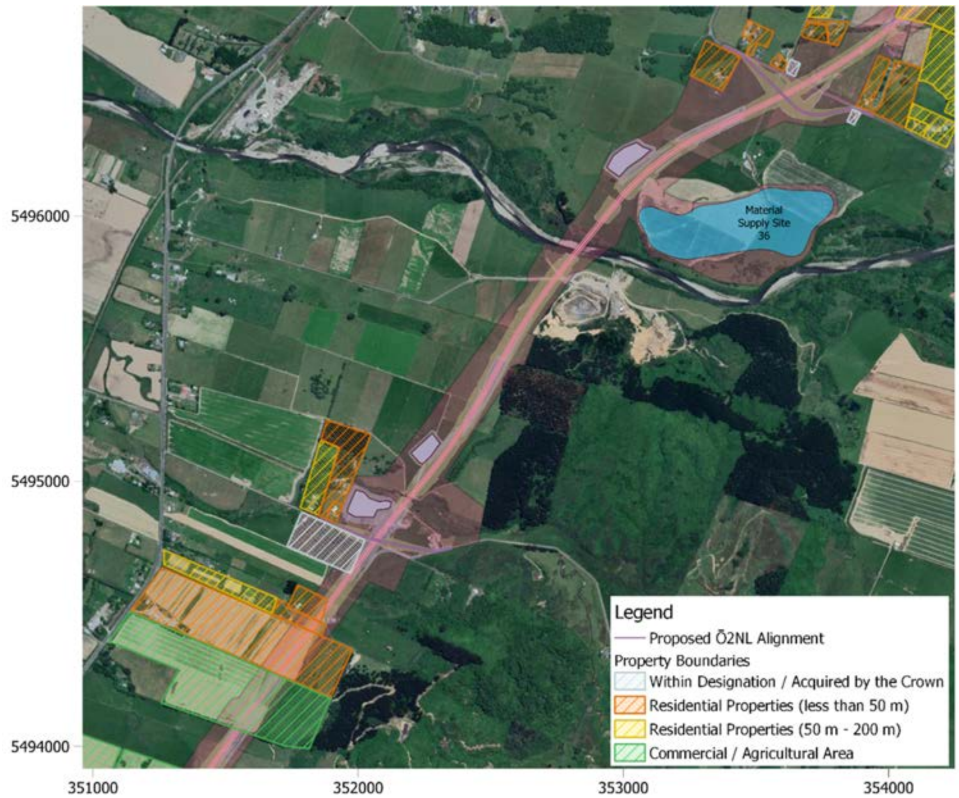


Figure C.19: Sensitive Locations in Zone E (Chainage 25,000 to 21,500)

<u>Zone F: McLeavy Road and Tararua Road (Chainage 21,500 to 18,300)</u>

189. Figure C.20 identifies the parcels boundaries where a residential property and commercial / agricultural activities have been identified.[64] The main source of dust that could result in nuisance effects in this zone are likely to come from the significant areas of cut and fill required and the construction of the Tararua Road dual roundabout intersection.

190. Winds speeds over 3 m/s occur over 25 percent of the time in this zone (refer to Figure C.9). The majority of these high wind speeds come from the western hemisphere. This means that for a significant period of time, the sensitive receptors to the east of the proposed designation could be downwind and have the potential to experience nuisance dust.

[64] Based on existing properties and new building platforms, identified in Technical Assessment B (Noise and Vibration).

191. However, a number of these sensitive receptors are located more than 50 m from the proposed designation and therefore unlikely to experience nuisance dust effects, if the CAQMP is properly implemented.

192. For the properties located within 50 m, if the dust mitigation measures are effectively implemented, the dust risk impact on these sensitive receptors will be low.

Figure C.20: Sensitive Locations in Zone F (Chainage 21,500 to 18,300)

<u>Zone G: Tararua Road and Queens Steet (Chainage 18,300 to 16,150)</u>

193. Figure C.21 identifies the parcels boundaries where a residential property and commercial / agricultural activities have been identified.[65] The main source of dust that could result in nuisance effects in this zone are likely to come from the large extent of cut required and the construction of four stormwater ponds.

194. The Prouse homestead (also known as "Ashleigh") is located within 50 m of the proposed designation. Technical Assessment M (Built Heritage) recommends specific, precautionary measures to address any potential dust

[65] Based on existing properties and new building platforms, identified in Technical Assessment B (Noise and Vibration).

effects during construction at the Prouse homestead. From an air quality perspective, given the heritage values of the site, 6 monthly inspections for external washing of the house and the tool shed during construction in the vicinity of the house will ensure potential dust effects are addressed.

195. The Tara-Ika development is proposed to the southeast of Zone G. That development is not part of the 'existing environment' in terms of the assessment of the Ō2NL Project, and at this stage it is not certain what sensitive receivers might be in place at Tara-Ika by the time the Ō2NL Project is under construction. That said, there may be some areas of the development within 200 m of the construction footprint, and therefore the proposed location of the development has been identified in Figure C.21.

196. For the properties located within 50 m, if the dust mitigation measures specified for the CAQMP are effectively implemented, the dust risk impact on these sensitive receptors will be low.

Figure C.21: Sensitive Locations in Zone G (Chainage 18,300 to 16,150)

Zone H: Queens Street and Waihou Road (west) Chainage 16,150 to 15,000)

197. Figure C.22 identifies the parcels boundaries where a residential property and commercial / agricultural activities have been identified.[66] The main sources of dust that could result in nuisance effects in this zone are likely to come from the cut and fill required, particularly the fill required for the Arapaepae Road overbridge and roundabout.

198. The predominant wind (Figure C.9) is from the western hemisphere and therefore the number of sensitive receptors located to the east of the proposed designation are likely to be affected by dust for a longer period of time (when compared to those to the west of the proposed designation).

199. As a number of these receptors are located within 50 m of the proposed designation, the CAQMP will need to be properly implemented. If dust mitigation measures are effectively implemented the dust risk impact on these sensitive receptors will be low.

Figure C.22: Sensitive Locations in Zone H (Chainage 16,150 to 15,000)

[66] Based on existing properties and new building platforms, identified in Technical Assessment B (Noise and Vibration).

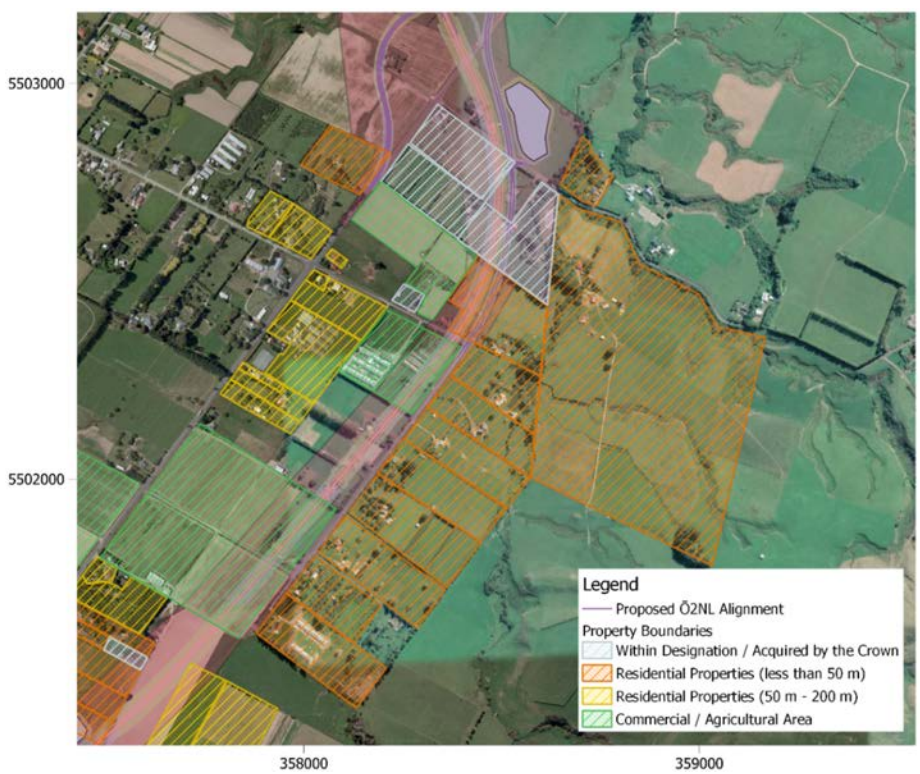
Zone I: Waihou Road (west) and Fairfield Road (north) (Chainage 15,000 to 13,000)

200. Figure C.23 identifies the parcel's boundaries where a residential property and commercial / agricultural activities have been identified.[67] The main source of dust that could result in nuisance effects in this zone are likely to come from the large extent of cut and fill required, especially around the construction of the stormwater pond.

201. As shown in Figure C.23, there are a small number of sensitive residential areas and sensitive crop areas located within close proximity to the proposed designation in this zone.

202. However, a number of these sensitive receptors are located more than 50 m from the proposed designation and therefore unlikely to experience nuisance dust effect, if the CAQMP is properly implemented.

203. For the properties located within 50 m, if the dust mitigation measures are effectively implemented, the dust risk impact on these sensitive receptors will be low.



[67] Based on existing properties and new building platforms, identified in Technical Assessment B.

Figure C.23: Sensitive Locations in Zone I (Chainage 15,000 to 13,000)

Zone J: Fairfield Road (north) and State Highway 1 (Chainage 13,000 to 10,000)

204. Figure C.24 identifies the parcels boundaries where a residential property and commercial / agricultural activities have been identified.[68] The main source of dust that could result in nuisance effects in this zone are likely to come from the large extent of cut and fill required, especially at the SH 57 interchange, Sorensons Road intersection and SH 1 interchange.

205. Material supply site 34a is also located within this zone, however due to the distance between this site and sensitive receptors and the site being located within the designation, it is unlikely that this will result in increased nuisance dust effects.

206. As high winds occur during the predominant southwest wind, it is likely that this zone will have a lower frequency of being downwind of the cut and fill sites during high wind periods than other zones due to the northwest to southeast orientation of the proposed designation.

207. There are a number of sensitive receptors located within 50 m of the proposed designation, particularly near the northern end of the proposed designation where the highway merges back on to the existing State Highway network. For the properties located within 50 m, if the dust mitigation measures are effectively implemented the dust risk impact on these sensitive receptors will be low.

[68] Based on existing properties and new building platforms, identified in Technical Assessment B (Noise and Vibration).

Figure C.24: Sensitive Locations in Zone J (Chainage 13,000 to 10,000)

Combustion Emissions from Construction Vehicles and Machines

208. The construction of the Ō2NL Project will require a number of vehicles and machines to operate along the length of the scheme for the duration that works occur. It is assumed that there will be up to 150 construction vehicles and machines travelling in the area per day. Given that the base year traffic volumes are in the order of 18,000 Annual Average Daily Traffic ("**AATD**") this increase, while resulting in a small increase in the level of combustion emission in areas adjacent to where the works are occurring, is extremely unlikely to give rise to ambient concentrations of pollutants that exceed the NES-AQ.

209. Notwithstanding the small scale of combustion emissions from construction vehicles and machines, the implementation of mitigation measures as described in the 'Measures to avoid, remedy or mitigate actual or potential adverse effects' section of this assessment will assist in minimising the effect of these emissions.

Summary of construction effects

210. Overall, the construction activities of the Ō2NL Project have been assessed as having the potential to cause nuisance dust emissions over a wide area due to the scale of earthworks required and its spatial extent. As some of the construction zones are within close proximity to high sensitivity areas, the potential for dust nuisance effects to be experienced by people and property from the Ō2NL Project is high.

211. It is considered likely that the sensitive receptors located within 50 m of the construction activities may experience dust nuisance effects that are considered more than minor.

212. The dust nuisance effects for the properties located more than 50 m from the construction activities are considered to have less than minor dust nuisance effects.

213. However, through the implementation of appropriate mitigation measures (as discussed in the mitigation section below), dust emissions will be minimised so that they are not considered offensive or objectionable.

214. It is considered unlikely that the construction will result in any other air quality effects eg, vehicle emissions.

215. Overall, with mitigation through a CAQMP, it is considered that the potential for adverse construction air quality effects to be experienced is more than minor for properties located with 50 m of the designation boundary. However, the effects are unlikely to be considered offensive or objectionable.

216. Based on the information in Technical Assessment J (Terrestrial Ecology) there are no locations identified that are highly sensitive to dust. Therefore, based on the criteria in Table C.22 (provided earlier in this assessment), the overall impact from the construction of the Ō2NL Project on ecological areas is "Low" to "Very Low".

Operational effects

217. This section presents the assessment of operational effects from the Ō2NL Project.

218. Different sections of the Ō2NL Project have been assessed using either a Stage 2 (the southern portion of the proposed designations to Ohau) or

Stage 3 assessment (Ohau to North of Levin). The outcomes from these two assessments are presented in the following sections.

Stage 2 Assessment of Environmental Effects from Vehicle Emissions (Air Quality Screening Model)

219. The following paragraphs provide the results from the air quality screening model for the three sections of the Ō2NL Project identified earlier in the Methodology section of this assessment.

220. The detailed input and output obtained from the air quality screening model are contained in Appendix C.2. A summary of the three roadway sections assessed using the Stage 2 assessment method are presented in Tables C.24 to C.26. The changes in predicted pollutant concentrations in 2029 when compared to 2018 for each assessment scenario are presented in the tables as "NC" (no change in concentration), "-ve" (the concentration in 2029 is higher than the concentration recorded in 2018) therefore showing a negative impact at the receptor, or "+ve" (the result in 2029 is lower than the concentration in 2018) therefore showing a positive impact at the receptor.

221. Figures C.25 to C.30 illustrate the changes in PM_{10} and NO_2 concentrations for the three sections with the top half of the circle indicating the ‘Without Project’ / ‘Do Minimum’ scenario (blue for NC, green for +ve, and red for -ve) and the bottom half of the circle the ‘With Project’ scenario.

222. It is noted that the effects associated with the Stage 2 assessment is based on the indicative alignment for the Ō2NL Project. As discussed later in the assessment moving the alignment closer than 50 m to any receptor will potentially result in a significant increase in exposure to the air pollutants and the potential for greater effects.

<u>Section 1: Taylors Road to Manakau (Chainage 34,450 to 29,000)</u>

223. This section of the Ō2NL Project runs from Taylors Road to Manakau as shown in Figures C.25 and C.26, which also show the locations of the sensitive receptors. Table C.24 shows the outputs from the screening assessment for this section.

Table C.24: Waka Kotahi Screening Model Outputs – Section 1			
Receptor	Pollutant	Change compared to base year (2018)	
		Without Project	With Project
R1	PM_{10}	NC	NC
	NO_2	-ve (+4%)	NC
R2	PM_{10}	NC	-ve (+4%)
	NO_2	-ve (+4%)	-ve (+9%)
R3	PM_{10}	NC	+ve (-4%)
	NO_2	-ve (+4%)	+ve (-4%)
R4 (SH1)	PM_{10}	NC	+ve (-4%)
	NO_2	-ve (+4%)	+ve (-4%)
R4 (Ō2NL Project)	PM_{10}	-	-ve (+4%)
	NO_2	-	-ve (+9%)
R5	PM_{10}	-	-ve (+4%)
	NO_2	-	-ve (+9%)
R6	PM_{10}	NC	+ve (-8%)
	NO_2	-ve (+7%)	+ve (-15%)
R7	PM_{10}	-	-ve (+4%)
	NO_2	-	-ve (+9%)
R8	PM_{10}	NC	+ve (-4%)
	NO_2	-ve (+4%)	+ve (-8%)

Note:

1. *Where the receptor is located along the Project no base emissions have been produced and therefore the comparison is against background concentrations.*

224. Figure C.25 (PM_{10}) and Figure C.26 (NO_2) show the changes between the base year and 2029 for Section 1 of the screening assessment.

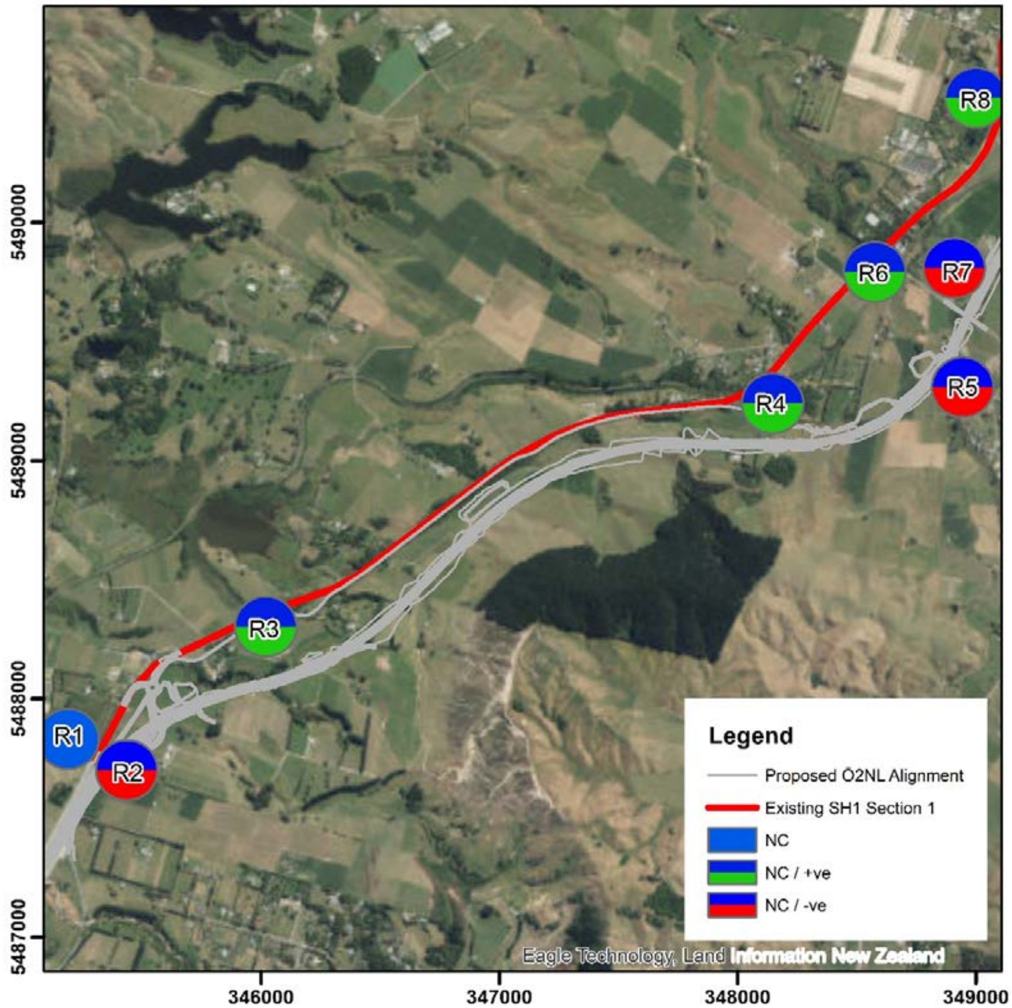


Figure C.25: PM_{10} Air Quality Screening Model Section 1

225. Figure C.25 shows that for the 'Without Project' / 'Do Minimum' scenario there is no change on the identified sensitive receptors and for the 'With Project' scenario either a positive or negative improvement in PM_{10} concentrations compared to the base year. The increase in PM_{10} concentrations for the 'With Project' scenario, however, is minimal at 0.2 µg/m^3 (or 0.4% of guideline value).

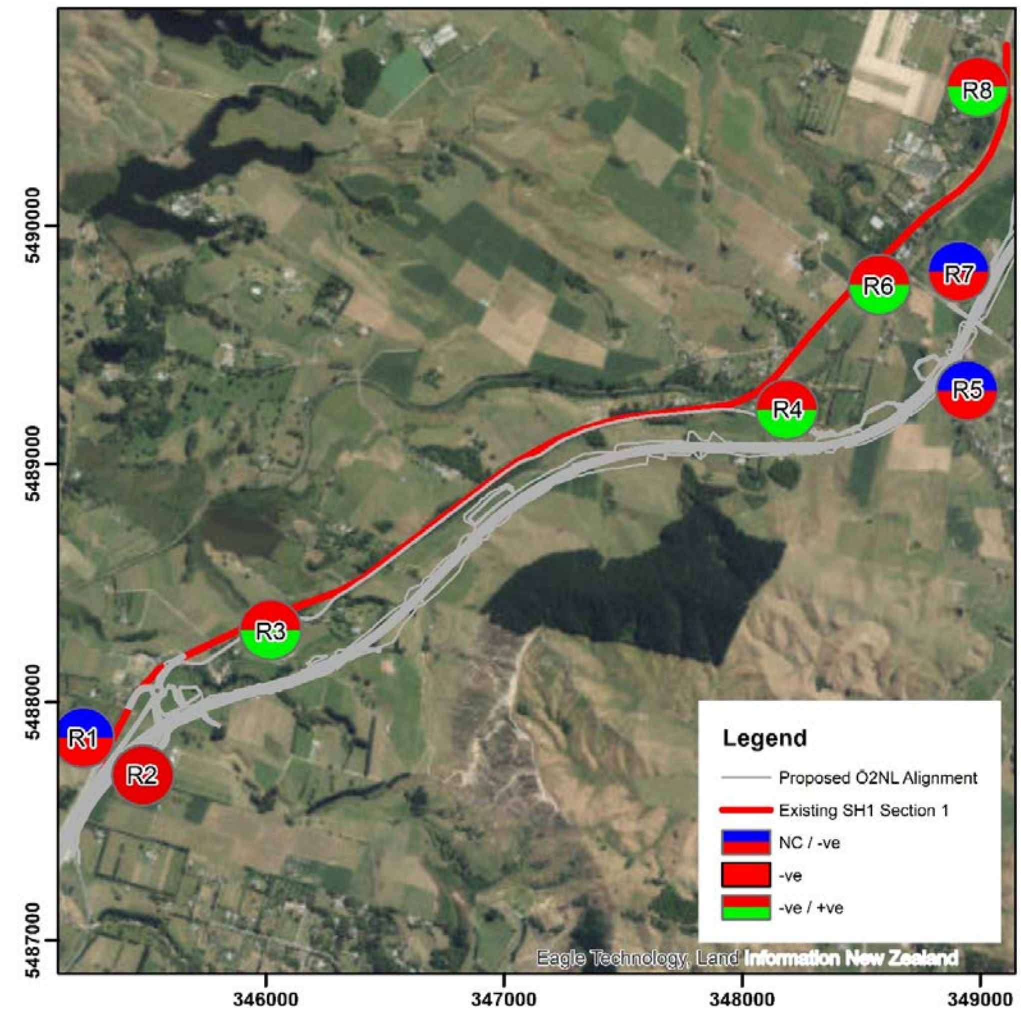


Figure C.26: NO_2 Air Quality Screening Model Section 1

226. Figure C.26 shows that for NO_2, there is an increased concentration experienced for six of the eight receptors for the 2029 'Without Project' / 'Do Minimum' scenario (R1 (115 SH 1), R2 (114 SH 1), R3 (Ōtaki Loco miniature railway and gardens), R4 (114 SH 1), R6 (Manakau cemetery), and R8 (Quarter Acre Café Bistro)), but an increase in concentrations at just three of the eight receptors for 'With Project' scenario R2 (114 SH 1), R5 (18 Mountain View Drive), and R7 (45 South Manakau Road)).

227. It is concluded that the overall adverse effect of the Ō2NL Project on the sensitive receptors located adjacent to this section of the project is less than minor (due to the increase in PM_{10} concentrations being minimal), and the cumulative concentrations remaining well below the relevant health criteria.

Section 2: Manakau Town Centre (approximate Chainage 29,000 to 27,100)

228. This section of the Ō2NL Project is for the Manakau town centre as shown in Figures C.27 and C.28, which also show the locations of the sensitive receptors.

229. Table C.25 shows the outputs from the screening assessment for Section 2 and shows the largest change in cumulative concentrations under the 2029 'Without Project' / 'Do Minimum' scenario are predicted at receptor R10 (Manakau Markets) and R11 (Manakau School).

230. Figure C.27 (PM_{10}) shows that the changes between the base year and 2029 have either no change or a positive overall impact. Whereas Figure C.28 (NO_2) shows no change or a negative impact for the 'Without Project' / 'Do Minimum scenario' and negative and positive impact for the 'With Project scenario'.

231. Overall, the air quality effects with the Project are positive compared to the 'Without Project' / 'Do Minimum' scenario due to the improvement in concentrations along the existing SH1.

Table C.25: NZTA Screening Model – Section 2

Receptor	Pollutant	Change compared to base year (2018)	
		Without Project	With Project
R9	PM_{10}	-	NC
	NO_2	-	-ve (+4%)
R10	PM_{10}	+ve (-4%)	+ve (-8%)
	NO_2	NC	+ve (-12%)
R11	PM_{10}	NC	+ve (-4%)
	NO_2	-ve (+4%)	+ ve (-8%)

Notes:
1. *Where the receptor is located along the Project, no base emissions have been produced and therefore the comparison is against background concentrations.*

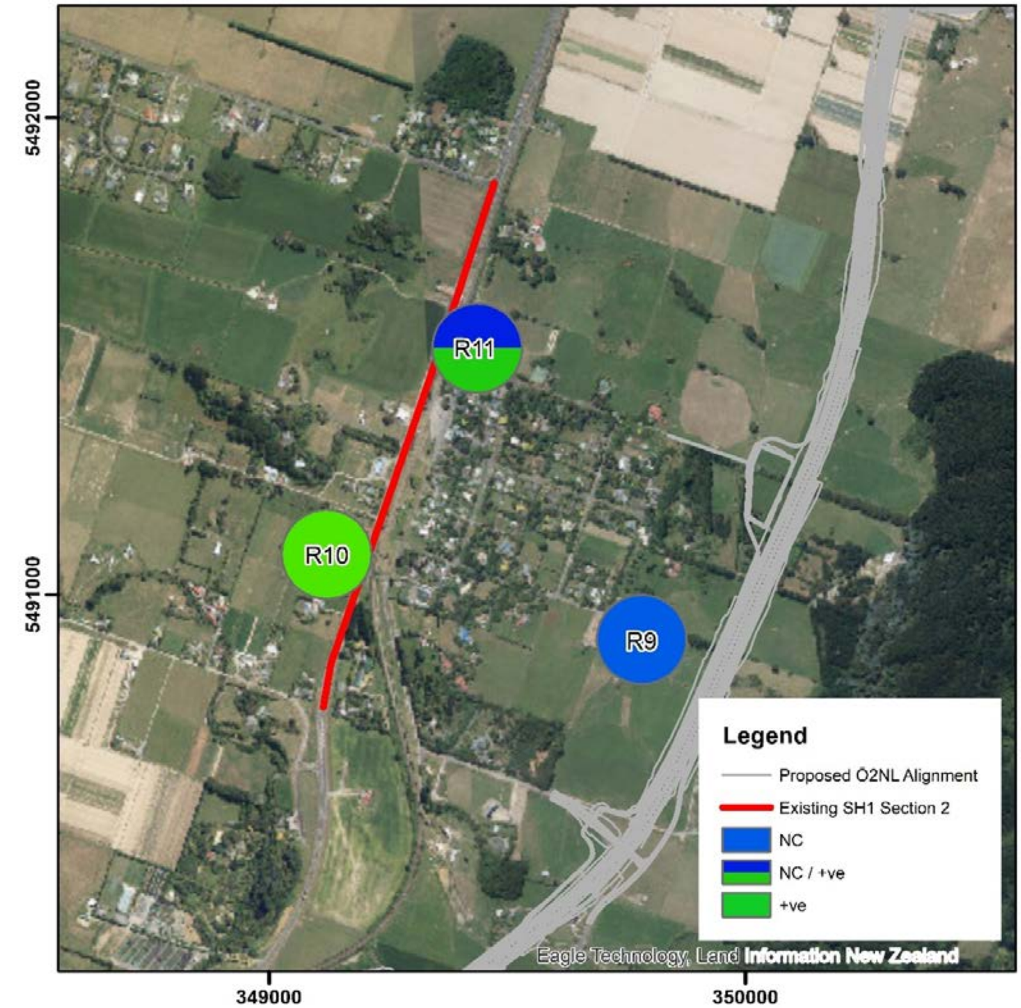


Figure C.27: PM_{10} Air Quality Screening Model Section 2

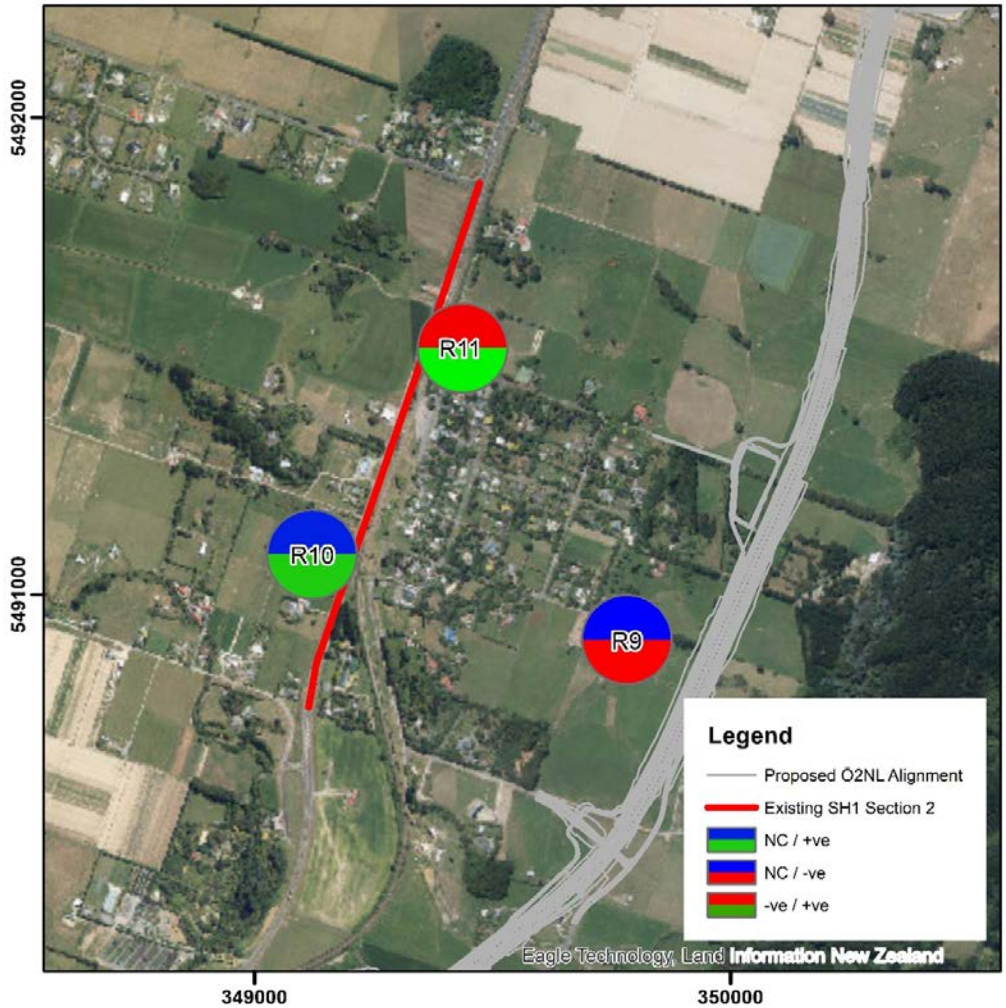


Figure C.28: NO_2 Air Quality Screening Model Section 2

Section 3: Manakau to Ohau (Chainage 29,000 to 27,100)

232. This section of the Ō2NL Project runs from Manakau to Ohau River as shown in Figures C.29 and C.30, which also show the locations of the sensitive receptors. Table C.26 shows the outputs from the screening assessment.

233. Table C.26 shows that the largest change in cumulative concentrations were recorded at receptor R15 (St Stephen's Church) (2029 'Without Project' / 'Do Minimum').

234. Figure C.29 (PM_{10}) and Figure C.30 (NO_2) show the changes between the base year and 2029.

235. Figure C.29 indicates that there is an increase in PM_{10} concentrations at receptor R14 (101 North Manakau Road) for the 'With Project' scenario. Figure C.30 indicates an increase in NO_2 concentrations for the 'With Project'

scenario at R12 (34 North Manakau Road), R14, and R16 (65 Kuku East Road, Manakau) will experience an increase in NO_2 concentrations.

Table C.26: Waka Kotahi Screening Model – Section 3

Receptor	Pollutant	Change compared to base year (2018)	
		Without Project	With Project
R12	PM_{10}	-	NC
	NO_2	-	-ve (+4%)
R13	PM_{10}	NC	+ve (-4%)
	NO_2	-ve (+4%)	+ve (-8%)
R14	PM_{10}	-	-ve (+4%)
	NO_2	-	-ve (+17%)
R15	PM_{10}	+ve (-4%)	+ve (-14%)
	NO_2	-ve (+15%)	+ve (-24%)
R16	PM_{10}	-	NC
	NO_2	-	-ve (+4%)

Notes:

1. *Where the receptor is located along the Project, no base emissions have been produced and therefore the comparison is against background concentrations.*

236. It is concluded that the overall adverse effect of the Ō2NL Project on the sensitive receptors located adjacent to this section of the project is less than minor (due to the increase in NO_2 concentrations being minimal), and the cumulative concentrations remaining well below the relevant health criteria.

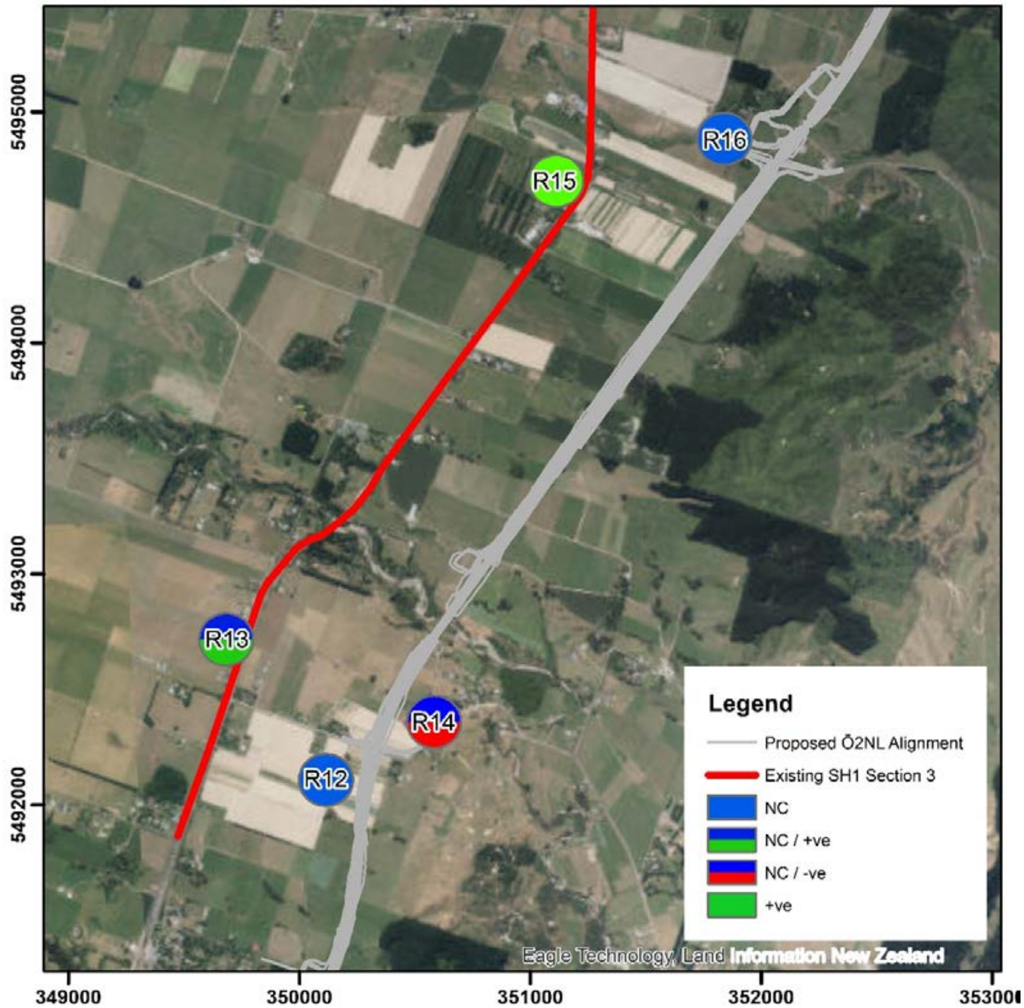


Figure C.29: PM_{10} Air Quality Screening Model Section 3

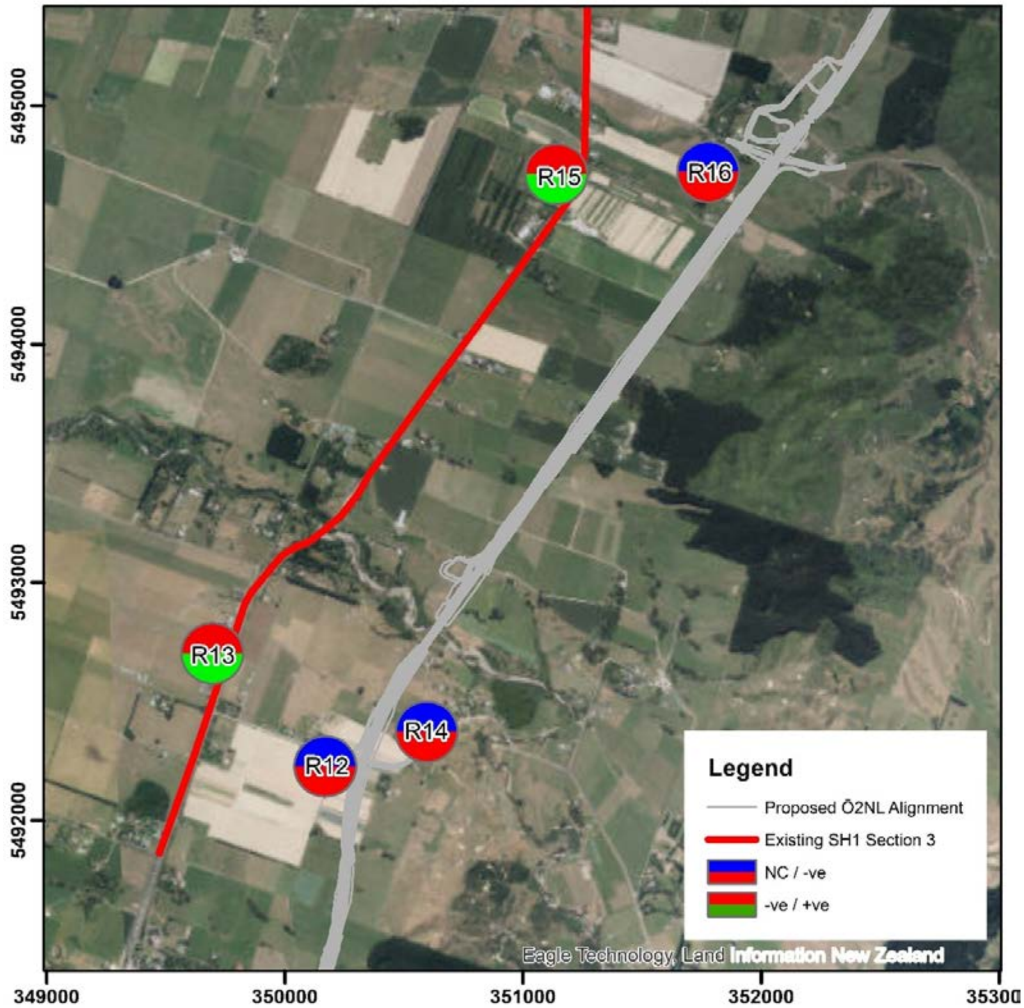


Figure C.30: NO_2 Air Quality Screening Model Section 3

Summary of Stage 2 Assessment

237. The screening model results show that sensitive receptors alongside the existing SH1 will see an improvement, or at worst no change, in air quality with the Ō2NL Project. The receptors located near the proposed alignment will see either no change or a small increase in concentration with the Project.

238. However, all of the predicted concentrations are well below the relevant health assessment criteria and any adverse effects are likely to be less than minor, with or without the Project.

239. The screening model results show that if the Ō2NL Project was not undertaken (2029 'Without Project' / 'Do Minimum'), there is likely to be a negative impact or at best no change in air quality along the existing SH1.

240. Overall, it is considered that the Stage 2 assessment demonstrates that there will be an overall improvement in the air quality with the Project compared to without the Project. Consequently, no Stage 3 assessment is required for these three sections of the Ō2NL Project.

Stage 3 Assessment of Environmental Effects from Vehicles Emissions (Air Quality Dispersion Model)

241. This section of the report presents the results of the road traffic pollution dispersion modelling assessment for the section between Ohau and North Levin (shown in Appendix C.6). The modelling scenarios 2018 (Base year), 2029 'Without Project' / 'Do Minimum' and 'With Project' and 2039 'Without Project' / 'Do Minimum' and 'With Project' were run to determine the concentrations of air pollutants in this section of the Ō2NL Project near the existing SH1.

242. The operational assessment is based on the indicative alignment; however, it is possible that the alignment may shift during detailed design. Figure C.31 shows the relative change in concentration with distance from the indicative alignment. The highest concentrations are experienced within 50 m of either side of the road.

243. If the road was to shift 50 m towards a sensitive receptor located within 100 m of the proposed alignment, it is likely that the concentration of air contaminants observed at that sensitive receptor will be 50% higher than what has been predicted. Any shift of 50 m of the alignment towards a sensitive receptor located greater than 100 m of the proposed alignment would result in an increase of concentrations of well less than 50%.

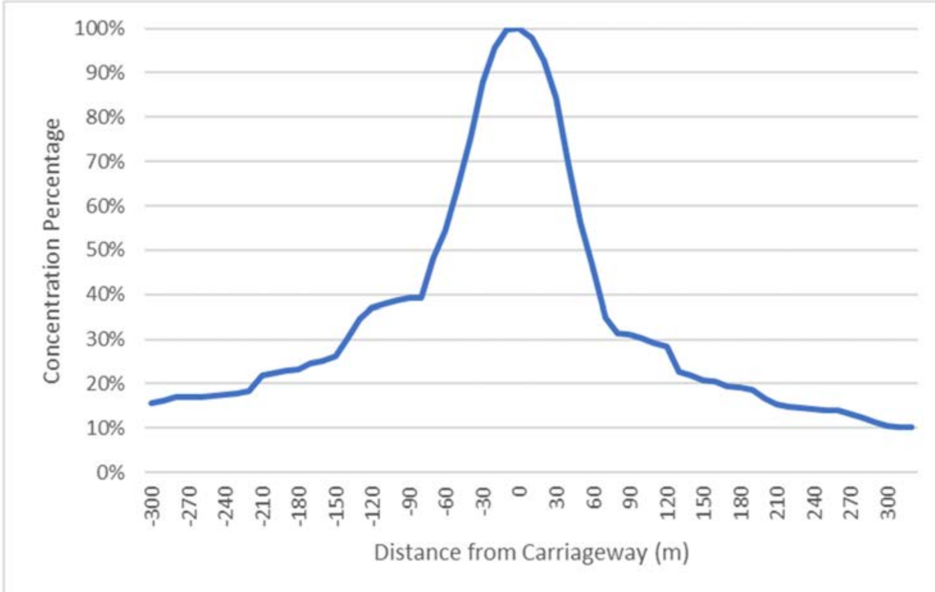


Figure C.31: Percentage of concentration at various distances from the road[69]

244. NO_2, PM_{10} and $PM_{2.5}$ concentrations were predicted for areas along the existing SH1, SH57, the Ō2NL Project and the main arterial routes in Levin for each of the scenarios.

245. Appendix C.9 provides the predicted 1-hr NO_2, 24-hr NO_2, 24-hr PM_{10} and 24-hr $PM_{2.5}$ concentrations at each of the sensitive receptors, and the significance of predicted change based on the MfE significance of change criteria. The following sections provide a summary of the key results from the road traffic pollution dispersion modelling assessment.

99.9%ile 1-Hour Nitrogen Dioxide (NO_2)

246. The highest maximum 99.9%ile 1-hour concentration recorded at any receptor in 2029 'Without Project' / 'Do Minimum' is 73 µg/m^3 at R34 (Levin Adventure Park). When combined with the background concentration of 58 µg/m^3 (refer to Table C.20), the cumulative concentration is 131 µg/m^3, which is below the NESAQ guideline value of 200 µg/m^3 (66%). The highest maximum 99.9%ile 1-hour concentration recorded for 2029 'With Project' was 49 µg/m^3 (107 µg/m^3 including background), which also occurred at R34 (Levin Adventure Park).

247. The maximum 99.9%ile 1-hour concentration decreases in 2039, with the highest concentration (including background) predicted to be 98 µg/m^3

[69] Cross-section of Ō2NL highway from east to west.

(‘Without Project’ / ‘Do Minimum’) and 84 µg/m^3 (‘With Project’). This is predicted at both R34 (Levin Adventure Park) and R36 (UCOL Levin).

248. Figure C.32, Figure C.33, Figure C.34, and Figure C.35 compare the ‘Without Project’ / ‘Do Minimum’ and ‘With Project’ options for the year 2029 for four subsections of the Ō2NL Project that were assessed using road traffic pollution dispersion modelling. The figures present changes in concentrations, as either being positive (reduction in concentrations ie improvements in air quality with the Project), which are indicated as green contour lines, or as negative (greater concentrations ie increases with the Project), which are indicated as the red contour lines.

249. The figures show a reduction in concentrations close to the existing SH1 and an increase in concentrations close to the Ō2NL Project (eg, within 200 m). However, these increases are not significant and will not result in exceedances of relevant air quality assessment criteria.

Figure C.32: Modelled Change in 2029 1-Hour NO_2 Concentrations (µg/m^3) (Chainage 22,600 to 19,000)[70]

[70] Green means a decrease in 1-hour NO_2 concentration and red indicates an increase.

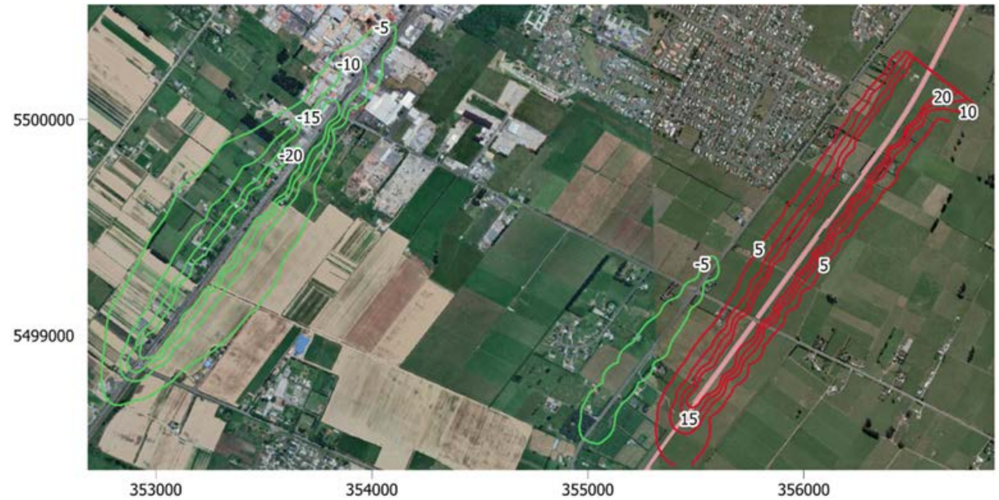


Figure C.33: Modelled change in 2029 1-Hour NO_2 Concentrations (µg/m^3) (Chainage 17,500 to 19,000) [71]

Figure C.34: Modelled change in 2029 1-Hour NO_2 Concentrations (µg/m^3) (Chainage 17,500 to 14,000) [72]

[71] Green means a decrease in 1-hour NO_2 concentration and red indicates an increase.
[72] Green means a decrease in 1-hour NO_2 concentration and red indicates an increase.

Figure C.35: Modelled change in 2029 1-Hour NO_2 Concentrations ($\mu g/m^3$) (Chainage 14,000 to 10,000) [73]

250. Figure C.36 provides a more detailed depiction of the change in 99.9%ile 1-hour NO_2 concentrations at the proposed Queen Street East intersection. Overall, the same trend applies to that seen in the previous figures, where the existing SH will see a decrease in NO_2 concentration and the Ō2NL highway will experience an increase in 1-hour NO_2 concentrations.

[73] Green means a decrease in 1-hour NO_2 concentration and red indicates an increase.

Figure C.36: 99.9%ile 1-hour change in NO_2 concentration at the Proposed Queen Street East Intersection[74]

24-hour Nitrogen Dioxide (NO_2)

251. The maximum 24-hour NO_2 concentration (14 µg/m^3) predicted at a receptor in 2029 'Without Project' / 'Do Minimum' occurred at R36 (UCOL Levin) and when combined with the background concentration (refer to Table C.20) had a cumulative concentration of 52 µg/m^3, which is below the NZAAQG concentration of 100 µg/m^3 (52%). The maximum 24-hour concentration of 10 µg/m^3, recorded for 2029 'With Project' also occurred at R36 (UCOL Levin), and resulted in a cumulative concentration of 48 µg/m^3. Due to the relatively low modelled concentrations compared to the guideline, no figures have been included in this report for the predicted 24-hour NO_2 average modelling results.

252. The maximum 24-hour concentration decreases in 2039, with the highest concentration (including background) predicted to be 46 µg/m^3 ('Without

[74] Green means a decrease in 1-hour NO_2 concentration and red indicates an increase.

Project' / 'Do Minimum') and 43 μg/m^3 ('With Project'). This was observed at R36 (UCOL Levin) and R34 (Levin Adventure Park), respectively.

253. The predicted increases in 24-hour NO_2 concentration are not significant when compared to base year (2018) concentrations and will not result in exceedances of relevant air quality assessment criteria.

Annual NO_2

254. The highest annual predicted NO_2 concentration in 2029 was 7.6 μg/m^3 ('Without Project' / 'Do Minimum') and 5.1 μg/m^3 ('With Project'). When background concentrations are included the annual NO_2 concentration was 16.6 μg/m^3 'Without Project' / 'Do Minimum' and 14.1 μg/m^3 'With Project'.

255. In 2039 the annual NO_2 concentrations decrease to 13.1 μg/m^3 ('Without Project' / 'Do Minimum') and 11.9 μg/m^3 ('With Project').

256. These modelling results suggest an exceedance of relevant air quality assessment criteria is highly unlikely.

24-hour PM_{10}

257. The highest maximum PM_{10} 24-hour concentration predicted at any receptor in 2029 'Without Project' / 'Do Minimum' is 2.8 μg/m^3 at R40 (Bentons Motel & Restaurant). When combined with the background concentration of 31.2 μg/m^3 (refer to Table C.20), the cumulative concentration is 34.0 μg/m^3, which is below the NESAQ guideline value of 50 μg/m^3 (68%). The highest maximum 24-hour concentration recorded for 2029 'With Project' was 1.9 μg/m^3 (33.1 μg/m^3 including background), which occurred at R36 (UCOL Levin) and R40 (Bentons Motel & Restaurant). Due to the relatively low modelled concentrations compared to the guideline, no figures have been included in this report for the predicted 24-hour PM_{10} average modelling results.

258. The maximum PM_{10} 24-hour concentration increases in 2039, compared to 2029 with the highest concentration (including background) predicted to be 34.7 μg/m^3 ('Without Project' / 'Do Minimum') and 33.5 μg/m^3 ('With Project'). This was observed at R40 (Benton's Motel & Restaurant).

259. Based on the modelling results, it is highly unlikely that the operation of the Ō2NL highway will result in exceedances of the relevant air quality assessment criteria.

Annual PM_{10}

260. The highest annual predicted PM_{10} concentration in 2029 was 1.5 µg/m^3 (‘Without Project’ / ‘Do Minimum’) and 1.2 µg/m^3 (‘With Project’). When background concentrations are included the annual PM_{10} concentration was 14.4 µg/m^3 ‘Without Project’ / ‘Do Minimum’ and 14.1 µg/m^3 ‘Without Project’.

261. The annual PM_{10} concentrations increases in 2039 when compared to 2029 to 14.7 µg/m^3 (‘Without Project’ / ‘Do Minimum’) and 14.3 µg/m^3 (‘With Project’).

262. These modelling results suggest an exceedance of relevant air quality assessment criteria is highly unlikely.

24-hour $PM_{2.5}$

263. The highest maximum $PM_{2.5}$ 24-hour concentration recorded at any receptor in 2029 ‘Without Project’ / ‘Do Minimum’ is 2.2 µg/m^3 at R36 (UCOL Levin). When combined with the background concentration of 20.9 µg/m^3 (refer to Table C.20), the cumulative concentration is 23.1 µg/m^3, which is below the proposed MfE guideline value of 25 µg/m^3 (92%). The highest maximum 24-hour concentration recorded for 2029 ‘With Project’ was 1.4 µg/m^3 (22.3 µg/m^3 including background) which also occurred at R36.

264. The maximum $PM_{2.5}$ 24-hour concentration decreases in 2039, with the highest concentration (including background) predicted to be 21.8 µg/m^3 (‘Without Project’ / ‘Do Minimum’) and 21.5 µg/m^3 (‘With Project’). This was observed for the ‘Without Project’ / ‘Do Minimum’ scenario at R17 (8 Parakawau Road), R34 (Levin Adventure Park), and R36 (UCOL Levin) and for the ‘With Project’ scenario at R26 (217 Kimberley Road), and R36 (UCOL Levin).

265. These modelling results suggest an exceedance of relevant air quality assessment criteria is highly unlikely. No comparison figure has been provided due to the low modelled concentrations.

Annual $PM_{2.5}$

266. The highest annual predicted $PM_{2.5}$ concentration in 2029 was 1.0 µg/m^3 (‘Without Project’ / ‘Do Minimum’) and 0.7 µg/m^3 (‘With Project’). When background concentrations are included the annual $PM_{2.5}$ concentration was 7.6 µg/m^3 ‘Without Project’ / ‘Do Minimum’ and 7.3 µg/m^3 ‘Without Project’.

267. The annual $PM_{2.5}$ concentrations decreases in 2039 to 7.0 µg/m^3 ('Without Project' / 'Do Minimum') and 6.9 µg/m^3 ('With Project').

268. These modelling results suggest an exceedance of relevant air quality assessment criteria is highly unlikely.

Summary of Stage 3 Assessment

269. The Stage 3 Assessment results indicate no material change between the 2018, 2029 and 2039 scenarios when using the MfE ambient air quality significance criteria. For NO_2 and $PM_{2.5}$ emissions the highest concentrations for the future scenarios are expected for the year 2029, with a slight reduction in concentrations over the following ten years to 2039. It is predicted that the 24-hour and annual PM_{10} concentrations will increase in 2039, however this increase is not significant when compared to the MfE ambient air quality significance criteria.

270. All scenarios show a decrease in maximum concentration for the 'With Project' scenario when compared to the 'Without Project' / 'Do Minimum' scenario for the corresponding year.

271. This reduction in concentrations is due to a decrease in vehicle emissions expected as vehicle emission control technologies improve, and a move to electric powered vehicles. The decrease in emissions is slightly offset by the small increase in vehicle traffic expected over this period, however overall, the reduction is not significant when compared to the MfE ambient air quality significance criteria.

272. The increase in concentrations along the Ō2NL highway are a result of increased traffic, however as with the decrease in concentrations this increase is not significant when compared to the MfE ambient air quality significance criteria.

273. Overall, it is concluded that the Ō2NL Project will have a positive effect on air quality by reducing vehicle movements through Levin and consequently reducing vehicle related air pollution. It is unlikely to result in any significant change in vehicle related pollutant emissions and resulting concentrations adjacent to the Ō2NL Project and will not result in any exceedances of relevant air quality assessment criteria.

MEASURES TO REMEDY OR MITIGATE ACTUAL OR POTENTIAL ADVERSE AIR QUALITY EFFECTS

Construction Activities

274. This section of the report presents the recommended mitigation measures that when implemented will be used to control the potential effects of discharges to air during the construction of the Ō2NL Project.

275. The mitigation measures that are contained in the following sections are consistent with the MfE GPG Dust and Waka Kotahi Guide. Ultimately, the mitigation measures detailed below will form the basis of the CAQMP. A draft CAQMP will be developed in accordance with recommended conditions (and incorporate the general measures below).

General Measures

276. The general measures that are recommended to assist in the mitigation of dust effects are:

    (a) where practical, defining an area around construction activities where there is the potential to create dust effects and putting in place appropriate mitigation, such as operating water trucks along haul roads, to minimise dust effects within that area;

    (b) developing location specific speed limits (eg 15 km/hr) on haul roads in order to minimise dust emissions when within 100 m from sensitive locations;

    (c) having a community liaison person available to promptly address concerns or complaints;

    (d) having a comprehensive complaints procedure (as set out below);

    (e) having a team dedicated to monitoring environmental effects for example build-up of dust on neighbouring properties;

    (f) ensuring all project staff are trained and inducted on dust management issues and mitigation requirements of the conditions and the CAQMP;

    (g) on-going community engagement as part of the broader project; and

    (h) identifying all potential sensitive receptors and listing them in the CAQMP.

Complaint Analysis

277. If complaints are received the following steps are recommended:

(a) The site manager responsible for control of environmental effects is to log the following:

(i) the date and time;

(ii) nature of the complaint;

(iii) the name, telephone number and address or approximate location of the complainant,

(iv) weather information (wind speed and direction based on meteorological information); and

(v) details of key sources of dust or likely sources of dust at the time of the complaint.

(b) If the complaint is investigated and works associated with Ō2NL are identified as being the source, then appropriate additional mitigation measures will be implemented. The primary focus should be to mitigate the effect at the source. If source mitigation has failed to prevent adverse impacts, the following are some examples of the measures which could be implemented on a case by case basis if required to deal with nuisance effects at specific locations:

(i) house cleaning service available for properties that are affected by dust;

(ii) alternative laundry services may be required, or contributions towards running a clothes dryer, when extended periods of work is being undertaken in dry windy conditions and it may not be possible for the resident to dry clothes outside;

(iii) if the residence is on roof-collected drinking water, upgrades to the system may need to be undertaken to minimise the impact of construction dust on drinking water supply; and

(iv) temporary relocation of the residents of severely affected properties if no other form of mitigation is available or appropriate.

Odour

278. The potential exists that odour sources such as septic tanks or offal pits may be encountered during the construction process. Despite the site information provided suggesting odour issues during construction are unlikely, it is appropriate for the CAQMP to contain mitigation measures to deal with odour in the event that it is encountered.

279. The following measures are recommended to be in place to deal with such an event:

(a) guidelines on assessing the level of odour during excavation should odorous material be found in areas close to sensitive receptors;

(b) transporting odorous material from the site to an appropriate facility for disposal as soon as practicable. Trucks used to transport the material will be covered by a tarpaulin or clean soil/fill to reduce the potential odour effects as the material is being disposed of;

(c) minimising open areas of excavations where odour material is excavated as much as practicable at all times, including ensuring that odorous sources are covered or temporarily backfilled when not excavating;

(d) considering wind direction and downwind receptors when deciding on when to excavate potentially odorous materials; and

(e) using an odour masking agent or deodoriser such as "Power Green", on the surface of odorous material as it is encountered. The deodoriser can be applied by a worker using a back-pack pressurised sprayer.

Earthworks

280. There will be considerable quantities of material excavated and placed as fill, as the roadway, bridges, intersections, and related structures are constructed. The following measures are recommended to minimise dust effects from earthworks:

(a) limiting or stopping the removal and stockpiling of topsoil during windy conditions in areas close to sensitive receptors. For example, this could mean that the activity does not occur, or is managed, such as not undertaking the activity when the wind is blowing towards the sensitive receptor and above a speed of 10 m/s;

(b) developing procedures for the operation of construction vehicles in areas within 100 m of sensitive receptors, for example restricting vehicle speeds to 15 km/hr;

(c) developing procedures for the removal of potentially dusty cut or placement of fill material, such as sand and silts at locations close to sensitive receptors. For example, this could include requiring material to be covered or dampened before excavation;

(d) where cut material is utilised immediately as fill material, minimising the haul distance as far as practical;

(e) where potentially dusty cut material is being transported for longer distances, the material should be dampened and/or covered to avoid dust generation;

(f) all finished cut batters should be vegetated or covered with hydroseed or mulch as soon as practicable;

(g) watercarts should be available to control dust, with water supply available along the length of the construction;

(h) wheel washes should be installed to prevent the transportation of material onto sealed surfaces where the material can become a source of dust emissions;

(i) minimising material drop heights; and

(j) as appropriate, dust suppression chemicals[75] may be applied to haul roads or open areas using watercarts.

Stockpiled Materials

281. As the Project is constructed, there will be quantities of material excavated and placed as fill. Stockpiling of construction materials such as sand and aggregate may also be required. The following management measures are recommended to be used to minimise dust emissions from stockpiles:

(a) developing procedures for the removal and stockpiling of topsoil and other potentially dusty materials during windy conditions at locations

[75] Dust suppression chemicals work by bonding dust particles together to prevent them from becoming airborne and causing dust nuisance effects.

close to sensitive receptors, for example, works not being undertaken when within 100 m of a sensitive receptor:

(i) when the wind is blowing towards the receptor and wind speeds are above 10 m/s; or

(ii) when the 1-hour average wind speed is over 5 m/s;

(b) keeping the size and height of stockpiles to a minimum and no more than 5 m high;

(c) using water as required to control dust such that it does not result in nuisance beyond the designation boundary. Water is commonly applied at a rate of 1 mm/m^2/hr in dry conditions where practicable and appropriate;

(d) material that is placed in temporary stockpiles that would not be disturbed for more than three months should be vegetated or covered with hydroseed or mulch as soon as practicable;

(e) installing wind breaks around large stockpiles; and

(f) locating stockpiles as far as practical from sensitive receptors.

Construction Yards

282. There will be a number of construction yards associated with the Project. These yards will be in the order of a hectare in size and are likely to have metalled surfaces. Depending on the activity being undertaken in them, there may be the need to use water carts on occasions, or place fresh metal to control the potential for dust. If the main construction yard is used for activities such as aggregate processing or construction of precast concrete components, then the following additional mitigation measures are recommended:

(a) storing fine aggregate in bunkers;

(b) using water misting systems to control dust on any crushing or screening plant;

(c) keeping the size of stockpiles to a minimum and no more than 5 m high;

(d) minimising the drop height of material on to the stockpile to no more than 3 m; and

(e) sheltering transfer points and conveyor belts by enclosing them.

Haul Roads

283. Vehicles travelling along haul roads are often the most significant dust source on a roadway construction project. The construction methodology is yet to be finalised; however, it is likely that haul roads will be located within the proposed Ō2NL Highway alignment. Tracking of dust on to sealed public roadway surfaces from the construction will also need to be monitored. Mitigation measures along these haul roads that I recommend include:

(a) wet suppression of unpaved areas using water carts or fixed sprinklers at a rate of 1 $mm/m^2/hr$ during dry conditions;

(b) metalling or chemical stabilisation of roadway surfaces;

(c) revegetation of exposed surfaces once construction works have been completed;

(d) ensuring vehicles are not overloaded, and

(e) speed controls on vehicle movements which are appropriate and dependent of proximity to sensitive receptors.

Construction Vehicle Exhaust Emissions

284. While there are unlikely to be significant emissions associated with construction vehicles, it is possible to minimise vehicle related emissions through the use of appropriate maintenance. The measures that are recommend be used include, but are not limited to:

(a) appropriate and regular engine maintenance;

(b) ensuing tyres are inflated to the correct pressure;

(c) ensuring haulage distances are kept as small as practicable; and

(d) ensuring haul roads are appropriately maintained.

Construction Monitoring

285. Monitoring of the proposed construction mitigation measures is required to ensure they are being effectively implemented. This section outlines the monitoring that is recommend to be included as part of the CAQMP. It is recommended that the wind and dust monitoring along with key dust mitigation measures are discussed at a daily site safety toolbox meeting.

Wind Monitoring

286. A weather station has been installed on Tame Porati Street in Manakau. This site will be configured to collect data automatically and display it on a website. This station will be used to identify when wind speeds exceed specific mitigation trigger values that can result in increased dust generation (average wind speeds in excess of 5 m/s or wind gust speeds in excess of 10 m/s when measured at a height of between 5 and 10 m). This information will be provided via text or email alerts to key individuals such as Site Engineers and Environmental Manager so that they can implement appropriate mitigation measures.

Visual Dust Monitoring

287. Table C.29 outlines the visual dust monitoring programme that is to be implemented during the construction process. The frequency of the monitoring is defined but in the instance of strong winds (gust wind speeds greater than 10 m/s), discharges of dust that cross the site boundary or receipt of a complaint, the monitoring programmes will be undertaken as often as necessary to ensure that off-site nuisance effects do not occur.

Table C.29: Dust Monitoring Programme	
Monitoring Activities	**Frequency**
Check weather forecasts for strong winds and rainfall to plan appropriate dust management response.	Daily
Inspect land adjacent to the site, construction exists and adjoining roads for the presence of dust deposits.	Daily
Site Walkover with observations detailed in a log sheet	Daily (in the afternoon)
Observe weather conditions, wind via observations and data outputs from weather stations and presence of rain.	Daily and as conditions change
Inspect all unsealed surfaces for dampness and to ensure that surface exposure is minimised.	Daily and as conditions change
Inspect stockpiles to ensure enclosure, covering, stabilisation or dampness. Ensure stockpile height is less than 5 m or appropriately stabilised.	Weekly and at times of expected high winds
Inspect dust generating activities to ensure dust emissions are effectively controlled.	Daily and as new activities are commenced
Inspect watering systems (sprays and water carts) to ensure equipment is maintained and functioning to effectively dampen exposed areas.	Weekly
Additional monitoring of dust generating activities and water application rate.	In winds over 5 m/s (11 knots or a Beaufort scale number of 3)
Inspect site access and egress points to ensure effective operation of wheelwash / truckwash systems and/or judder bars (if installed).	Weekly
Ensure site windbreak fences, if used, are intact.	Weekly

288. Real time monitoring is not currently proposed as, the visual dust monitoring is considered sufficient and appropriate. Real time monitoring along sections of the construction footprint can be implemented to respond to any serious and validated concerns raised through the visual monitoring or in the event of repetitive complaints. If real time monitoring is considered during the Project, then I recommend it monitor PM_{10}, wind speed and wind direction.

Operational measures

289. When the Project is operational, it is predicted that concentrations of compounds from vehicle emissions will be well below the assessment criteria. Consequently, the Ō2NL Project should not result in any significant decrease in air quality, and therefore mitigation of the operational effects of the Project is not required.

Post Project Air Quality Monitoring

290. As the predicted contribution of vehicle pollutants to ambient air quality in the Ō2NL Project area is negligible, no post-Project ambient air quality monitoring is considered necessary.

CONCLUSION

291. Potential adverse air quality effects during construction and operation have been assessed by using best practice methods and adopting the recommendations of relevant good practice guides.

Dust effects

292. The primary potential air discharge from the construction of the Ō2NL Project will be dust. Overall, this Project has been assessed as having the potential to cause nuisance dust emissions over a wide area due to the scale of earthworks required and their spatial extent. Generally, sensitive receptors located within 50 m of construction activities could experience dust nuisance effects.

293. In order to reduce the potential for these nuisance effects so that they are not considered offensive or objectionable, a number of well tested mitigation measures have been recommended. These measures will be required through the consent conditions and detailed in the CAQMP.

Vehicle emission effects

294. There will also be minor emissions (exhaust fumes) from construction vehicles. These are not considered significant due to the relatively small number of vehicles that will be operating during the construction period.

295. The assessment of potential adverse air quality effects during the operation of the Ō2NL Project has predicted ambient concentrations of NO_2, PM_{10} and $PM_{2.5}$ from vehicle emissions from the Ō2NL concept design and existing

SH1 and SH57 for the opening year (2029) and the design year (2039). These predictions have been added to background concentrations to provide a cumulative effects assessment.

296. The assessment shows that predicted concentrations of all pollutants assessed are less than the relevant health impact assessment guidelines and the NESAQ values at the identified sensitive receptors.

297. A reduction in concentration can be expected between 2029 and 2039 for pollutants assessed except for 24-hour PM_{10} concentrations, where the concentrations slightly increase. The reduction in concentration is primarily due to a decrease in vehicle emissions as a result of improvement in vehicle emission technologies and a move toward electric vehicles. For PM_{10} concentrations this increase in concentrations is a result of increased vehicle numbers.

298. The results from the road traffic dispersion model indicate that reductions in the concentration of vehicle air pollutants can be expected in the township of Ohau, along the existing SH1, and the Levin town centre. For both of the years assessed, concentrations are generally predicted to reflect a minor increase in areas located within 200 m of the Ō2NL Project. The predicted concentrations will remain below relevant air quality assessment criteria.

299. Overall, effects of the Ō2NL Project are able to be mitigated to avoid objectionable or offensive dust emissions, and modelling predicts an improvement of air quality in the areas adjacent to the Project, in particular Ohau and the Levin town centre. There will be a decrease in concentrations for the ‘With Project’ scenario for all pollutants when compared to the ‘Without Project’ / ‘Do Minimum’ scenario for the corresponding year.

Andrew Curtis

14 October 2022

APPENDIX C.1 – SENSITIVE RECEPTORS

Table C.1.1: Sensitive (Discrete) Receptors				
Sensitive Receptors	**Receptor No.**	**Receptor Location (Universal Transverse Mercator, Zone 60)**		**Receptor Type**
		m E	**m S**	
Stage 2 Assessment Receptors				
115 State Highway 1	R1	345,265	5,487,798	Residential
114 State Highway 1	R2	345,556	5,487,707	Residential
Ōtaki Loco miniature Railway and Gardens	R3	346,007	5,488,290	Other
426 State highway 1	R4	348,184	5,489,234	Residential
18 Mountain View Drive, Manakau	R5	349,006	5,489,360	Residential
Manakau Cemetery	R6	348,555	5,489,779	Cemetery
45 South Manakau Road	R7	348,945	5,489,855	Residential
Quarter Acre Café Bistro	R8	349,026	5,490,515	Cafe
Growing Things	R9	349,695	5,490,988	Garden Centre
Manakau Markets	R10	349,225	5,491,265	Café
Manakau School	R11	349,442	5,491,491	School
Agricultural Activity (34 North Manakau Road)	R12	350,129	5,492,119	Garden
Ngati Wehi Wehi Marae	R13	349,681	5,492,698	Marae
101 North Manakau Road	R14	350,509	5,492,406	Residential
St Stephans Church	R15	351,213	5,494,677	Church
65 Kuku East Road, Manakau	R16	351,901	5,494,896	Residential

Table C.1.1: Sensitive (Discrete) Receptors				
Sensitive Receptors	**Receptor No.**	**Receptor Location (Universal Transverse Mercator, Zone 60)**		**Receptor Type**
		m E	**m S**	
Stage 3 Sensitive Receptors				
8 Parakawau Road	R17	351,563	5,496,522	Residential
4 Bishops Road	R18	351,928	5,496,812	Residential
Ohau School	R19	352,167	5,497,291	School
Salt and Pepper Café	R20	352,648	5,498,567	Café
Fruit and Vege Store	R21	352,801	5,498,775	Store
Speldhurst Country Estate - Retirement Community	R22	353,731	5,498,4780	Retirement Village
205 Muhunoa East Road	R23	353,581	5,496,580	Residential
245 Muhunoa East Road	R24	353,912	5,496,424	Residential
429 Arapaepae Road South	R25	354,658	5,497,264	Residential
217 Kimberley Road,	R26	354,905	5,498,021	Residential
Travelodge Motel Levin	R27	353,569	5,499,761	Motel
85 Tararua Road	R28	354,648	5,499,666	Residential
249 Arapaepae South Road	R29	355,339	5,498,829	Residential
205 Arapaepae South Road	R30	355,565	5,499,239	Residential
248 Tararua Road	R31	356,030	5,498,911	Residential
105 Arapaepae Road South	R32	356,164	5,500,033	Residential
Sunshine Kids Daycare	R33	354,894	5,501,173	School
Levin Adventure Park	R34	354,722	5,501,371	Park

Table C.1.1: Sensitive (Discrete) Receptors				
Sensitive Receptors	Receptor No.	Receptor Location (Universal Transverse Mercator, Zone 60)		Receptor Type
		m E	m S	
Levin Seventh Day Adventist Church	R35	354,895	5,501,358	Church
UCOL Levin	R36	354,911	5,501,556	School
Fanau Pasifika Kindergarten	R37	355,014	5,501,531	School
Te Takeretanga o Kura-hau-pō (Levin Community Centre)	R38	354,882	5,501,682	Community Centre
Zachary's Motel	R39	355,364	5,502,241	Motel
Bentons Motel & Restaurant	R40	355,445	5,502,328	Motel
12 Ngaio Street	R41	356,367	5,500,423	Residential
New Development House	R42	356,629	5,500,024	Residential
26 Redwood Grove	R43	357,057	5,500,453	Residential
Levin East School	R44	356,025	5,501,039	School
Parsons Avenue Kindergarten	R45	356,190	5,501,072	School
Plymouth Brethren Church Levin	R46	356,580	5,500,884	Church
Horowhenua Masonic Village - Retirement Community	R47	356,821	5,500,991	Retirement
1033 Queen Street East	R48	357,126	5,500,806	Residential
20 Arapaepae Road	R49	356,916	5,501,027	Residential
1 Gordon Place	R50	356,003	5,502,976	Residential
3 Lindsay Road	R51	356,143	5,503,748	Residential
Panorama Motel	R52	356,224	5,504,700	Motel
96 Avenue North Road	R53	355,963	5,505,091	Residential

Table C.1.1: Sensitive (Discrete) Receptors				
Sensitive Receptors	**Receptor No.**	**Receptor Location (Universal Transverse Mercator, Zone 60)**		**Receptor Type**
		m E	**m S**	
56 Sorensons Road	R54	356,799	5,504,555	Residential
86 Arapaepae Road	R55	357,329	5,501,529	Residential
40 Waihou Road	R56	357,926	5,501,626	Residential
152 Waihou Road	R57	358,068	5,502,544	Residential
118 Waihou Road	R58	358,513	5,502,331	Residential
Farmhouse Preschool and Nursery	R59	357,672	5502775	Gardens

APPENDIX C.2 – AIR QUALITY SCREENING MODEL OUTPUTS

Table C.2.1: NZTA Air Quality Screening Model Inputs

Receptor Distance (m)		Category	2018 (Base Year)	2029	
SH 1	Project			Without Project	With Project
Receptor A1					
50	65	ADTC	14,900	20,800	22,400
		%HV	13	14	14
		PM_{10} concentration from road (µg/m^3)	0.4	0.4	0.3
		Cumulative PM_{10} (%)	24	24	24
		NO_2 Concentration from road (µg/m^3)	0.9	1.3	1.1
		Cumulative NO_2 (%)	25	26	25
Receptor A2					
220	100	AATC	14,900	20,800	21,600
		%HV	13	14	14
		PM_{10} concentration from road (µg/m^3)	0	0	0.2
		Cumulative PM_{10} (%)	23	23	24
		NO_2 Concentration from road (µg/m^3)	0.3	0.5	0.8
		Cumulative NO_2 (%)	23	24	25
Receptor A3					
45	130	ADTC	14,900	20,800	21,600
		%HV	13	14	14
		PM_{10} concentration from road (µg/m^3)	0.5	0.4	0.1
		Cumulative PM_{10} (%)	24	24	23
		NO_2 Concentration from road (µg/m^3)	1	1.3	0.7
		Cumulative NO_2 (%)	25	26	24
Receptor A4 (to SH1)					
90	-	AATC	14,700	20,700	1,700
		%HV	13	14	16
		PM_{10} concentration from road (µg/m^3)	0.2	0.2	0
		Cumulative PM_{10} (%)	24	24	23
		NO_2 Concentration from road (µg/m^3)	0.6	0.9	0.1

Table C.2.1: NZTA Air Quality Screening Model Inputs					
Receptor Distance (m)		Category	2018 (Base Year)	2029	
SH 1	Project			Without Project	With Project
		Cumulative NO_2 (%)	24	25	23
Receptor A4					
-	80	AATC	-	-	21,600
		%HV	-	-	14
		PM_{10} concentration from road (µg/m^3)	-	-	0.2
		Cumulative PM_{10} (%)	-	-	24
		NO_2 Concentration from road (µg/m^3)	-	-	1
		Cumulative NO_2 (%)	-	-	25
Receptor A5					
-	85	AATC	-	-	21,600
		%HV	-	-	14
		PM_{10} concentration from road (µg/m^3)	-	-	0.2
		Cumulative PM_{10} (%)	-	-	24
		NO_2 Concentration from road (µg/m^3)	-	-	0.9
		Cumulative NO_2 (%)	-	-	25
Receptor A6					
15	-	AATC	14,700	20,700	1,700
		%HV	13	14	16
		PM_{10} concentration from road (µg/m^3)	1.1	1.0	0.1
		Cumulative PM_{10} (%)	25	25	23
		NO_2 Concentration from road (µg/m^3)	1.9	2.7	0.2
		Cumulative NO_2 (%)	27	29	23
Receptor A7					
-	85	AATC	-	-	21,600
		%HV	-	-	14
		PM_{10} concentration from road (µg/m^3)			0.2
		Cumulative PM_{10} (%)			24
		NO_2 Concentration from road (µg/m^3)			0.9
		Cumulative NO_2 (%)			25

Table C.2.1: NZTA Air Quality Screening Model Inputs

Receptor Distance (m)		Category	2018 (Base Year)	2029	
SH 1	Project			Without Project	With Project
Receptor A8					
50	-	AATC	15,100	21,500	2,300
		%HV	13	14	15
		PM_{10} concentration from road ($\mu g/m^3$)	0.5	0.4	0
		Cumulative PM_{10} (%)	24	24	23
		NO_2 Concentration from road ($\mu g/m^3$)	0.9	1.3	0.1
		Cumulative NO_2 (%)	25	26	23
Receptor A9					
-	230	ADTC	-	-	21,600
		%HV	-	-	14
		PM_{10} concentration from road ($\mu g/m^3$)	-	-	0
		Cumulative PM_{10} (%)	-	-	23
		NO_2 Concentration from road ($\mu g/m^3$)	-	-	0.5
		Cumulative NO_2 (%)	-	-	24
Receptor A10					
25	-	AATC	15,100	21,400	2,300
		%HV	13	14	15
		PM_{10} concentration from road ($\mu g/m^3$)	0.8	0.4	0.1
		Cumulative PM_{10} (%)	25	24	23
		NO_2 Concentration from road ($\mu g/m^3$)	1.4	1.3	0.2
		Cumulative NO_2 (%)	26	26	23
Receptor A11					
50	-	AATC	15,700	22,100	2,900
		%HV	13	14	13
		PM_{10} concentration from road ($\mu g/m^3$)	0.4	0.4	0.1
		Cumulative PM_{10} (%)	24	24	23
		NO_2 Concentration from road ($\mu g/m^3$)	1	1.3	0.2
		Cumulative NO_2 (%)	25	26	23

Table C.2.1: NZTA Air Quality Screening Model Inputs					
Receptor Distance (m)		**Category**	**2018 (Base Year)**	**2029**	
SH 1	**Project**			**Without Project**	**With Project**
Receptor A12					
-	180	ADTC			21,600
		%HV			14
		PM_{10} concentration from road (µg/m^3)			0.1
		Cumulative PM_{10} (%)			23
		NO_2 Concentration from road (µg/m^3)			0.6
		Cumulative NO_2 (%)			24
Receptor A13					
55	-	AATC	17,300	24,200	5,100
		%HV	13	13	11
		PM_{10} concentration from road (µg/m^3)	0.5	0.4	0.1
		Cumulative PM_{10} (%)	24	24	23
		NO_2 Concentration from road (µg/m^3)	1	1.4	0.3
		Cumulative NO_2 (%)	25	26	23
Receptor A14					
-	35	ADTC	-	-	21,600
		%HV	-	-	14
		PM_{10} concentration from road (µg/m^3)	-	-	0.6
		Cumulative PM_{10} (%)	-	-	24
		NO_2 Concentration from road (µg/m^3)	-	-	1.6
		Cumulative NO_2 (%)	-	-	27
Receptor A15					
5	-	AATC	17,300	24,200	5,100
		%HV	13	13	11
		PM_{10} concentration from road (µg/m^3)	2.2	1.9	0.4
		Cumulative PM_{10} (%)	28	27	24
		NO_2 Concentration from road (µg/m^3)	4.7	6.5	1.4
		Cumulative NO_2 (%)	34	39	26

Table C.2.1: NZTA Air Quality Screening Model Inputs					
Receptor Distance (m)		**Category**	**2018 (Base Year)**	**2029**	
SH 1	**Project**			**Without Project**	**With Project**
Receptor A16					
-	150	AATC	-	-	21,600
		%HV	-	-	14
		PM_{10} concentration from road (µg/m^3)	-	-	0.1
		Cumulative PM_{10} (%)	-	-	23
		NO_2 Concentration from road (µg/m^3)	-	-	0.6
		Cumulative NO_2 (%)	-	-	24

Notes:

1. *AATC = Annual Average Daily Traffic Count. HV = Heavy Vehicle percentage. PM_{10} and NO_2 concentration from the road is the concentration emitted from that stretch of road (ignores all other sources). Cumulative PM_{10} and NO_2 are the combined road emissions and background concentrations as a percentage against the guideline value.*

APPENDIX C.3 – CALPUFF METEOROLOGICAL DATASET STEPS

1. One of the key components of the CALPUFF model is detailed meteorological data, some of which is not easily measured such as changes with temperature and wind direction in the upper atmosphere. Therefore, we have used another meteorological model called The Air Pollution Model ("**TAPM**")[76] to predict those meteorological conditions that we cannot measure.

2. In order to produce the meteorological data set to run CALPUFF, TAPM was configured with:

   (a) four nested meteorological grids with a grid spacing of 30, 10, 3, 1 km;

   (b) default vegetation, topography and soil types as supplied in the TAPM databases for New Zealand;

   (c) grid centre at UTM 349,769 m E, 5,492,582 m S UTM Zone 60H;

   (d) deep soil moisture used was 0.15 m3 m-3 (volume of water per volume of soil);

   (e) grid dimensions (nx, ny, nz) = 40, 40, 25; and

   (f) prognostic turbulence scheme and hydrostatic approximation.

3. No observations were added to this dataset as those were included in the CALMET model.

4. Meteorological dataset was extracted from the model which was converted to a .dat file from the M3D file that TAPM produces. This file was used to input to CALMET.

[76] Commonwealth Scientific and Industrial Research (CSIRO), *The Air Pollution Model, Version 4.04*.

5. The results from TAPM and local surface station observations have been incorporated into the CALMET model. This approach is most appropriate as it enables more inputs to be included. This approach is consistent with accepted best practice.

6. Observational station data from five sites, identified in Table C.3.1 was added into the CALMET model.

7. The stations were assimilated into the CALMET model with a radius of influence of 3 km to improve the correlation of the model predictions with actual surface wind measurements.

8. A windrose of the surface air data file generated by CALMET for use with CALPUFF is provided in Table C.3.1 and was taken at UTM 353,007 m E and 5,498,650 m S. The windrose is for January 2019 to December 2020 and shows the prominent winds on the site are coming from the west northwest and east which reflects the surrounding topography.

Table C.2.1: Climate stations used in CALMET dataset

Model ID	Station Name	Operating Authority	Parameters Measured
41352	Levin EWS	Metservice	WD, WS
40984	Masterton EWS	Metservice	WD, WS
21963	Palmerston North EWS	Metservice	WD, WS
22222	Ohakea	NIWA	Ccover, Cheight
11111	Levin	NIWA	T, rainfall, P, RH, WD, WS

Notes:

1. *WS = Wind Speed, WD = Wind Direction, T = Temp, RH = Relative Humidity, P = Pressure, Ccover = cloud cover, Cheight = Cloud Height*

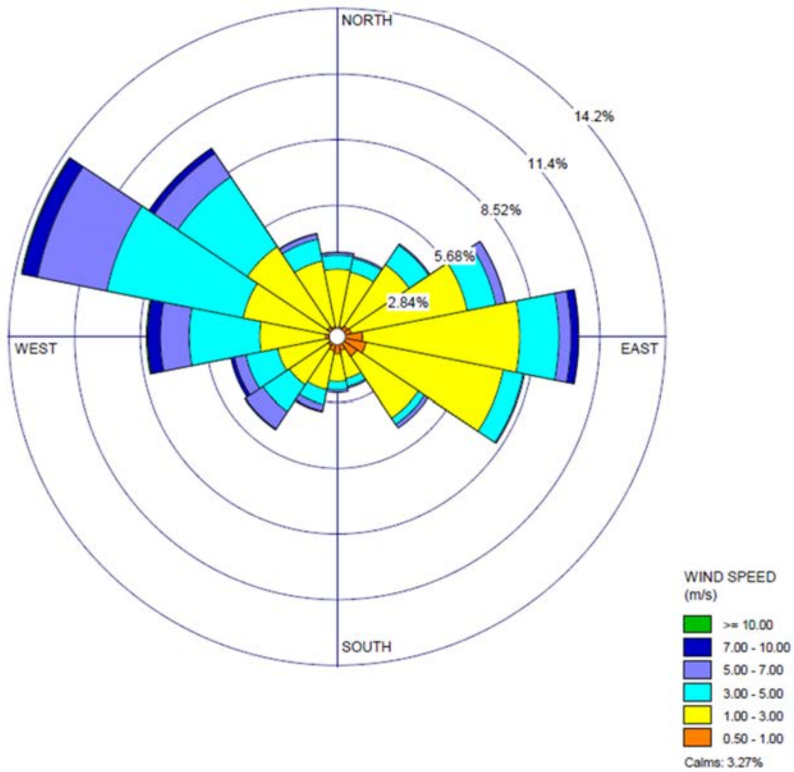


Figure C.3.1: CALMET Generated Windrose (1 January 2019 to 31 December 2020)

CALPUFF Model Configuration

9. The CALPUFF model was configured to predict contaminant ground level concentration at a number of discrete receptor locations at sensitive receptors (Appendix C.1), as well as over a 10 x 7 km domain with a meteorological grid spacing of 0.25 km, and a receptor spacing of 0.083 km. The sampling grid was split into three sections to decrease the model run time.

10. The grids were set out according to Table C.3.2, some road sources and receptors were analysed in multiple grids to ensure the highest predicted concentration has been identified.

Table C.3.2: CALPUFF Model Configuration			
Grid	**Domain Size**	**Line Sources**	**Receptors**
A	6 x 4 km	A, B, C, H, I, A1, 1, 2	R1 to R17
B	4 x 3 km	D, E, I, J, A1, A2, A3, 1, 2, 3	R15 to R34, R40 (excludes R24 and R25)
C	4 x 5 km	F, G, J, K, A2, A3, A4, 3, 4, 5	R18 to R25 and R30 to R44

Emission Rate Calculations

11. Emissions rates are produced in VEPM as g/km, in order input these results into the atmospheric dispersion model a conversion to g/s/m is required.

12. In order to do this, the daily vehicle count was used. As the hourly breakdown of vehicles were provided the following equation was used with NO2 being an example.

$$NO_2\ (hour) = (\%\ of\ vehicles\ for\ that\ hour\ \times Daily\ Vehicle\ Count)$$

$$NO_2\ (g/h/km) = NO_2\ (hour)\ \times VEPM\ Output\ (g/km)$$

From there the value was converted to g/s/m.

Sigma Values

13. The following sigma values were used:

(a) Existing SH Sigma Y = 8.0 m (single lane each direction).

(b) Ō2NL Highway Sigma Y = 16.0 m (two lanes each direction).

(c) Sigma Z for all roads 2.0 m (based on the approximate average height of vehicles).

Effective Height = 0.4 m (based on the approximate average exhaust height)

CALPUFF Probability Density Function

14. This function is designed to be used for buoyant sources, and therefore not considered applicable. However, for completeness a model run was undertaken to determine the impact this function would have. For all pollutants the concentrations decreased as a result of this function and therefore the results are presented with this function turned off.

APPENDIX C.4 – CALMET INPUT FILE

CALMET Parameters

O2NL Set up

INPUT GROUP: 0 -- Input and Output File Names		
Parameter	**Description**	**Value**
GEODAT	Input file of geophysical data (GEO.DAT)	GEO.DAT
SRFDAT	Input file of hourly surface meteorological data (SURF.DAT)	SURF.DAT
METLST	Output file name of CALMET list file (CALMET.LST)	CALMET.LST
METDAT	Output file name of generated gridded met files (CALMET.DAT)	CALMET.DAT
LCFILES	Lower case file names (T = lower case, F = upper case)	F
NUSTA	Number of upper air stations	0
NOWSTA	Number of overwater stations	0
NM3D	Number of prognostic meteorological data files (3D.DAT)	1
NIGF	Number of IGF-CALMET.DAT files used as initial guess	0
DIADAT	Input file of diagnostic wind field data (DIAG.DAT)	O2NL.dat

INPUT GROUP: 1 -- General Run Control Parameters		
Parameter	**Description**	**Value**
IBYR	Starting year	2019
IBMO	Starting month	1
IBDY	Starting day	1
IBHR	Starting hour	0
IBSEC	Starting second	0
IEYR	Ending year	2020
IEMO	Ending month	12
IEDY	Ending day	31
IEHR	Ending hour	23
IESEC	Ending second	0
ABTZ	Base time zone	UTC+1200
NSECDT	Length of modeling time-step (seconds)	3600
IRTYPE	Output run type (0 = wind fields only, 1 = CALPUFF/CALGRID)	1
LCALGRD	Compute CALGRID data fields (T = true, F = false)	T
ITEST	Flag to stop run after setup phase (1 = stop, 2 = run)	2
MREG	Regulatory checks (0 = no checks, 1 = US EPA LRT checks)	0

INPUT GROUP: 2 -- Map Projection and Grid Control Parameters		
Parameter	**Description**	**Value**
PMAP	Map projection system	UTM
FEAST	False easting at projection origin (km)	0.0
FNORTH	False northing at projection origin (km)	0.0

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INPUT GROUP: 2 -- Map Projection and Grid Control Parameters		
Parameter	**Description**	**Value**
IUTMZN	UTM zone (1 to 60)	60
UTMHEM	Hemisphere of UTM projection (N = northern, S = southern)	S
XLAT1	1st standard parallel latitude (decimal degrees)	30S
XLAT2	2nd standard parallel latitude (decimal degrees)	60S
DATUM	Datum-Region for the coordinates	WGS-84
NX	Meteorological grid - number of X grid cells	100
NY	Meteorological grid - number of Y grid cells	120
DGRIDKM	Meteorological grid spacing (km)	0.25
XORIGKM	Meteorological grid - X coordinate for SW corner (km)	338.1930
YORIGKM	Meteorological grid - Y coordinate for SW corner (km)	5478.9920
NZ	Meteorological grid - number of vertical layers	11
ZFACE	Meteorological grid - vertical cell face heights (m)	0.00,20.00,32.00,40.00,80.00,160.00,320.00,640.00,1200.00,2000.00,3000.00,4000.00

INPUT GROUP: 3 -- Output Options		
Parameter	**Description**	**Value**
LSAVE	Save met fields in unformatted output file (T = true, F = false)	T
IFORMO	Type of output file (1 = CALPUFF/CALGRID, 2 = MESOPUFF II)	1
LPRINT	Print met fields (F = false, T = true)	F
IPRINF	Print interval for output wind fields (hours)	1
STABILITY	Print gridded PGT stability classes? (0 = no, 1 = yes)	0
USTAR	Print gridded friction velocities? (0 = no, 1 = yes)	0
MONIN	Print gridded Monin-Obukhov lengths? (0 = no, 1 = yes)	0
MIXHT	Print gridded mixing heights? (0 = no, 1 = yes)	0
WSTAR	Print gridded convective velocity scales? (0 = no, 1 = yes)	0
PRECIP	Print gridded hourly precipitation rates? (0 = no, 1 = yes)	0
SENSHEAT	Print gridded sensible heat fluxes? (0 = no, 1 = yes)	0
CONVZI	Print gridded convective mixing heights? (0 = no, 1 = yes)	0
LDB	Test/debug option: print input met data and internal variables (F = false, T = true)	F
NN1	Test/debug option: first time step to print	1
NN2	Test/debug option: last time step to print	1
LDBCST	Test/debug option: print distance to land internal variables (F = false, T = true)	F
IOUTD	Test/debug option: print control variables for writing winds? (0 = no, 1 = yes)	0
NZPRN2	Test/debug option: number of levels to print starting at the surface	1
IPR0	Test/debug option: print interpolated winds? (0 = no, 1 = yes)	0
IPR1	Test/debug option: print terrain adjusted surface wind? (0 = no, 1 = yes)	0

INPUT GROUP: 3 -- Output Options		
Parameter	**Description**	**Value**
IPR2	Test/debug option: print smoothed wind and initial divergence fields? (0 = no, 1 = yes)	0
IPR3	Test/debug option: print final wind speed and direction? (0 = no, 1 = yes)	0
IPR4	Test/debug option: print final divergence fields? (0 = no, 1 = yes)	0
IPR5	Test/debug option: print winds after kinematic effects? (0 = no, 1 = yes)	0
IPR6	Test/debug option: print winds after Froude number adjustment? (0 = no, 1 = yes)	0
IPR7	Test/debug option: print winds after slope flow? (0 = no, 1 = yes)	0
IPR8	Test/debug option: print final winds? (0 = no, 1 = yes)	0

INPUT GROUP: 4 -- Meteorological Data Options		
Parameter	**Description**	**Value**
NOOBS	Observation mode (0 = stations only, 1 = surface/overwater stations with prognostic upper air, 2 = prognostic data only)	1
NSSTA	Number of surface stations	5
NPSTA	Number of precipitation stations	0
ICLDOUT	Output the CLOUD.DAT file? (0 = no, 1 = yes)	0
MCLOUD	Method to compute cloud fields (1 = from surface obs, 2 = from CLOUD.DAT, 3 = from prognostic (Teixera), 4 = from prognostic (MM5toGrads)	4
IFORMS	Surface met data file format (1 = unformatted, 2 = formatted)	2
IFORMP	Precipitation data file format (1 = unformatted, 2 = formatted)	2
IFORMC	Cloud data file format (1 = unformatted, 2 = formatted)	1

INPUT GROUP: 5 -- Wind Field Options and Parameters		
Parameter	**Description**	**Value**
IWFCOD	Wind field model option (1 = objective analysis, 2 = diagnostic)	1
IFRADJ	Adjust winds using Froude number effects? (0 = no, 1 = yes)	1
IKINE	Adjust winds using kinematic effects? (0 = no, 1 = yes)	0
IOBR	Adjust winds using O'Brien velocity procedure? (0 = no, 1 = yes)	0
ISLOPE	Compute slope flow effects? (0 = no, 1 = yes)	1
IEXTRP	Extrapolation of surface winds to upper layers method (1 = none, 2 = power law, 3 = user input, 4 = similarity theory, - = same except layer 1 data at upper air stations are ignored)	-1
ICALM	Extrapolate surface winds even if calm? (0 = no, 1 = yes)	0
BIAS	Weighting factors for surface and upper air stations (NZ values)	0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0
RMIN2	Minimum upper air station radius of influence for surface extrapolation exclusion (km)	4
IPROG	Use prognostic winds as input to diagnostic wind model (0 = no, 13 = use winds from 3D.DAT as Step 1 field, 14 = use winds from 3D.DAT as initial guess field, 15 = use winds from 3D.DAT file as observations)	14
ISTEPPGS	Prognostic data time step (seconds)	3600

INPUT GROUP: 5 -- Wind Field Options and Parameters		
Parameter	**Description**	**Value**
IGFMET	Use coarse CALMET fields as initial guess? (0 = no, 1 = yes)	0
LVARY	Use varying radius of influence (F = false, T = true)	F
RMAX1	Maximum radius of influence in the surface layer (km)	3
RMAX2	Maximum radius of influence over land aloft (km)	3
RMAX3	Maximum radius of influence over water (km)	0
RMIN	Minimum radius of influence used in wind field interpolation (km)	0.1
TERRAD	Radius of influence of terrain features (km)	5
R1	Relative weight at surface of step 1 fields and observations (km)	2.5
R2	Relative weight aloft of step 1 field and observations (km)	2.5
RPROG	Weighting factors of prognostic wind field data (km)	0
DIVLIM	Maximum acceptable divergence	5E-006
NITER	Maximum number of iterations in the divergence minimization procedure	50
NSMTH	Number of passes in the smoothing procedure (NZ values)	2,10*4
NINTR2	Maximum number of stations used in each layer for interpolation (NZ values)	11*99
CRITFN	Critical Froude number	1
ALPHA	Empirical factor triggering kinematic effects	0.1
NBAR	Number of barriers to interpolation of the wind fields	0
KBAR	Barrier - level up to which barriers apply (1 to NZ)	11
IDIOPT1	Surface temperature (0 = compute from obs/prognostic, 1 = read from DIAG.DAT)	0
ISURFT	Surface station to use for surface temperature (between 1 and NSSTA)	-1
IDIOPT2	Temperature lapse rate used in the computation of terrain-induced circulations (0 = compute from obs/prognostic, 1 = read from DIAG.DAT)	0
IUPT	Upper air station to use for the domain-scale lapse rate (between 1 and NUSTA)	-1
ZUPT	Depth through which the domain-scale lapse rate is computed (m)	200
IDIOPT3	Initial guess field winds (0 = compute from obs/prognostic, 1 = read from DIAG.DAT)	1
IUPWND	Upper air station to use for domain-scale winds	-1
ZUPWND	Bottom and top of layer through which the domain-scale winds are computed (m)	1.0, 1.00
IDIOPT4	Read observed surface wind components (0 = from SURF.DAT, 1 = from DIAG.DAT)	0
IDIOPT5	Read observed upper wind components (0 = from UPn.DAT, 1 = from DIAG.DAT)	0
LLBREZE	Use Lake Breeze module (T = true, F = false)	F
NBOX	Lake Breeze - number of regions	0

INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation Parameters		
Parameter	**Description**	**Value**
CONSTB	Mixing height constant: neutral, mechanical equation	1.41

INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation Parameters		
Parameter	**Description**	**Value**
CONSTE	Mixing height constant: convective equation	0.15
CONSTN	Mixing height constant: stable equation	2400
CONSTW	Mixing height constant: overwater equation	0.16
FCORIOL	Absolute value of Coriolis parameter (1/s)	0.0001
IAVEZI	Spatial mixing height averaging? (0 = no, 1 = yes)	1
MNMDAV	Maximum search radius in averaging process (grid cells)	1
HAFANG	Half-angle of upwind looking cone for averaging (degrees)	30
ILEVZI	Layer of winds used in upwind averaging (between 1 and NZ)	1
IMIXH	Convective mixing height method (1 = Maul-Carson, 2 = Batchvarova-Gryning, - for land cells only, + for land and water cells)	1
THRESHL	Overland threshold boundary flux (W/m**3)	0
THRESHW	Overwater threshold boundary flux (W/m**3)	0.05
ITWPROG	Overwater lapse rate and deltaT options (0 = from SEA.DAT, 1 = use prognostic lapse rates and SEA.DAT deltaT, 2 = from prognostic)	0
ILUOC3D	Land use category in 3D.DAT	16
DPTMIN	Minimum potential temperature lapse rate (K/m)	0.001
DZZI	Depth of computing capping lapse rate (m)	200
ZIMIN	Minimum overland mixing height (m)	50
ZIMAX	Maximum overland mixing height (m)	3000
ZIMINW	Minimum overwater mixing height (m)	50
ZIMAXW	Maximum overwater mixing height (m)	3000
ICOARE	Overwater surface fluxes method	10
DSHELF	Coastal/shallow water length scale (km)	0
IWARM	COARE warm layer computation (0 = off, 1 = on)	0
ICOOL	COARE cool skin layer computation (0 = off, 1 = on)	0
IRHPROG	Relative humidity read option (0 = from SURF.DAT, 1 = from 3D.DAT)	0
ITPROG	3D temperature read option (0 = stations, 1 = surface from station and upper air from prognostic, 2 = prognostic)	1
IRAD	Temperature interpolation type (1 = 1/R, 2 = 1/R**2)	1
TRADKM	Temperature interpolation radius of influence (km)	500
NUMTS	Maximum number of stations to include in temperature interpolation	5
IAVET	Conduct spatial averaging of temperatures? (0 = no, 1 = yes)	1
TGDEFB	Default overwater mixed layer lapse rate (K/m)	-0.0098
TGDEFA	Default overwater capping lapse rate (K/m)	-0.0045
JWAT1	Beginning land use category for temperature interpolation over water	999
JWAT2	Ending land use category for temperature interpolation over water	999
NFLAGP	Precipitation interpolation method (1 = 1/R, 2 = 1/R**2, 3 = EXP/R**2)	2
SIGMAP	Precipitation interpolation radius of influence (km)	100.
CUTP	Minimum precipitation rate cutoff (mm/hr)	0.01

APPENDIX C.5 – CALPUFF Input File

CALPUFF Parameters

2039 Part 1A

INPUT GROUP: 0 -- Input and Output File Names		
Parameter	**Description**	**Value**
METDAT	CALMET gridded meteorological data file (CALMET.DAT)	CALMET.DAT
PUFLST	CALPUFF output list file (CALPUFF.LST)	CALPUFF.LST
CONDAT	CALPUFF output concentration file (CONC.DAT)	CONC.DAT
DFDAT	CALPUFF output dry deposition flux file (DFLX.DAT)	DFLX.DAT
WFDAT	CALPUFF output wet deposition flux file (WFLX.DAT)	WFLX.DAT
LCFILES	Lower case file names (T = lower case, F = upper case)	F
NMETDOM	Number of CALMET.DAT domains	1
NMETDAT	Number of CALMET.DAT input files	1
NPTDAT	Number of PTEMARB.DAT input files	0
NARDAT	Number of BAEMARB.DAT input files	0
NVOLDAT	Number of VOLEMARB.DAT input files	0
NFLDAT	Number of FLEMARB.DAT input files	0
NRDDAT	Number of RDEMARB.DAT input files	0
NLNDAT	Number of LNEMARB.DAT input files	0

INPUT GROUP: 1 -- General Run Control Parameters		
Parameter	**Description**	**Value**
METRUN	Run all periods in met data file? (0 = no, 1 = yes)	0
IBYR	Starting year	2019
IBMO	Starting month	1
IBDY	Starting day	1
IBHR	Starting hour	0
IBMIN	Starting minute	0
IBSEC	Starting second	0
IEYR	Ending year	2020
IEMO	Ending month	12
IEDY	Ending day	31
IEHR	Ending hour	0
IEMIN	Ending minute	0
IESEC	Ending second	0
ABTZ	Base time zone	UTC+1200
NSECDT	Length of modeling time-step (seconds)	3600
NSPEC	Number of chemical species modeled	3
NSE	Number of chemical species to be emitted	3
ITEST	Stop run after SETUP phase (1 = stop, 2 = run)	2

INPUT GROUP: 1 -- General Run Control Parameters		
Parameter	**Description**	**Value**
MRESTART	Control option to read and/or write model restart data	0
NRESPD	Number of periods in restart output cycle	0
METFM	Meteorological data format (1 = CALMET, 2 = ISC, 3 = AUSPLUME, 4 = CTDM, 5 = AERMET)	1
MPRFFM	Meteorological profile data format (1 = CTDM, 2 = AERMET)	1
AVET	Averaging time (minutes)	60
PGTIME	PG Averaging time (minutes)	60
IOUTU	Output units for binary output files (1 = mass, 2 = odour, 3 = radiation)	1

INPUT GROUP: 2 -- Technical Options		
Parameter	**Description**	**Value**
MGAUSS	Near field vertical distribution (0 = uniform, 1 = Gaussian)	1
MCTADJ	Terrain adjustment method (0 = none, 1 = ISC-type, 2 = CALPUFF-type, 3 = partial plume path)	3
MCTSG	Model subgrid-scale complex terrain? (0 = no, 1 = yes)	0
MSLUG	Near-field puffs modeled as elongated slugs? (0 = no, 1 = yes)	0
MTRANS	Model transitional plume rise? (0 = no, 1 = yes)	1
MTIP	Apply stack tip downwash to point sources? (0 = no, 1 = yes)	1
MRISE	Plume rise module for point sources (1 = Briggs, 2 = numerical)	1
MTIP_FL	Apply stack tip downwash to flare sources? (0 = no, 1 = yes)	0
MRISE_FL	Plume rise module for flare sources (1 = Briggs, 2 = numerical)	2
MBDW	Building downwash method (1 = ISC, 2 = PRIME)	1
MSHEAR	Treat vertical wind shear? (0 = no, 1 = yes)	0
MSPLIT	Puff splitting allowed? (0 = no, 1 = yes)	0
MCHEM	Chemical transformation method (0 = not modeled, 1 = MESOPUFF II, 2 = User-specified, 3 = RIVAD/ARM3, 4 = MESOPUFF II for OH, 5 = half-life, 6 = RIVAD w/ISORROPIA, 7 = RIVAD w/ISORROPIA CalTech SOA)	0
MAQCHEM	Model aqueous phase transformation? (0 = no, 1 = yes)	0
MLWC	Liquid water content flag	1
MWET	Model wet removal? (0 = no, 1 = yes)	1
MDRY	Model dry deposition? (0 = no, 1 = yes)	1
MTILT	Model gravitational settling (plume tilt)? (0 = no, 1 = yes)	0
MDISP	Dispersion coefficient calculation method (1= PROFILE.DAT, 2 = Internally, 3 = PG/MP, 4 = MESOPUFF II, 5 = CTDM)	3
MTURBVW	Turbulence characterization method (only if MDISP = 1 or 5)	3
MDISP2	Missing dispersion coefficients method (only if MDISP = 1 or 5)	3
MTAULY	Sigma-y Lagrangian timescale method	0
MTAUADV	Advective-decay timescale for turbulence (seconds)	0
MCTURB	Turbulence method (1 = CALPUFF, 2 = AERMOD)	1
MROUGH	PG sigma-y and sigma-z surface roughness adjustment? (0 = no, 1 = yes)	0
MPARTL	Model partial plume penetration for point sources? (0 = no, 1 = yes)	1

INPUT GROUP: 2 -- Technical Options		
Parameter	**Description**	**Value**
MPARTLBA	Model partial plume penetration for buoyant area sources? (0 = no, 1 = yes)	0
MTINV	Strength of temperature inversion provided in PROFILE.DAT? (0 = no - compute from default gradients, 1 = yes)	0
MPDF	PDF used for dispersion under convective conditions? (0 = no, 1 = yes)	0
MSGTIBL	Sub-grid TIBL module for shoreline? (0 = no, 1 = yes)	0
MBCON	Boundary conditions modeled? (0 = no, 1 = use BCON.DAT, 2 = use CONC.DAT)	0
MSOURCE	Save individual source contributions? (0 = no, 1 = yes)	0
MFOG	Enable FOG model output? (0 = no, 1 = yes - PLUME mode, 2 = yes - RECEPTOR mode)	0
MREG	Regulatory checks (0 = no checks, 1 = USE PA LRT checks)	0

INPUT GROUP: 3 -- Species List		
Parameter	**Description**	**Value**
CSPEC	Species included in model run	PM10
CSPEC	Species included in model run	PM2.5
CSPEC	Species included in model run	NO2

INPUT GROUP: 4 -- Map Projection and Grid Control Parameters		
Parameter	**Description**	**Value**
PMAP	Map projection system	UTM
FEAST	False easting at projection origin (km)	0.0
FNORTH	False northing at projection origin (km)	0.0
IUTMZN	UTM zone (1 to 60)	60
UTMHEM	Hemisphere (N = northern, S = southern)	S
RLAT0	Latitude of projection origin (decimal degrees)	0.00N
RLON0	Longitude of projection origin (decimal degrees)	0.00E
XLAT1	1st standard parallel latitude (decimal degrees)	30S
XLAT2	2nd standard parallel latitude (decimal degrees)	60S
DATUM	Datum-region for the coordinates	WGS-84
NX	Meteorological grid - number of X grid cells	100
NY	Meteorological grid - number of Y grid cells	120
NZ	Meteorological grid - number of vertical layers	11
DGRIDKM	Meteorological grid spacing (km)	0.25
ZFACE	Meteorological grid - vertical cell face heights (m)	0.0, 20.0, 32.0, 40.0, 80.0, 160.0, 320.0, 640.0, 1200.0, 2000.0, 3000.0, 4000.0
XORIGKM	Meteorological grid - X coordinate for SW corner (km)	338.1930
YORIGKM	Meteorological grid - Y coordinate for SW corner (km)	5478.9920

INPUT GROUP: 4 -- Map Projection and Grid Control Parameters		
Parameter	**Description**	**Value**
IBCOMP	Computational grid - X index of lower left corner	1
JBCOMP	Computational grid - Y index of lower left corner	1
IECOMP	Computational grid - X index of upper right corner	100
JECOMP	Computational grid - Y index of upper right corner	120
LSAMP	Use sampling grid (gridded receptors) (T = true, F = false)	T
IBSAMP	Sampling grid - X index of lower left corner	54
JBSAMP	Sampling grid - Y index of lower left corner	70
IESAMP	Sampling grid - X index of upper right corner	70
JESAMP	Sampling grid - Y index of upper right corner	85
MESHDN	Sampling grid - nesting factor	3

INPUT GROUP: 5 -- Output Options		
Parameter	**Description**	**Value**
ICON	Output concentrations to CONC.DAT? (0 = no, 1 = yes)	1
IDRY	Output dry deposition fluxes to DFLX.DAT? (0 = no, 1 = yes)	1
IWET	Output wet deposition fluxes to WFLX.DAT? (0 = no, 1 = yes)	1
IT2D	Output 2D temperature data? (0 = no, 1 = yes)	0
IRHO	Output 2D density data? (0 = no, 1 = yes)	0
IVIS	Output relative humidity data? (0 = no, 1 = yes)	0
LCOMPRS	Use data compression in output file (T = true, F = false)	T
IQAPLOT	Create QA output files suitable for plotting? (0 = no, 1 = yes)	1
IPFTRAK	Output puff tracking data? (0 = no, 1 = yes use timestep, 2 = yes use sampling step)	0
IMFLX	Output mass flux across specific boundaries? (0 = no, 1 = yes)	0
IMBAL	Output mass balance for each species? (0 = no, 1 = yes)	0
INRISE	Output plume rise data? (0 = no, 1 = yes)	0
ICPRT	Print concentrations? (0 = no, 1 = yes)	0
IDPRT	Print dry deposition fluxes? (0 = no, 1 = yes)	0
IWPRT	Print wet deposition fluxes? (0 = no, 1 = yes)	0
ICFRQ	Concentration print interval (timesteps)	1
IDFRQ	Dry deposition flux print interval (timesteps)	1
IWFRQ	Wet deposition flux print interval (timesteps)	1
IPRTU	Units for line printer output (e.g., 3 = ug/m**3 - ug/m**2/s, 5 = odor units)	3
IMESG	Message tracking run progress on screen (0 = no, 1 and 2 = yes)	2
LDEBUG	Enable debug output? (0 = no, 1 = yes)	F
IPFDEB	First puff to track in debug output	1
NPFDEB	Number of puffs to track in debug output	1000
NN1	Starting meteorological period in debug output	1
NN2	Ending meteorological period in debug output	10

INPUT GROUP: 6 -- Subgrid Scale Complex Terrain Inputs		
Parameter	**Description**	**Value**
NHILL	Number of terrain features	0
NCTREC	Number of special complex terrain receptors	0
MHILL	Terrain and CTSG receptor data format (1= CTDM, 2 = OPTHILL)	2
XHILL2M	Horizontal dimension conversion factor to meters	1.0
ZHILL2M	Vertical dimension conversion factor to meters	1.0
XCTDMKM	X origin of CTDM system relative to CALPUFF system (km)	0.0
YCTDMKM	Y origin of CTDM system relative to CALPUFF system (km)	0.0

INPUT GROUP: 9 -- Miscellaneous Dry Deposition Parameters		
Parameter	**Description**	**Value**
RCUTR	Reference cuticle resistance (s/cm)	30
RGR	Reference ground resistance (s/cm)	10
REACTR	Reference pollutant reactivity	8
NINT	Number of particle size intervals for effective particle deposition velocity	9
IVEG	Vegetation state in unirrigated areas (1 = active and unstressed, 2 = active and stressed, 3 = inactive)	1

INPUT GROUP: 11 -- Chemistry Parameters		
Parameter	**Description**	**Value**
MOZ	Ozone background input option (0 = monthly, 1 = hourly from OZONE.DAT)	1
BCKO3	Monthly ozone concentrations (ppb)	80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00
MNH3	Ammonia background input option (0 = monthly, 1 = from NH3Z.DAT)	0
MAVGNH3	Ammonia vertical averaging option (0 = no average, 1 = average over vertical extent of puff)	1
BCKNH3	Monthly ammonia concentrations (ppb)	10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00
RNITE1	Nighttime SO2 loss rate (%/hr)	0.2
RNITE2	Nighttime NOx loss rate (%/hr)	2
RNITE3	Nighttime HNO3 loss rate (%/hr)	2
MH2O2	H2O2 background input option (0 = monthly, 1 = hourly from H2O2.DAT)	1
BCKH2O2	Monthly H2O2 concentrations (ppb)	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00
RH_ISRP	Minimum relative humidity for ISORROPIA	50.0
SO4_ISRP	Minimum SO4 for ISORROPIA	0.4
BCKPMF	SOA background fine particulate (ug/m**3)	1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00

INPUT GROUP: 11 -- Chemistry Parameters		
Parameter	**Description**	**Value**
OFRAC	SOA organic fine particulate fraction	0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15
VCNX	SOA VOC/NOX ratio	50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00
NDECAY	Half-life decay blocks	0

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters		
Parameter	**Description**	**Value**
SYTDEP	Horizontal puff size for time-dependent sigma equations (m)	550
MHFTSZ	Use Heffter equation for sigma-z? (0 = no, 1 = yes)	0
JSUP	PG stability class above mixed layer	5
CONK1	Vertical dispersion constant - stable conditions	0.01
CONK2	Vertical dispersion constant - neutral/unstable conditions	0.1
TBD	Downwash scheme transition point option (<0 = Huber-Snyder, 1.5 = Schulman-Scire, 0.5 = ISC)	0.5
IURB1	Beginning land use category for which urban dispersion is assumed	10
IURB2	Ending land use category for which urban dispersion is assumed	19
ILANDUIN	Land use category for modeling domain	20
Z0IN	Roughness length for modeling domain (m)	.25
XLAIIN	Leaf area index for modeling domain	3.0
ELEVIN	Elevation above sea level (m)	.0
XLATIN	Meteorological station latitude (deg)	-999.0
XLONIN	Meteorological station longitude (deg)	-999.0
ANEMHT	Anemometer height (m)	10.0
ISIGMAV	Lateral turbulence format (0 = read sigma-theta, 1 = read sigma-v)	1
IMIXCTDM	Mixing heights read option (0 = predicted, 1 = observed)	0
XMXLEN	Slug length (met grid units)	1
XSAMLEN	Maximum travel distance of a puff/slug (met grid units)	1
MXNEW	Maximum number of slugs/puffs release from one source during one time step	99
MXSAM	Maximum number of sampling steps for one puff/slug during one time step	99
NCOUNT	Number of iterations used when computing the transport wind for a sampling step that includes gradual rise	2
SYMIN	Minimum sigma-y for a new puff/slug (m)	1
SZMIN	Minimum sigma-z for a new puff/slug (m)	1
SZCAP_M	Maximum sigma-z allowed to avoid numerical problem in calculating virtual time or distance (m)	5000000
SVMIN	Minimum turbulence velocities sigma-v (m/s)	0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.37, 0.37, 0.37, 0.37, 0.37, 0.37

INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters		
Parameter	**Description**	**Value**
SWMIN	Minimum turbulence velocities sigma-w (m/s)	0.2, 0.12, 0.08, 0.06, 0.03, 0.016, 0.2, 0.12, 0.08, 0.06, 0.03, 0.016
CDIV	Divergence criterion for dw/dz across puff (1/s)	0, 0
NLUTIBL	TIBL module search radius (met grid cells)	4
WSCALM	Minimum wind speed allowed for non-calm conditions (m/s)	0.5
XMAXZI	Maximum mixing height (m)	3000
XMINZI	Minimum mixing height (m)	50
TKCAT	Emissions scale-factors temperature categories (K)	265., 270., 275., 280., 285., 290., 295., 300., 305., 310., 315.
PLX0	Wind speed profile exponent for stability classes 1 to 6	0.07, 0.07, 0.1, 0.15, 0.35, 0.55
PTG0	Potential temperature gradient for stable classes E and F (deg K/m)	0.02, 0.035
PPC	Plume path coefficient for stability classes 1 to 6	0.5, 0.5, 0.5, 0.5, 0.35, 0.35
SL2PF	Slug-to-puff transition criterion factor (sigma-y/slug length)	10
FCLIP	Hard-clipping factor for slugs (0.0 = no extrapolation)	0
NSPLIT	Number of puffs created from vertical splitting	3
IRESPLIT	Hour for puff re-split	0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0
ZISPLIT	Minimum mixing height for splitting (m)	100
ROLDMAX	Mixing height ratio for splitting	0.25
NSPLITH	Number of puffs created from horizontal splitting	5
SYSPLITH	Minimum sigma-y (met grid cells)	1
SHSPLITH	Minimum puff elongation rate (SYSPLITH/hr)	2
CNSPLITH	Minimum concentration (g/m**3)	0
EPSSLUG	Fractional convergence criterion for numerical SLUG sampling integration	0.0001
EPSAREA	Fractional convergence criterion for numerical AREA source integration	1E-006
DSRISE	Trajectory step-length for numerical rise integration (m)	1.0
HTMINBC	Minimum boundary condition puff height (m)	500
RSAMPBC	Receptor search radius for boundary condition puffs (km)	10
MDEPBC	Near-surface depletion adjustment to concentration (0 = no, 1 = yes)	1

INPUT GROUP: 13 -- Point Source Parameters		
Parameter	**Description**	**Value**
NPT1	Number of point sources	0
IPTU	Units used for point source emissions (e.g., 1 = g/s)	1
NSPT1	Number of source-species combinations with variable emission scaling factors	0

INPUT GROUP: 13 -- Point Source Parameters		
Parameter	**Description**	**Value**
NPT2	Number of point sources in PTEMARB.DAT file(s)	0

INPUT GROUP: 14 -- Area Source Parameters		
Parameter	**Description**	**Value**
NAR1	Number of polygon area sources	0
IARU	Units used for area source emissions (e.g., 1 = g/m**2/s)	1
NSAR1	Number of source-species combinations with variable emission scaling factors	0
NAR2	Number of buoyant polygon area sources in BAEMARB.DAT file(s)	0

INPUT GROUP: 15 -- Line Source Parameters		
Parameter	**Description**	**Value**
NLN2	Number of buoyant line sources in LNEMARB.DAT file	0
NLINES	Number of buoyant line sources	0
ILNU	Units used for line source emissions (e.g., 1 = g/s)	1
NSLN1	Number of source-species combinations with variable emission scaling factors	0
NLRISE	Number of distances at which transitional rise is computed	6

INPUT GROUP: 16 -- Volume Source Parameters		
Parameter	**Description**	**Value**
NVL1	Number of volume sources	0
IVLU	Units used for volume source emissions (e.g., 1 = g/s)	1
NSVL1	Number of source-species combinations with variable emission scaling factors	0
NVL2	Number of volume sources in VOLEMARB.DAT file(s)	0

INPUT GROUP: 17 -- FLARE Source Control Parameters (variable emissions file)		
Parameter	**Description**	**Value**
NFL2	Number of flare sources defined in FLEMARB.DAT file(s)	0

INPUT GROUP: 18 -- Road Emissions Parameters		
Parameter	**Description**	**Value**
NRD1	Number of road-links sources	2
NRD2	Number of road-links in RDEMARB.DAT file	0
NSFRDS	Number of road-links and species combinations with variable emission-rate scale-factors	6

INPUT GROUP: 19 -- Emission Rate Scale-Factor Tables		
Parameter	**Description**	**Value**
NSFTAB	Number of emission scale-factor tables	1

INPUT GROUP: 20 -- Non-gridded (Discrete) Receptor Information		
Parameter	**Description**	**Value**
NREC	Number of discrete receptors (non-gridded receptors)	44
NRGRP	Number of receptor group names	0

APPENDIX C.6 – ROAD LINKS

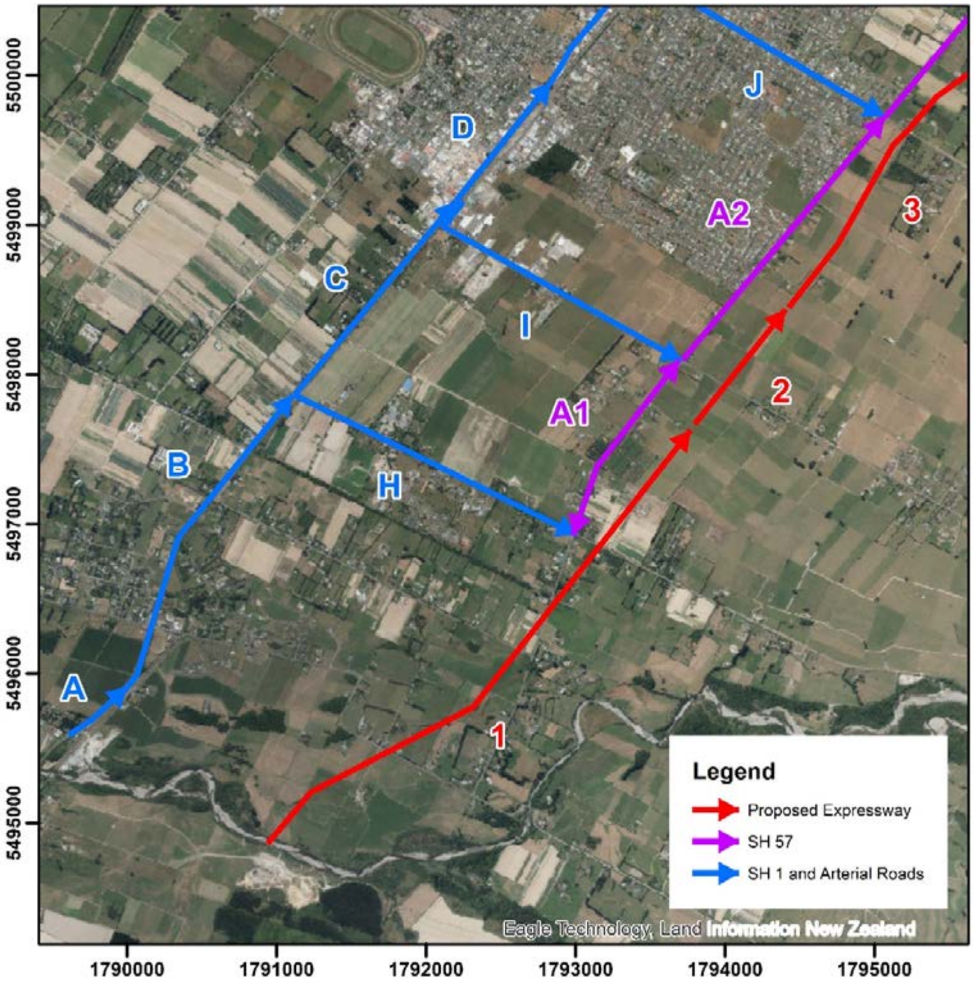

Figure C.6.1: Traffic Links Modelled (Approximate Chainage 22,600 to 16,200)

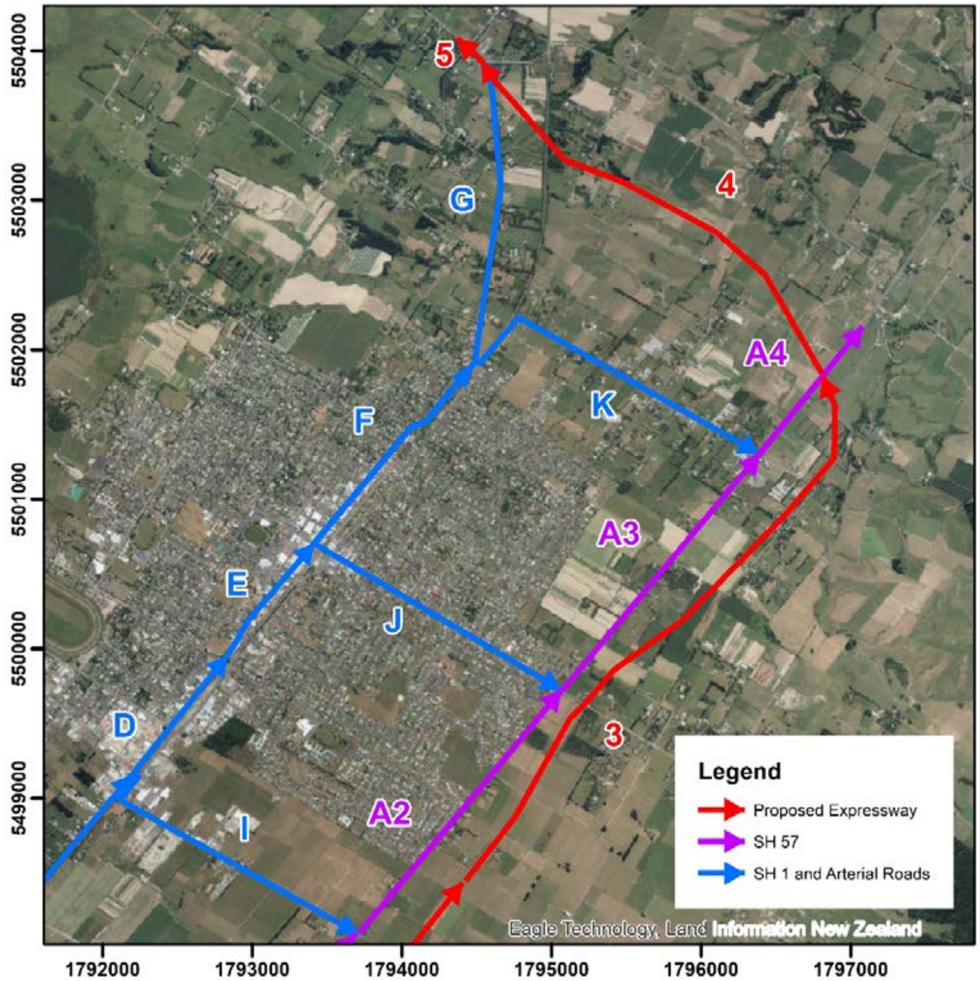

Figure C.6.2: Traffic Links Modelled (Approximate Chainage 19,600 to 10,000)

APPENDIX C.7 – TRAFFIC DATA

Table C.7.1: Traffic Data

Traffic Link	AADT (Vehicles / day)				
	2018	2029		2039	
	Base Year	Without Project	With Project	Without Project	With Project
A	18,100	25,100	6,000	32,200	8,100
B	19,650	27,033	8,417	33,433	11,167
C	15,500	20,150	8,600	26,350	11,300
D	19,625	22,550	22,240	24,175	23,280
E	15,017	19,650	14,433	22,367	16,567
F	12,906	18,044	12,322	22,656	15,106
G	11,100	15,860	10,020	20,240	12,020
H	6,000	9,900	2,800	10,700	4,300
I	3,500	13,200	14,900	21,200	19,000
J	10,267	17,011	13,256	21,411	17,600
K	1,567	3,333	2,600	5,900	4,500
A1	6,000	10,100	2,200	12,100	3,600
A2	7,300	11,625	8,013	17,825	13,200
A3	9,800	14,200	6,300	18,700	8,600
A4	10,400	13,900	9,500	18,300	13,167
1	N/A	N/A	21,600	N/A	29,200
2	N/A	N/A	13,600	N/A	18,300
3	N/A	N/A	16,800	N/A	24,300
4	N/A	N/A	11,200	N/A	16,300
5	N/A	N/A	15,200	N/A	20,500

APPENDIX C.8 – VEPM EMISSION FACTORS

Table C.8.1: Base Year 2018 Link Information and Emission Factors

Link ID	AADT	Vehicle Type	Vehicle Speed km/hr (HV if different)	Emission Factors (g/km)		
		% HV		NO_2	$PM_{2.5}$	PM_{10}
A	18,100	13	94 (86)	0.14	0.04	0.01
B	19,650	12	80	0.12	0.04	0.02
			94 (86)	0.13	0.04	0.01
C	15,500	11	80	0.12	0.04	0.02
D	19,625	8	50	0.12	0.03	0.03
E	15,017	9	22	0.19	0.06	0.03
F	12,906	11	50	0.13	0.04	0.03
G	11,100	13	94 (86)	0.14	0.04	0.01
H	6,000	12	65	0.13	0.04	0.02
I	3,500	9	65	0.11	0.03	0.02
J	10,267	3	50	0.10	0.02	0.02
K	1,567	4	65	0.10	0.02	0.02
A1	6,000	12	65	0.13	0.04	0.02
A2	7,300	12	94 (86)	0.13	0.04	0.01
A3	9,800	11	94 (86)	0.13	0.04	0.01
A4	10,400	10	94 (86)	0.13	0.04	0.01

Table C.8.2: 2009 Without Project Link Information and Emission Factors

Link ID	AADT	Vehicle Type	Vehicle Speed (km/hr)	Emission Factors (g/km)		
		% HV		NO_2	$PM_{2.5}$	PM_{10}
A	25,100	13	80	0.11	0.02	0.02
B	27,033	12	80	0.11	0.02	0.02
C	20,150	11	80	0.11	0.02	0.02
D	22,550	9	50	0.11	0.01	0.03
E	19,650	10	22	0.18	0.03	0.03
F	18,044	11	50	0.12	0.02	0.03
			65	0.11	0.02	0.02

Table C.8.2: 2009 Without Project Link Information and Emission Factors						
Link ID	AADT	Vehicle Type	Vehicle Speed (km/hr)	Emission Factors (g/km)		
		% HV		NO_2	$PM_{2.5}$	PM_{10}
G	15,860	13	94 (86)	0.12	0.02	0.01
H	9,900	11	65	0.11	0.02	0.02
I	13,200	7	65	0.10	0.01	0.02
J	17,011	4	50	0.10	0.01	0.02
K	3,333	5	65	0.10	0.01	0.02
A1	10,100	11	65	0.11	0.02	0.02
		10	80	0.11	0.02	0.02
A2	11,625	10	65	0.11	0.01	0.02
A3	14,200	11	80	0.11	0.01	0.02
A4	13,900	11	80	0.11	0.02	0.02

Table C.8.3: 2009 With Project Link Information and Emission Factors						
Link ID	AADT	Vehicle Type	Vehicle Speed (km/hr)	Emission Factors (g/km)		
		% HV		NO_2	$PM_{2.5}$	PM_{10}
A	6,000	11	80	0.11	0.02	0.02
B	8,417	8	80	0.10	0.01	0.01
C	8,600	5	80	0.10	0.01	0.01
D	22,240	6	50	0.10	0.01	0.02
E	14,433	8	22	0.16	0.02	0.03
F	12,322	10	50	0.12	0.02	0.03
		13	65	0.11	0.01	0.02
G	10,020	13	94 (86)	0.12	0.02	0.01
H	2,800	9	65	0.11	0.02	0.02
I	14,900	4	65	0.10	0.01	0.02
J	13,256	6	50	0.10	0.01	0.02
K	2,600	11	65	0.10	0.01	0.02
A1	2,200	17	65	0.12	0.02	0.02
			80	0.11	0.02	0.02
A2	8,013	7	65	0.10	0.01	0.02

Table C.8.3: 2009 With Project Link Information and Emission Factors						
Link ID	AADT	Vehicle Type	Vehicle Speed (km/hr)	Emission Factors (g/km)		
		% HV		NO_2	$PM_{2.5}$	PM_{10}
A3	6,300	6	80	0.10	0.01	0.01
A4	9,500	11	80	0.11	0.02	0.02
1	21,600	14	94 (86)	0.12	0.02	0.01
2	13,600	10	94 (86)	0.12	0.02	0.01
3	16,800	11	94 (86)	0.12	0.02	0.01
4	11,200	10	94 (86)	0.12	0.02	0.01
5	15,200	13	94 (86)	0.12	0.02	0.01

Table C.8.4: 2039 Without Project Link Information and Emission Factors						
Link ID	AADT	Vehicle Type	Vehicle Speed (km/hr)	Emission Factors (g/km)		
		% HV		NO_2	$PM_{2.5}$	PM_{10}
A	32,200	14	80	0.05	0.01	0.02
B	33,433	13	80	0.05	0.01	0.02
C	26,350	12	80	0.05	0.01	0.02
D	24,175	10	50	0.05	0.01	0.03
E	22,367	11	22	0.08	0.01	0.03
F	22,656	12	50	0.05	0.01	0.03
			65	0.05	0.01	0.02
G	20,240	13	94 (86)	0.06	0.01	0.01
H	10,700	13	65	0.05	0.01	0.02
I	21,200	7	65	0.05	0.00	0.02
J	21,411	4	50	0.05	0.00	0.02
K	5,900	5	65	0.05	0.00	0.02
A1	12,100	12	65	0.05	0.01	0.02
			80	0.05	0.01	0.02
A2	17,825	10	65	0.05	0.00	0.02
A3	18,700	11	80	0.05	0.01	0.02
A4	18,300	11	80	0.05	0.01	0.02

Table C.8.5: 2019 With Project Link Information and Emission Factors

Link ID	AADT	Vehicle Type	Vehicle Speed (km/hr)	Emission Factors (g/km)		
		% HV		NO_2	$PM_{2.5}$	PM_{10}
A	8,100	11	80	0.05	0.01	0.02
B	11,167	8	80	0.05	0.00	0.01
C	11,300	5	80	0.05	0.00	0.01
D	23,280	6	50	0.05	0.00	0.02
E	16,567	8	22	0.07	0.01	0.03
F	15,106	10	50	0.05	0.01	0.03
			65	0.05	0.00	0.02
G	12,020	12	94 (86)	0.06	0.01	0.01
H	4,300	11	65	0.05	0.01	0.02
I	19,000	10	65	0.05	0.00	0.02
J	17,600	4	50	0.05	0.00	0.02
K	4,500	5	65	0.05	0.00	0.02
A1	3,600	13	65	0.05	0.01	0.02
			80	0.05	0.01	0.02
A2	13,200	6	65	0.05	0.00	0.02
A3	8,600	6	80	0.05	0.00	0.01
A4	13,167	12	80	0.05	0.01	0.02
1	29,200	14	94 (86)	0.06	0.01	0.01
2	18,300	10	94 (86)	0.06	0.01	0.01
3	24,300	12	94 (86)	0.06	0.01	0.01
4	16,300	10	94 (86)	0.06	0.01	0.01
5	20,500	13	94 (86)	0.06	0.01	0.01

APPENDIX C.9 – STAGE 3 ASSESSMENT PREDICTED CONCENTRATIONS

Table C.9.1: Predicted 99.9%ile 1-hour NO_2 (Excluding Background)							
Receptor	Base Year 2018 (µg/m³)	Without Project (µg/m³)		With Project (µg/m³)		Significance of Change (+ve, NC, -ve)[77]	
		2029	2039	2029	2039	2029	2039
R17	35.4	39.3	23.0	9.5	5.9	+ve	NC
R18	23.3	26.1	15.3	6.7	4.1	NC	NC
R19	17.4	20.9	11.9	6.2	3.8	NC	NC
R20	36.4	43.7	24.8	13.3	8.3	+ve	NC
R21	41.4	50.6	28.8	15.5	9.8	+ve	NC
R22	14.4	20.1	10.2	6.7	4.5	NC	NC
R23	0.8	0.9	0.5	15.3	9.5	NC	NC
R24	0.6	0.7	0.4	12.1	7.5	NC	NC
R25	0.8	1.1	0.6	16.5	10.2	NC	NC
R26	7.7	10.8	5.6	24.9	15.5	NC	NC
R27	36.8	43.5	25.9	20.0	12.3	+ve	NC
R28	7.7	21.4	15.8	24.1	14.3	NC	NC
R29	4.4	6.5	3.6	7.5	4.8	NC	NC
R30	11.1	16.2	10.6	13.9	8.9	NC	NC
R31	1.2	2.2	1.5	3.6	2.3	NC	NC
R32	14.0	17.6	12.3	13.9	9.9	NC	NC
R33	11.3	14.0	7.6	9.5	5.2	NC	NC
R34	59.4	73.4	39.6	49.2	25.7	+ve	NC
R35	19.6	24.0	12.6	16.1	8.7	NC	NC
R36	58.4	71.8	38.2	48.0	25.7	+ve	NC
R37	19.6	26.1	14.2	16.1	9.5	NC	NC
R38	30.2	38.1	20.1	25.2	14.5	NC	NC
R39	28.3	35.1	20.2	23.4	13.4	NC	NC
R40	33.1	40.9	23.5	27.2	15.7	NC	NC
R41	15.0	18.7	13.1	19.4	14.0	NC	NC
R42	1.6	2.2	1.4	8.1	4.6	NC	NC
R43	1.9	2.7	1.7	6.0	3.9	NC	NC

[77] The 'significance of change' criteria is explained in the Assessment Criteria.

Table C.9.1: Predicted 99.9%ile 1-hour NO_2 (Excluding Background)							
Receptor	Base Year 2018 (µg/m³)	Without Project (µg/m³)		With Project (µg/m³)		Significance of Change (+ve, NC, -ve)[77]	
		2029	2039	2029	2039	2029	2039
R44	4.1	6.5	3.9	4.4	3.8	NC	NC
R45	6.0	9.4	5.6	6.2	5.3	NC	NC
R46	10.0	13.8	8.8	12.3	9.4	NC	NC
R47	25.2	31.1	20.2	26.1	18.4	NC	NC
R48	3.0	4.4	2.7	8.6	5.7	NC	NC
R49	24.2	29.8	19.1	20.9	14.6	NC	NC
R50	34.4	37.6	22.2	26.4	14.9	NC	NC
R51	24.3	31.4	19.9	20.1	11.2	NC	NC
R52	17.6	22.5	14.1	17.1	10.6	NC	NC
R53	6.1	7.8	4.9	19.9	12.4	NC	NC
R54	1.8	2.3	1.4	8.5	5.7	NC	NC
R55	18.2	20.8	13.4	14.5	9.8	NC	NC
R56	3.6	3.6	2.7	17.6	12.0	NC	NC
R57	15.1	18.1	11.8	11.3	7.8	NC	NC
R58	2.4	2.9	1.8	12.6	8.5	NC	NC
R59	5.0	7.9	5.7	7.3	5.3	NC	NC

Table C.9.2: Predicted 24-hour NO_2 (Excluding Background)							
Receptor	Base Year 2018 (µg/m³)	Without Project (µg/m³)		With Project (µg/m³)		Significance of Change (+ve, NC, -ve)[78]	
		2029	2039	2029	2039	2029	2039
R17	11.4	12.7	7.4	3	1.9	+ve	+ve
R18	6.4	7.2	4.2	1.8	1.1	+ve	NC
R19	4.4	5.2	3.0	1.6	1.0	NC	NC
R20	9.3	11	6.3	3.5	2.2	+ve	NC
R21	9.5	11.5	6.5	3.7	2.3	+ve	NC
R22	4.4	5.0	3.1	2.0	1.4	NC	NC

[78] The ‘significance of change’ criteria is explained in the Assessment Criteria section.

Table C.9.2: Predicted 24-hour NO_2 (Excluding Background)							
Receptor	Base Year 2018 (µg/m³)	Without Project (µg/m³)		With Project (µg/m³)		Significance of Change (+ve, NC, -ve)[78]	
		2029	2039	2029	2039	2029	2039
R23	0.3	0.3	0.2	2.6	1.6	NC	NC
R24	0.2	0.3	0.2	3.3	2.0	NC	NC
R25	0.3	0.4	0.2	4.6	2.9	NC	NC
R26	2.5	3.5	1.8	7.5	4.7	NC	NC
R27	7.5	8.7	5.3	4.0	2.5	NC	NC
R28	1.9	5.7	4.2	6.7	4.0	NC	NC
R29	1.4	2.1	1.3	2.4	1.6	NC	NC
R30	2.7	3.8	2.7	4.2	2.8	NC	NC
R31	0.4	0.7	0.5	1.2	0.8	NC	NC
R32	3.2	4.0	2.8	4.0	2.8	NC	NC
R33	2.1	2.6	1.4	1.8	1.1	NC	NC
R34	11.6	14.3	7.5	9.6	5.1	NC	NC
R35	3.5	4.3	2.3	2.9	1.7	NC	NC
R36	11.7	14.4	7.6	9.7	5.1	NC	NC
R37	3.8	5	2.8	3.3	2.1	NC	NC
R38	6.8	8.6	4.6	5.7	3.3	NC	NC
R39	7.5	9.3	5.4	6.2	3.6	NC	NC
R40	9.6	11.8	6.8	7.9	4.5	NC	NC
R41	3.7	4.7	3.2	5.1	3.7	NC	NC
R42	0.5	0.7	0.5	2.2	1.5	NC	NC
R43	0.6	0.9	0.5	1.5	1.0	NC	NC
R44	1.3	2.0	1.2	1.4	1.1	NC	NC
R45	1.9	2.9	1.8	1.9	1.6	NC	NC
R46	3.2	4.5	2.8	3.9	3.0	NC	NC
R47	6.1	7.4	4.6	6.5	4.5	NC	NC
R48	0.9	1.3	0.8	2.8	1.9	NC	NC
R49	6.1	7.5	5.0	5.5	3.8	NC	NC
R50	8.4	9.3	5.3	6.4	3.6	NC	NC
R51	4.3	5.6	3.5	3.7	2.1	NC	NC

Table C.9.2: Predicted 24-hour NO_2 (Excluding Background)							
Receptor	Base Year 2018 (µg/m³)	Without Project (µg/m³)		With Project (µg/m³)		Significance of Change (+ve, NC, -ve)[78]	
		2029	2039	2029	2039	2029	2039
R52	5.4	6.9	4.3	6.9	4.0	NC	NC
R53	1.3	1.6	1	6	3.8	NC	NC
R54	0.5	0.7	0.4	1.9	1.3	NC	NC
R55	4.6	5.5	3.4	3.7	2.5	NC	NC
R56	1	1.2	0.7	4.4	3.0	NC	NC
R57	4.3	5.4	3.5	4	2.7	NC	NC
R58	0.8	0.9	0.6	3.5	2.4	NC	NC
R59	1.5	2.3	1.7	2.1	1.5	NC	NC

Table C.9.3: Predicted 24-hour PM_{10} (Excluding Background) Concentrations							
Receptor	Base Year 2018 (µg/m³)	Without Project (µg/m³)		With Project (µg/m³)		Significance of Change (+ve, NC, -ve)[79]	
		2029	2039	2029	2039	2029	2039
R17	1.1	2	2.6	0.5	0.6	NC	NC
R18	0.7	1.1	1.5	0.3	0.4	NC	NC
R19	0.6	0.9	1.1	0.3	0.3	NC	NC
R20	1.1	1.8	2.2	0.5	0.7	NC	NC
R21	1.3	1.8	2.3	0.6	0.7	NC	NC
R22	0.8	1.2	1.4	0.4	0.6	NC	NC
R23	0.04	0.07	0.08	0.3	0.4	NC	NC
R24	0.04	0.06	0.07	0.4	0.5	NC	NC
R25	0.07	0.1	0.1	0.5	0.7	NC	NC
R26	0.5	0.7	0.8	0.9	1.2	NC	NC
R27	1	1.4	1.8	0.7	0.9	NC	NC
R28	0.4	1.2	1.9	1.4	1.8	NC	NC
R29	0.3	0.4	0.5	0.4	0.5	NC	NC
R30	0.4	0.8	1.2	0.7	1.1	NC	NC

[79] The ‘significance of change’ criteria is explained in the Assessment Criteria section.

Table C.9.3: Predicted 24-hour PM_{10} (Excluding Background) Concentrations							
Receptor	Base Year 2018 (μg/m³)	Without Project (μg/m³)		With Project (μg/m³)		Significance of Change (+ve, NC, -ve)[79]	
		2029	2039	2029	2039	2029	2039
R31	0.07	0.1	0.2	0.2	0.3	NC	NC
R32	0.3	0.8	1.2	0.7	1.0	NC	NC
R33	0.5	0.7	0.8	0.5	0.6	NC	NC
R34	1.8	2.5	2.9	1.8	2.0	NC	NC
R35	0.7	1	1.2	0.7	0.9	NC	NC
R36	2	2.6	3	1.9	2.1	NC	NC
R37	0.8	1.2	1.4	0.9	1.1	NC	NC
R38	1.2	1.7	2	1.2	1.5	NC	NC
R39	1.6	2.2	2.8	1.5	1.9	NC	NC
R40	2	2.8	3.5	1.9	2.3	NC	NC
R41	0.4	1.1	1.6	0.9	1.4	NC	NC
R42	0.1	0.2	0.3	0.3	0.5	NC	NC
R43	0.1	0.2	0.3	0.3	0.4	NC	NC
R44	0.3	0.5	0.6	0.4	0.5	NC	NC
R45	0.4	0.8	1	0.6	0.8	NC	NC
R46	0.6	1.1	1.4	0.9	1.3	NC	NC
R47	0.7	1.3	1.8	1	1.5	NC	NC
R48	0.2	0.3	0.4	0.4	0.6	NC	NC
R49	0.6	1.5	2.1	0.9	1.4	NC	NC
R50	1.7	1.9	2.4	1.3	1.6	NC	NC
R51	0.4	0.6	0.8	0.4	0.5	NC	NC
R52	0.5	0.8	0.9	0.8	0.9	NC	NC
R53	0.1	0.2	0.2	0.6	0.8	NC	NC
R54	0.06	0.09	0.1	0.2	0.3	NC	NC
R55	0.5	0.9	0.9	0.5	0.7	NC	NC
R56	0.1	0.2	0.3	0.5	0.8	NC	NC
R57	0.5	0.9	1.2	0.6	0.8	NC	NC
R58	0.1	0.2	0.3	0.4	0.6	NC	NC

Table C.9.3: Predicted 24-hour PM_{10} (Excluding Background) Concentrations							
Receptor	**Base Year 2018 (µg/m³)**	**Without Project (µg/m³)**		**With Project (µg/m³)**		**Significance of Change (+ve, NC, -ve)[79]**	
		2029	**2039**	**2029**	**2039**	**2029**	**2039**
R59	0.2	0.4	0.7	0.4	0.6	NC	NC

Table C.9.4: Predicted 24-hour $PM_{2.5}$ (Excluding Background) Concentrations							
Receptor	**Base Year 2018 (µg/m³)**	**Without Project (µg/m³)**		**With Project (µg/m³)**		**Significance of Change (+ve, NC, -ve)[80]**	
		2029	**2039**	**2029**	**2039**	**2029**	**2039**
R17	3.8	2	0.9	0.5	0.2	+ve	NC
R18	2.1	1.2	0.5	0.3	0.1	NC	NC
R19	1.5	0.9	0.4	0.2	0.1	NC	NC
R20	3.1	1.7	0.8	0.5	0.2	+ve	NC
R21	3	1.8	0.8	0.5	0.2	+ve	NC
R22	1.3	0.9	0.4	0.3	0.2	NC	NC
R23	0.1	0.06	0.03	0.4	0.2	NC	NC
R24	0.1	0.06	0.02	0.6	0.3	NC	NC
R25	0.1	0.08	0.03	0.8	0.4	NC	NC
R26	0.8	0.5	0.2	1.3	0.6	NC	NC
R27	2.3	1.3	0.6	0.5	0.2	NC	NC
R28	0.6	0.7	0.4	0.9	0.4	NC	NC
R29	0.5	0.3	0.2	0.4	0.2	NC	NC
R30	0.9	0.5	0.3	0.6	0.3	NC	NC
R31	0.1	0.09	0.05	0.2	0.1	NC	NC
R32	1.1	0.6	0.3	0.6	0.3	NC	NC
R33	0.8	0.5	0.2	0.3	0.1	NC	NC
R34	3.5	2.1	0.9	1.3	0.5	NC	NC
R35	1.2	0.7	0.3	0.5	0.2	NC	NC
R36	3.7	2.2	0.9	1.4	0.6	NC	NC

[80] The ‘significance of change’ criteria is explained in the Assessment Criteria section.

Table C.9.4: Predicted 24-hour $PM_{2.5}$ (Excluding Background) Concentrations

Receptor	Base Year 2018 (µg/m³)	Without Project (µg/m³)		With Project (µg/m³)		Significance of Change (+ve, NC, -ve)[80]	
		2029	2039	2029	2039	2029	2039
R37	1.3	0.8	0.3	0.5	0.2	NC	NC
R38	2.1	1.3	0.5	0.8	0.3	NC	NC
R39	2.2	1.3	0.6	0.9	0.4	NC	NC
R40	2.7	1.7	0.8	1.1	0.5	NC	NC
R41	1.3	0.7	0.4	0.8	0.4	NC	NC
R42	0.2	0.1	0.06	0.3	0.2	NC	NC
R43	0.2	0.1	0.06	0.3	0.1	NC	NC
R44	0.4	0.3	0.1	0.2	0.1	NC	NC
R45	0.6	0.4	0.2	0.3	0.2	NC	NC
R46	1.1	0.6	0.3	0.6	0.3	NC	NC
R47	2.1	1.1	0.5	1.0	0.5	NC	NC
R48	0.3	0.2	0.08	0.4	0.2	NC	NC
R49	2.1	1.1	0.5	0.9	0.4	NC	NC
R50	2.4	1.3	0.6	0.9	0.4	NC	NC
R51	1.5	0.9	0.4	0.6	0.2	NC	NC
R52	1.8	1.1	0.5	1.1	0.5	NC	NC
R53	0.5	0.3	0.1	0.9	0.4	NC	NC
R54	0.2	0.1	0.06	0.3	0.1	NC	NC
R55	1.6	0.8	0.4	0.6	0.3	NC	NC
R56	0.4	0.2	0.1	0.6	0.3	NC	NC
R57	1.4	0.8	0.4	0.6	0.3	NC	NC
R58	0.3	0.2	0.08	0.5	0.3	NC	NC
R59	0.5	0.3	0.2	0.3	0.2	NC	NC