Warkworth to Wellsford

Air Quality Assessment

July 2019

QUALITY ASSURANCE

Prepared By

Jacobs GHD Joint Venture. Prepared subject to the terms of the Professional Services Contract between the Client and GHD Jacobs Joint Venture for the Route Protection and Consenting of the Warkworth to Wellsford Project.

Revision history:

Revision	Author	Reviewer		Approved for Issue		
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Final	Charlotte Moore	Deborah Ryan		Brad Nobilo		05/07/2019

Quality information

Document title: Ara Tūhono Project, Warkworth to Wellsford Section; Air Quality Assessment

Version: Final

Date: July 2019

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File name: Air Quality Assessment_5July19_FINAL.docx

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GLOSSARY OF ABBREVIATIONS

The table below sets out the technical abbreviations.

Abbreviation	Term
AADT	Average Annual Daily Traffic
AEE	Assessment of Effects on the Environment
AUP(OP)	Auckland Unitary Plan (Operative in Part)
CAQMP	Construction Air Quality Management Plan
CEMP	Construction Environmental Management Plan
CO	Carbon monoxide
Council	Auckland Council
EPA	Environmental Protection Authority
GIS	Geographic Information System
HSR	Highly Sensitive Receiver
IAQM	The Institute of Air Quality Management
km	Kilometres
km/hr	Kilometres per hour
m	Metres
m^2	Square metres
m^3	Cubic metres
MfE	Ministry for the Environment
NES	National Environmental Standard
NESAQ	Resource Management (National Environmental Standard for Air Quality) Regulations 2004
NIWA	National Institute of Water and Atmosphere
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_X	Oxides of nitrogen
NoR	Notice of Requirement

Abbreviation	Term
NZAAQG	New Zealand Ambient Air Quality Guideline Values, set in Ministry for the Environment Ambient air quality guidelines: 2002 Update
O_3	Ozone
PM_{10}	Fine particulate matter less than 10 microns in diameter
$PM_{2.5}$	Fine particulate matter less than 2.5 microns in diameter
P-W	Ara Tūhono Pūhoi to Wellsford Project
RMA	Resource Management Act 1991
SH(x)	State Highway (number)
SO_2	Sulphur dioxide
Transport Agency	NZ Transport Agency
TSP	Total Suspended Particulates
VEPM	Vehicle Emissions Prediction Model (Version 5.1)
vpd	Vehicles Per Day
WHO	World Health Organisation

GLOSSARY OF DEFINED TERMS

The table below sets out the defined terms (and some acronyms above apply)

Term	Definition
Airshed	A volume of air, bounded by geographical and/or meteorological constraints, within which activities discharge contaminants, as defined in Ministry for the Environment Ambient air quality guidelines: 2002 Update
Ambient air	The air outside that reflects the cumulative effect of all activities both human induced and natural. It does not refer to indoor air, air in the workplace, or to contaminated air as it is discharged from a source.
Annual average daily traffic	The equivalent to the total volume of traffic passing a roadside observation point over the period of a calendar year, divided by the number of days in that year for which traffic volumes were recorded. Measured in vehicles per day.
Best practicable option	Defined in section 2(1) of the RMA, as in relation to a discharge of a contaminant or an emission of noise, means the best method for preventing or minimising the adverse effects on the environment having regard, among others things, to – (a) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and (b) the financial implications, and the effects on the environment, of that option when compared with other options; and (c) the current state of technical knowledge and the likelihood that the option can be successfully applied.
Construction works	Activities undertaken to construct the Project.
Contaminant	Defined in section 2(1) of the RMA, as including any substance (including gases, odorous compounds, liquids, solids, and micro-organisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy, or heat – (a) when discharged into water, changes or is likely to change the physical, chemical, or biological condition of water; or (b) when discharged onto or into land or into air, changes or is likely to change the physical, chemical or biological condition of the land or air onto or into which it is discharged.
Designation	Defined in section 166 of the RMA, as a provision made in a district plan to give effect to a requirement made by a requiring authority under section 168 or section 168A or clause 4 of Schedule 1 of the RMA

Term	Definition
Earthworks	Defined in section J1 of the AUP as disturbance of soil, earth or substrate land surfaces. Includes: blading, boring (greater than 250mm diameter); contouring; cutting; drilling (greater than 250mm diameter); excavation; filling; ripping; moving; placing; removing; replacing; trenching; and thrusting (greater than 250mm diameter). Excludes: ancillary forest earthworks; and ancillary farming earthworks.
Heavy vehicle	A motor vehicle having a gross laden weight exceeding 3500 kg
Highly Sensitive Receiver	As defined in the Transport Agency Guide to assessing air quality impacts from State highway projects (2015) as "receivers in locations where people or surroundings may be particularly sensitive to the effects of air pollution. Examples include residential houses, hospitals, schools, early childhood centres, childcare facilities, rest homes, marae, other cultural facilities, and sensitive ecosystems."
Indicative Alignment	An indicative road design alignment assessed by the technical experts that may be refined on detailed design within the designation boundary. The Indicative Alignment is a preliminary alignment of a state highway that could be constructed within the proposed designation boundary. The Indicative Alignment has been prepared for assessment purposes, and to indicate what the final design of the Project may look like. The final alignment for the Project will be refined and confirmed at the detailed design stage.
Light vehicle	A motor vehicle having a gross laden weight less than 3500 kg
Project	The Ara Tūhono Pūhoi to Wellsford Project: Warkworth to Wellsford section, which extends from Warkworth in the south, to the north of Te Hana.
Project Area	The area within the proposed designation boundary, and immediate surrounds to the extent Project works extend beyond this boundary.
Project works	All proposed activities associated with the Project
Proposed designation boundary	The boundary of the land to which the notice of requirement applies.
State highway	A road, whether or not constructed or vested in the Crown, that is declared to be a State highway under section 11 of the National Roads Act 1953, section 60 of the Government Roading Powers Act 1989 (formerly known as the Transit New Zealand Act 1989), or under section 103 of the Land Transport Management Act 2003.
The Dome	The highest elevation within the Dome Forest Conservation Area.

Term	Definition
Trackout	The transport of dust and dirt from construction activities.

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1 INTRODUCTION

1.1 Overview of the Project

The NZ Transport Agency (Transport Agency) is lodging a Notice of Requirement (NoR) and applications for resource consent (collectively referred to as "the Application") for the Warkworth to Wellsford Project (the Project).

This report is part of a suite of technical assessments prepared to inform the Assessment of Effects on the Environment (AEE) and to support the Application. This assessment report addresses the potential air quality effects arising from the Project. The assessment considers the effects of an Indicative Alignment and other potential effects that could occur if that alignment shifts within the proposed designation boundary when the design is finalised in the future.

1.2 Project description

The Project involves the construction, operation and maintenance of a new four lane state highway. The route is approximately 26 km long. The Project commences at the interface with the Pūhoi to Warkworth project (P-Wk) near Woodcocks Road. It passes to the west of the existing State Highway 1 (SH1) alignment near The Dome, before crossing SH1 just south of the Hōteo River. North of the Hōteo River the Project passes to the east of Wellsford and Te Hana, bypassing these centres. The Project ties into SH1 to the north of Te Hana near Maeneene Road.

The key components of the Project, based on the Indicative Alignment, are as follows:

a) A new four lane dual carriageway state highway offline from the existing SH1, with the potential for crawler lanes on the steeper grades.

b) Three interchanges as follows:

   i. Warkworth Interchange, to tie-in with the Pūhoi to Warkworth section of SH1 and provide a connection to the northern outskirts of Warkworth.

   ii. Wellsford Interchange, located at Wayby Valley Road to provide access to Wellsford and eastern communities including Tomarata and Mangawhai.

   iii. Te Hana Interchange, located at Mangawhai Road to provide access to Te Hana, Wellsford and communities including Port Albert, Tomarata and Mangawhai.

c) Twin bore tunnels under Kraack Road, each serving one direction that are approximately 850 metres (m) long and approximately 180 m below ground level at the deepest point.

d) A series of steep cut and fills through the forestry area to the west of the existing SH1 within the Dome Valley and other areas of cut and fill along the remainder of the Project.

e) A viaduct (or twin structures) approximately 485 m long, to span over the existing SH1 and the Hōteo River.

f) A tie in to existing SH1 in vicinity of Maeneene Road, including a bridge over Maeneene Stream.

g) Changes to local roads:

   i. Maintaining local road connections through grade separation (where one road is over or under the other). The Indicative Alignment passes over Woodcocks Road, Wayby Valley Road, Whangaripo Valley Road, Silver Hill Road, Mangawhai Road and Maeneene Road. The Indicative Alignment passes under Kaipara Flats Road, Rustybrook Road and Farmers Lime Road.

   ii. Realignment of sections of Wyllie Road, Carran Road, Kaipara Flats Road, Phillips Road, Wayby Valley Road, Mangawhai Road, Vipond Road, Maeneene Road and Waimanu Road.

   iii. Closing sections of Phillips Road, Robertson Road, Vipond Road and unformed roads affected by the Project.

h) Associated works including bridges, culverts, stormwater management systems, signage, lighting at interchanges, landscaping, realignment of access points to local roads, and maintenance facilities.

i) Construction activities, including construction yards, lay down areas and establishment of construction access and haul roads.

For description and assessment purposes in this report, the Project has been divided into the following areas (as shown in Figure 1 below):

a) Hōteo South: From the southern extent of the Project at Warkworth to the Hōteo River.

b) Hōteo North: Hōteo River to the northern tie in with existing SH1 near Maeneene Road.

For construction purposes, the Hōteo South section is divided into two subsections being

- South – from the southern tie in with P-Wk to the northern tunnel portals; and

- Central – from the northern tunnel portals to the Hōteo River.

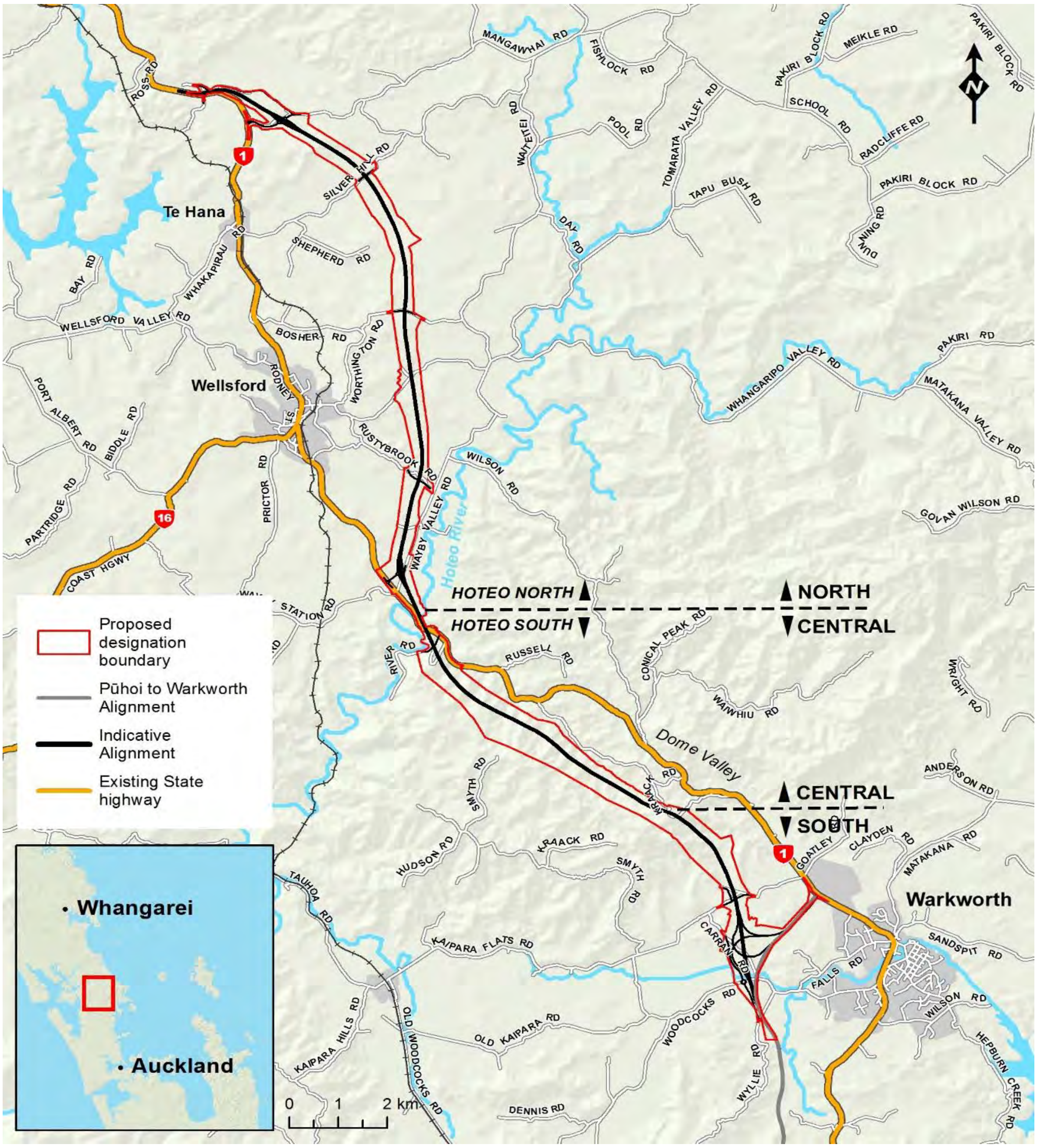

Figure 1 – Project Area

The Indicative Alignment shown on the Project drawings is a preliminary alignment for the Project that can be constructed within the proposed designation boundary. The Indicative Alignment has been prepared for assessment purposes, and to indicate what the final design of the Project may look like. The final alignment for the Project (including the design and location of ancillary components, such as stormwater treatment devices and soil disposal sites), will be refined and confirmed at the detailed design stage, through the outline plans of works process, and in compliance with the designation and consent conditions.

A full description of the Project including its design, construction and operation is provided in Section 4: Description of the Project and Section 5: Construction and Operation of the AEE contained in Volume 1 and shown on the Drawings in Volume 3.

1.3 Air discharge consents

The Auckland Unitary Plan (Operative in Part) (AUP(OP)) sets out the requirements for air discharge consents. The Project requires a resource consent for discharges to air as a discretionary activity for mineral extraction activities at a rate exceeding 200 tonnes/hour and for temporary mobile rock crushing exceeding 60 tonnes/hour.

There are no other air discharge consents being sought or required as part of the Project, for construction and operational discharges including from the proposed tunnel.

1.4 Purpose and scope of this report

This report presents an assessment of air quality effects of both the construction and operational phases of the Project. Road construction and motor vehicles travelling on road networks can negatively impact on air quality and some locations can be particularly sensitive to the effects of air pollution. These locations are referred to as highly sensitive receivers (HSRs). HSRs can include residential houses (dwellings), hospitals, schools, early childhood centres, childcare facilities, rest homes, marae, other cultural facilities, and sensitive ecosystems[1].

The scope of the air quality assessment includes:

- Identification of HSRs.
- A technical assessment of potential construction effects on air quality:
  - The assessment identified construction dust generating activities. We discuss the potential effects on air quality from Project construction. Our assessment includes an assessment of effects on HSRs to a distance of 200 m outside of the proposed designation boundary. All construction areas, yards and access roads are understood to be located within the proposed designation boundary. For the purposes of this assessment, construction activities have been assumed to be possibly located anywhere within the proposed designation boundary, with the exception of the location of the mobile crushing plant. It is unlikely that the construction works will occur immediately adjacent to the proposed designation boundary for the entire length of the Project, therefore we consider that this approach is conservative;
  - We have assessed potential dust discharges from local roads used for access, including consideration of potential dust discharges where those roads are unsealed.
- A technical assessment of potential operational phase air quality effects:
  - The assessment evaluates the potential effects and their significance on air quality and human health. We consider HSRs within a distance of 200 m of the Indicative Alignment as a result of air discharges from vehicles travelling along the Indicative Alignment. We have undertaken a sensitivity analysis to assess possible movement of the Indicative Alignment within the proposed

[1] NZ Transport Agency Draft Guide to Assessing Air Quality Impacts from State Highway Projects 2015.

designation boundary. We have also sensitivity tested if future traffic flows are higher than those predicted for the Project;

- We have considered the potential air quality effects of the proposed tunnel portal discharges on HSRs.

2 AIR EMISSIONS

2.1 Introduction

The Ministry for the Environment (MfE) Good Practice Guide for Assessing Discharges to Air from Land Transport (2008)[2] (MfE Transport Guide 2008) identifies the indicator contaminants for transport effects and the pollutants of most concern are carbon monoxide (CO), particulate matter smaller than 10 microns (PM_{10}) and oxides of nitrogen (NO_X). The MfE Transport Guide (2008) states that if the assessment of these indicator contaminants is within relevant assessment criteria, then there is reasonable confidence that levels of other traffic related pollutants will also be acceptable.

Carbon monoxide from road projects consistently complies with the guideline values except in the vicinity of roadways with very high traffic flow and significant congestion; baseline monitoring data from Auckland Council presented in Section 4.4.1 supports this. The Project is not expected to have high traffic flow or significant congestion. The potential environmental effects of NO_x and particulate matter are discussed below.

2.2 Key contaminants from road projects

2.2.1 Oxides of Nitrogen

NO_x is principally formed by the oxidation of nitrogen contained in air at high combustion temperatures. Vehicle traffic is a major source of anthropogenic NO_x emissions and nitrogen dioxide (NO_2) in particular has been identified as an indicator pollutant for motor vehicle pollutants[3]. Most NO_x (approximately 95%) is emitted as nitric oxide (NO) at the point of discharge. NO is generally considered not harmful to human health. The remaining 5% of NO_x is NO_2, and is known to have an effect on human respiratory function[4]. NO will convert to NO_2 depending on the presence of atmospheric oxidants, primarily ozone; atmospheric oxidants increase the rate of conversion of NO to NO_2[5].

NO_2 causes inflammation of the airways, particularly in young children, asthmatics and those with respiratory disease; it can cause both short-term and long-term effects[6].

2.2.2 Particulate matter

Particulate matter is composed of a mixture of various sizes of solid and liquid particles suspended in air and may have an adverse effect on health and amenity. Large particulate matter (e.g. dust) generally causes loss of amenity or nuisance caused by soiling of surfaces due to deposition. PM_{10} poses adverse health effects as it can enter the human respiratory tract.

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[2] Ministry for the Environment, 2016. Good Practice Guide for Assessing and Managing Dust. http://www.mfe.govt.nz/sites/default/files/media/Air/good-practice-guide-dust.pdf

[3] World Health Organization (WHO), 2006, Air Quality Guidelines Global Update 2005: Particulate matter, ozone, nitrogen dioxide, and sulphur dioxide. Published by WHO Regional Office for Europe, Denmark, October 2006

[4] Ministry for the Environment (2002) Ambient Air Quality Guidelines: 2002 Update. Available at: http://www.mfe.govt.nz/publications/air/ambient-air-quality-guidelines-2002-update

[5] Ministry for the Environment (2008) Good Practice Guide for Assessing Discharges to Air from Land Transport

[6] USEPA, Integrated Science Assessment for Oxides of Nitrogen, July 2008

The health effects of fine particulate (PM_{10} and particulate matter smaller than 2.5 microns $PM_{2.5}$) have been well studied in New Zealand and overseas. The principal motivation for this work in New Zealand has been the relatively high levels measured in areas such as Christchurch as a result of solid fuel combustion.

PM_{10} is inhalable, penetrating into and depositing in the respiratory tract, and if in high concentration for sufficient time will increase lung irritation and decrease lung function. Epidemiological studies have shown increased levels of PM_{10} are associated with an increase in a range of health effects including respiratory disease, cardiopulmonary disease and the exacerbation of asthma[7].

Increases in PM_{10} and $PM_{2.5}$ have also been associated with increases in daily mortality rates[8]. Most of these effects are associated with short-term exposure. The evidence of long-term health effects associated with fine particulate is not clear. Biological accumulation is not a concern unless the particulate contains significant concentrations of contaminants like heavy metals (MfE Dust Guide 2016).

$PM_{2.5}$ has the same effects as PM_{10}, but because the particles can be inhaled more deeply into the lungs, the effects are likely to be greater.

2.3 Potential air quality effects from road projects

2.3.1 Construction phase emissions

The construction phase of roading projects has the potential to generate dust, particularly from earthworks, topsoil removal and spreading, cut and fill operations, and other activities involved in road construction such as blasting and trackout to access roads from construction yards and mobile rock crushing.

Dust can be generated both as a result of vehicle movements and the action of wind (particularly where greater than 5 m/s) on exposed or unsealed surfaces.

Other discharges to air from construction include emissions from vehicle and equipment exhausts. It has been shown that most of the particulate matter in vehicle exhausts is less than one micron in diameter and is therefore in the $PM_{2.5}$ range[9]. The percentage of $PM_{2.5}$ as a proportion of particulate matter from vehicle tyre and brake wear is, however, highly variable, and is dependent on vehicle type.

Abrasion plays a part in three distinct sources of non-tailpipe discharges from vehicles: tyre wear, brake wear and re-suspension of material from roads. Abrasion processes produce particulate matter across a wide range of particles size, with approximately 40% of tyre wear being greater than PM_{10}. Brake wear is predominantly (> 90%) PM_{10}.[10]

[7] USEPA, Integrated Science Assessment for Particulate Matter, July 2009

[8] HAPINZ 2012, http://www.hapinz.org.nz/HAPINZ%20Update_Vol%201%20Summary%20Report.pdf

[9] Vehicle Emissions Prediction Model (VEPM 5.1) User Guide (2013)

[10] EMEP/EEA Air pollution emission inventory guidebook, 1.A.3.b.vi Road vehicle tyre and brake wear, 2009.

2.3.2 Operation phase emissions

The emissions to air from the operation of roadways are dependent on: the number of vehicles travelling; the characteristics of the vehicle fleet; driving patterns; and the characteristics of the road, particularly average speed, gradient and the presence of intersections.

Air emissions from vehicles arise from:

- the by-products of fuel combustion (emitted via the exhaust system);
- the evaporation of fuel itself; and
- particulate matter from brakes and tyre wear and re-suspension from the road surface.

Principal factors affecting emissions from vehicles are:

- Vehicle type (light or heavy);
- Fuel type and composition of the fuel used by a vehicle (diesel or petrol);
- Type and condition of a vehicle's emission control equipment; and
- Age, state and maintenance of the vehicle.

Congestion is a significant factor influencing vehicle emissions, with emissions typically a factor of five to ten times higher in congested traffic when compared to a free flowing highway without interruptions. Average trip length also influences emission rates, as emissions are greatest when the vehicles are started up (cold start emissions), and decrease after the engine warms (MfE Transport Guide, 2008).

Air quality in and around tunnels is influenced by factors including: tunnel geometry, tunnel length, traffic flow, vehicle fleet mix, vehicle emission standards, traffic speed, road gradient, tunnel ventilation system design and operation, tunnel operation, surrounding topography, background air quality, and local meteorology.

Road tunnels essentially restrict dispersion of air pollutants emitted by traffic as it travels through a tunnel. Tunnels generally result in an increased concentration of the contaminants in the area around portals and ventilation stacks (if present) when compared to open road sections. In tunnels without stacks (i.e. the current Project Indicative Alignment design), contaminants are emitted from the tunnel portals.

3 ASSESSMENT METHODOLOGY

Assessment methodology summary

We have assessed the construction and operational effects of the Project on air quality. We have applied guidance and methods available from the MfE and the Transport Agency, and considered relevant provisions of the Auckland Unitary Plan (AUP).

<u>Construction Phase Effects</u>

We have undertaken the construction effects assessment with reference to the MfE Good practice guide for assessing and managing dust (2016). Our assessment of construction effects on air quality is qualitative, based on experience of the potential for adverse effects from dust with good practice dust mitigation measures and recommendations for management during the construction phase.

We identified HSRs within 200 m of the proposed designation boundary, within 50 m of sealed access roads up to 500 m outside of the proposed designation boundary, and within 100 m of unsealed access roads outside of the proposed designation boundary. We understand that all residential properties within the proposed designation boundary will be acquired as part of the Project. The Indicative Alignment below 161 Kraack Road (within the proposed designation boundary) will pass through a tunnel, therefore the dwelling will likely remain occupied during construction and following operation, therefore, we have also included the residence at 161 Kraack Road as a HSR.

There are known areas of high ecological value identified in the Ecological Assessment Report. The potential sensitivity of ecological receptors to dust has been has been identified by the ecologists and assessed in the Ecological Assessment Report. Subsequently, ecological areas have not been considered as HSRs in this assessment of construction phase air quality effects.

We qualitatively assessed identified HSRs assuming that any construction activity, with the exception of the mobile crushing plant, may occur at any location within the proposed designation boundary, and that all residential properties would be unoccupied for the period of construction, with the exception of 161 Kraack Road.

We have assessed potential air quality effects from access roads by evaluating trackout and dust suspension from unsealed roads.

<u>Operational Phase Effects</u>

We undertook the operational phase assessment with reference to the NZ Transport Agency Guide to assessing air quality impacts from State highway projects (2015), and the MfE Good Practice Guide on Assessing Discharges to Air from Land Transport (2008).

Our technical assessment of the operational effects on air quality uses a screening dispersion modelling tool to predict the effects of vehicle emissions on air quality as consistent with the size and scale of the Project once operational. Traffic volumes for this assessment are based on the traffic modelling presented in the Transportation and Traffic Assessment Report.

We considered all HSRs within 200 m of the proposed designation boundary and 161 Kraack Road which is located within the proposed designation boundary, but on a hill above the location of the proposed tunnels in the operational air quality effects assessment. The Ecology Assessment Report has identified ecological areas that are potentially sensitive to air contaminants from road operation and the assessment of the potential effect on ecological receptors has been undertaken in the Ecology Assessment Report. Subsequently, we have not specifically considered ecological areas as HSRs in the operational air quality effects assessment.

We identified "worst-case" HSRs, that would likely experience the highest concentrations of air contaminants from the Project operation. We assessed the potential operational air quality effects of the Indicative Alignment on these worst case HSRs. We then undertook a sensitivity analysis which assessed the impact of changes to the Indicative Alignment within the proposed designation boundary. We have also sensitivity tested for the potential that future traffic flows may be higher than those predicted for the Project.

<u>Assessment Framework</u>

We applied relevant assessment criteria from the following documents:

- National Environmental Standards for Air Quality (NESAQ);
- New Zealand Ambient Air Quality Guidelines (NZAAQG); and
- The Auckland Unitary Plan (Operative in Part) (AUP(OP)).

For construction effects relating to dust, the relevant assessment criterion is for there to be "no adverse effects on health or dust nuisance predicted i.e. no noxious, dangerous, offensive or objectionable dust or odour from dust deposition, beyond the proposed designation boundary". This assessment criterion is necessarily subjective, but is in line with the MfE Dust Guide 2016 and relevant provisions of the AUP(OP).

For operational effects, we considered assessment criteria from a range of sources, including ambient air quality standards and guidelines material; and criteria taken from the Transport Agency Guide (2015) to evaluate the level of risk from the predicted increment in contaminant levels for land transport projects.

The criteria we have used to evaluate operational phase effects relevant to a Tier 2 screening level assessment are:

- NO_2 guideline of 40 $\mu g/m^3$ as an annual average (WHO) and significance criteria of 4 $\mu g/m^3$ as an annual average
- PM_{10} standard of 50 $\mu g/m^3$ as a 24 hour average (NESAQ) and significance criteria of 5 $\mu g/m^3$ as a 24 hour average
- $PM_{2.5}$ guideline of 25 $\mu g/m^3$ as a 24 hour average (ARAQT) and significance criteria of 2.5 $\mu g/m^3$ as a 24 hour average.

3.1 Introduction

We have assessed the construction and operational effects of the Project on local air quality. The following variables influence the level of effect on air quality from construction activities and from road and tunnel operation:

- The existing air quality in the Project Area;

- The proximity and number of HSRs that could be exposed to air emissions from the construction and operational phases of the Project;
- The scale and extent of the construction works and associated activities;
- The total predicted emissions resulting from the operation of the road, determined by the predicted daily traffic flow, speed and percentage of heavy vehicles; and
- The prevailing meteorology, in particular, wind speed and direction.

Our overall approach to this assessment has taken account of the following:

- The NZ Transport Agency Guide to assessing air quality impacts from state highway projects (2015)[11] (Transport Agency Guide 2015);
- The Ministry for the Environment (MfE) Good practice guide for assessing and managing dust (2016) (MfE Dust Guide (2016);
- The Ministry for the Environment (MfE) Good practice guide for assessing discharges to air from land transport (2008) (MfE Transport Guide 2008); and
- Relevant provisions of the AUP(OP).

Where gaps in the above guidance documents exist, other documents have been referenced to assist the undertaking of an appropriate level of assessment of air quality effects from the Project. These documents and their source are detailed at the relevant assessment stages in Sections 3.3 and 3.4 below.

The Transport Agency Guide (2015), promotes the Transport Agency's recommended approach to assess air quality effects resulting from State highway projects. Our assessment approach has been adopted and is consistent with this guide. The Transport Agency Guide (2015) prescribes the following levels of assessment depending on the potential air quality risk level:

- Environmental and social responsibility (ESR) screen (Tier 1) – a high level assessment to identify any potential effects and risks;
- Preliminary technical assessment (Tier 2) – an assessment based on simplified techniques and on an air quality screening model; and
- Technical assessment (Tier 3) – a detailed level of assessment for construction and operational effects, based on the level of potential effect identified at Tier 2. Tier 3 includes atmospheric dispersion modelling of predicted operational emissions. This level of assessment is required if a higher air quality risk is identified in Tier 1 or Tier 2 level assessments.

11 New Zealand Transport Agency, 2015. Guide to assessing air quality impacts from state highway projects Version 2.0, December 2015, Draft

3.1.1 Environmental and Social Responsibility Air Quality Risk Screen

The ESR screen / Tier 1 assessment informs the risk management process and ensures environmental and social matters of a State Highway roading development project have been considered. The ESR screen assessment considers the zoning of adjacent land, construction timeframe, road network classification, whether the area of interest is within a designated non-compliant airshed and if there are HSRs within 200 m of the proposed activities.

Table 1 below summarises the Project ESR screen to determine the level of air quality risk for the Project.

Table 1 – Environmental and Social Responsibility Air Quality Risk Screen

Question	Answer
What is the zoning of adjacent land?	Rural – i.e. potential for a low number of residential properties to be adjacent to the Project and at risk to vehicle emissions.
What is the construction timeframe? More or less than 18 months?	The construction timeframe is expected to be more than 18 months, therefore there are greater potential effects from construction dust discharges.
What is the One Network Road Classification?	National – i.e. there is a high potential number of vehicle movements which may present an operational air emissions risk.
Is the area of interest designated as a non-compliant airshed?	No – i.e. there is a low risk that any incremental effects of additional vehicle movements may cause human health effects and a low risk of exceeding air quality standards.
Are there HSRs located within 200 m of the area of interest?	Yes – i.e. there are HSRs within a close proximity to the Project construction and operational air emissions.
Are there hazardous activities and industries list (HAIL) (contaminated) sites within 200 m of the areas of interest?	No – i.e. there are no contaminated sites nearby therefore there is a low risk of discharge of odours and airborne contaminants to air during construction.

Based on the factors in Table 1, the ESR screen highlights that air quality risks should be considered and assessed further in a Tier 2 or a Tier 3 technical assessment. Tier 2 and Tier 3 assessments involve a separate assessment of construction and operational phase effects at an assessment level reflecting the potential risk from each phase.

3.2 Baseline air quality

Pollutants are present in the environment as 'background' concentrations which, in addition to contributions from roads, can be from anthropogenic sources such as domestic home heating and industrial processes as well as naturally occurring sources, for example wind-blown particulate matter. Background concentrations of contaminants will therefore vary depending on land-use activities and seasonal variations.

Background air quality levels are used as a baseline in air quality assessments of roading projects to indicate the cumulative impact for each new contaminant. The contribution of the proposed road is added to the background concentration to assess the overall (cumulative) impact on air quality for comparison with air quality standards.

To establish background concentrations for this assessment, we have had regard to the Auckland Council document, Use of Background Air Quality Data in Resource Consent Applications (2014)[12]. We have also reviewed all available local air quality monitoring data.

The most conservative background values have been used to assess cumulative concentrations. Background air quality concentrations are detailed in Section 4.4 of this report.

3.3 Construction effects

We have undertaken an assessment of the construction phase consistent with a Tier 3 construction effects assessment prescribed in the Transport Agency Guide (2015). This is due to the scale of earthworks and vehicles movements likely required to support the construction of the Project, and the proximity of construction activities to HSRs.

The primary emission to air from the Project construction phase is dust. To undertake the assessment of effects from dust during construction, we therefore had regard to the MfE Dust Guide (2016) and relevant provisions in the AUP(OP). Discharges to air from vehicle and equipment exhausts have not been specifically assessed in this report. This is because the effects will be less than those assessed for vehicle travel from the operational phase of the Project, and will be less than minor.

We have assessed construction air quality effects using an experience-based qualitative assessment and FIDOL factors (i.e. Frequency, Intensity, Duration, Offensiveness and Location). The potential for adverse effects therefore depends on the location of the construction areas and associated activities, vehicle movements, indicative construction yards and access roads relative to HSRs for the Project.

Table 2 summarises the FIDOL factors that are used in New Zealand in accordance with the MfE Dust Guide (2016) to assess the potential effects of dust discharges.

Table 2 – Description of FIDOL Factors

Frequency	How often an individual is exposed to the dust
Intensity	The concentration of the dust
Duration	The length of exposure
Offensiveness/character	The type of dust
Location	The type of land use and nature of human activities in the vicinity of the dust source

We have considered the HSRs within 200 m of the proposed designation boundary as being potentially affected by any of the construction activities, with the exception of mobile rock crushing. This is because the construction areas and associated activities could be located at any position within the proposed designation boundary at this stage in the design process. Areas where mobile rock crushing are reasonably expected to be located have been assessed as such in relation to HSRs.

[12] Auckland Council (2014) Use of Background Air Quality Data in Resource Consent Applications. Available at: (2014)http://temp.aucklandcouncil.govt.nz/EN/planspoliciesprojects/reports/technicalpublications/Documents/gd201401useofbackgroundairqualitydatainresourceconsentapp.pdf

For the purposes of this assessment, we understand that any human HSRs (i.e. residential properties) which fall within the proposed designation boundary will be unoccupied or demolished as part of the Project, and have therefore been excluded from the list of HSRs potentially impacted by construction dust from the Project. The Indicative Alignment below 161 Kraack Road (a residential property within the proposed designation boundary) will pass through a tunnel, therefore the dwelling will likely remain occupied during construction and following operation. We have consequently included 161 Kraack Road as a HSR as part of the construction effects assessment. The list of excluded HSRs is presented in Appendix A.

Vehicle movements on sealed and unsealed roads are the only proposed construction phase activity relevant to the effects assessment that will occur outside of the proposed designation boundary.

The transport of dust and dirt from the Project construction activities on the public road network, where it may be deposited and re-suspended by vehicles using the network is referred to as trackout effects. To identify HSRs that may be affected by trackout dust, we had reference to the Institute of Air Quality Management Guidance on the assessment of dust from demolition and construction (2014)[13](IAQM 2014): a guidance from the UK, because New Zealand guidance does not specifically address trackout effects.

We have considered the air quality effects of access roads in the dust effects assessment by evaluating trackout on sealed roads and unsealed roads. Trackout dust is considered on access roads up to 500 m from the proposed designation boundary. The effect of trackout dust on HSRs within 50 m of access roads for the construction phase of the Project has been assessed. Dust suspension into air may increase from the construction traffic for the Project using unsealed roads, especially from heavy commercial vehicles (HCVs). Accordingly, the effect of dust on HSRs in close proximity to unsealed access roads has a larger impact area than dust from sealed roads. The effects of dust within 100 m of unsealed roads, used as access and haul roads for the construction phase of the Project, has therefore been assessed. This is consistent with recent research undertaken by the Transport Agency on impact of exposure to dust from unsealed roads[14].

There is currently little information on the effects of air contaminants on native New Zealand flora and fauna as noted in the Transport Agency Guide (2015). The Project's ecologist identified areas of high ecological value (see Ecology Assessment Report) relevant to the Project; these areas fall both within and outside of the proposed designation boundary. The potential effects of dust on flora and fauna within and outside of the proposed designation boundary have been considered in the Ecology Assessment Report. We have therefore not included these areas as HSRs for the construction effects assessment.

3.4 Operational effects

3.4.1 Road operation effects

We have undertaken a preliminary technical assessment approach of the Project road operation effects on air quality, as appropriate to the scale and nature of the operational effects of the Project. This is consistent with a Tier 2 operational phase effects assessment

[13] Institute of Air Quality Management (2014) Guidance on the assessment of dust from demolition and construction http://www.iaqm.co.uk/text/guidance/construction-dust-2014.pdf.

[14] Impacts of exposure to dust from unsealed roads (2017) https://nzta.govt.nz/assets/resources/590/590.pdf.

prescribed in the Transport Agency Guide (2015). Further work involving air quality dispersion modelling (equivalent to a Tier 3 assessment with reference to the Transport Agency Guide (2015)) is not considered to be required; the reasons for this are explained as part of the Tier 2 operation effects assessment results in Section 5.2.4.

The operational effects assessment has been undertaken with reference to the Transport Agency Guide (2015) and the MfE Transport Guide (2008).

We have characterised the potential operational air quality risk from the proposed tunnel portals and no further assessment has been undertaken as a result of this risk assessment process. This consideration is explained as part of the Tier 2 operational effects assessment results in Section 5.2.3 taking the relevant AUP(OP) tunnel provisions into account. We have also reviewed available monitoring data for air quality around tunnels in Appendix C.

Our road operation air quality effects assessment approach uses a web-based screening model developed by the Transport Agency[15] to assist with air quality effects assessments. The Air Quality Screening Model incorporates the Vehicle Emissions Prediction Model (Version 5.1) (VEPM) and predicts the road contribution concentration of PM_{10} and NO_2. The Transport Agency Screening Model has been shown as part of a validation study[16] undertaken by the Transport Agency to be generally conservative compared to estimated actual concentrations experienced at that location. This study evaluated against the results from four detailed technical assessments undertaken for road developments in New Zealand.

The web-based Transport Agency Screening Model calculates contaminant concentrations for specified distances from the road edge based on the traffic flow in annual average daily traffic (AADT), fleet composition and average speed for specified years. To allow $PM_{2.5}$ to be included in the assessment, we have assumed that all PM_{10} road contribution – including exhaust emissions and tyre and brake wear – is $PM_{2.5}$. Not all of the non-exhaust PM_{10} is actually $PM_{2.5}$ with reference to Section 2.3.1, therefore this model will produce conservative $PM_{2.5}$ road emission concentrations.

The potential effects of air contaminants from road operation on flora and fauna within and outside of the proposed designation boundary have been considered in the Ecology Assessment Report. We have therefore not included high value ecosystems as HSRs for the purposes of our operational air quality effects assessment.

All HSRs within 200 m of the proposed designation boundary were considered in the operational air quality effects assessment. We understand that any HSRs which fall within the proposed designation boundary will be unoccupied or demolished as part of the Project and have therefore been excluded from the list of HSRs potentially impacted by operational air quality emissions from the Project. We have included the residential property at 161 Kraack Road, which is located within the proposed designation boundary, as a HSR for the operational effects assessment. Appendix A contains the list of excluded HSRs.

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15 Transport Agency Screening Model available at: https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/planning-and-assessment/air-quality-screening-model/.

16 Transport Agency Air Quality Screening Tool User Notes (2014) Available at https://www.nzta.govt.nz/assets/Highways-Information-Portal/Technical-disciplines/Air-and-climate/Planning-and-assessment/Air-Quality-Screening-Model/NZTA-AQ-Screening-Model-Users-Notes-Final.pdf

We assessed worst-case HSR locations to present a worst-case situation for the effects of operation on air quality. The worst-case HSRs are based on those HSRs which are likely to be adversely affected by the Project.

The operational phase of the Project has benefits for air quality by reducing current and future exposure to air contaminants along the existing SH1. This assessment does not specifically quantify the benefits to air quality, although they are described in Section 5.2.1.

We predicted contaminant concentrations at identified worst-case HSRs using the Transport Agency web-based Air Quality Screening Model for the following scenarios:

1. Base year 2016 (as representative of the "current year") scenario;
2. Future operation year 2036 scenario for:
    a. Do minimum without the Project, but with consented developments including the Pūhoi to Warkworth Project; and
    b. With Project, and with consented developments including the Pūhoi to Warkworth Project.
3. Future design year 2046 scenario for:
    a. Do minimum without the Project, but with consented developments including the Pūhoi to Warkworth Project; and
    b. With Project, and with consented developments including the Pūhoi to Warkworth Project.

We also undertook a sensitivity analysis to assess the impact of changes to the Indicative Alignment location within the proposed designation boundary. Our sensitivity analysis of the Project alignment was also based on the worst-case HSRs Sensitivity analysis was also undertaken to assess the potential effects if traffic flows are higher than predicted.

3.4.2 Traffic data inputs

The Operational Transport Assessment summarises the traffic modelling undertaken for the Project. A SATURN (Simulation and Assignment of Traffic to Urban Road Networks) model, extending from Pūhoi in the south to Te Hana in the north, has been used in the Operational Transport Assessment to understand traffic volume levels on this network. Future year models reflect the proposed changes in the road network and the forecast demographic changes.

The Operational Transport Assessment notes that peak model volume data was factored up to obtain AADT current year. Projections for the opening and design years i.e. 2036 and 2046 respectively, were forecast as part of the Operational Transport Assessment and provided for this assessment.

Traffic data used in the air quality assessment is presented in Appendix B of this report for the road links relevant for the Project as considered in the air quality assessment.

3.5 Assessment framework

3.5.1 Introduction

The legal and planning framework for the air quality assessment is outlined in the AEE, including the Resource Management Act 1991 (RMA) and the AUP(OP). This section of our report outlines the statutory and non-statutory criteria specific to the assessment of effects of discharges to air. It addresses air quality standards, guidelines and other criteria used to assess the Project's effects on air quality.

3.5.2 National Environmental Standards for Air Quality

The National Environmental Standards for Air Quality (NESAQ) are designed to protect public health and the environment by setting concentration limits of contaminants in air for specified averaging periods and regulating or prohibiting certain activities. Other than the ambient air quality standards themselves, there are no provisions of the NESAQ relevant to emissions from the transport sector. Table 3 presents the ambient air standards in the NESAQ relevant to the Project.

As shown by the data presented in Section 4 of this report, the Warkworth airshed and by implication the Project Area complies with the relevant ambient air quality standards under the NESAQ.

Table 3 – New Zealand national environmental standards for ambient air quality

Contaminant	Standard	Averaging time	Permissible excess
Particulate matter (PM_{10})	50 $\mu g/m^3$	24 hour	One in a 12-month period
Carbon monoxide (CO)	10 mg/m^3	8 hour	One in a 12-month period
Nitrogen dioxide (NO_2)	200 $\mu g/m^3$	1 hour	Nine in a 12-month period

3.5.3 Ambient Air Guidelines

The New Zealand Ambient Air Quality Guidelines (NZAAQG) were published in 2002. The primary purpose of the guidelines is *"to promote sustainable management of the air resource in New Zealand*". We have used the published NZAAQG values as the minimum requirements that outdoor air quality should meet in order to protect human health and the environment.

The NZAAQG include values for contaminants that are commonly discharged from road transport. Table 4 presents the NZAAQG values relevant to the Project.

Table 4 – New Zealand ambient air quality guideline values

Contaminant	Guideline value	Averaging time
Particulate matter (PM_{10})	50 $\mu g/m^3$	24 hour
	20 $\mu g/m^3$	Annual
Carbon monoxide (CO)	30 mg/m^3	1 hour
	10 mg/m^3	8 hour
Nitrogen dioxide (NO_2)	200 $\mu g/m^3$	1 hour

Contaminant	Guideline value	Averaging time
	100 μg/m³	24 hour
	30 μg/m³	Annual (ecosystems)

The World Health Organisation (WHO) criteria for human health for NO_2 is 40 μg/m³ as an annual average compared to the NZAAQG of 30 μg/m³ for ecosystem effects. We note that critical levels for NO_2 assume either ozone (O_3) or sulphur dioxide (SO_2) to be present at near guideline levels for there to be adverse effects on vegetation from the NO_2 critical levels. While we are not expecting critical levels of O_3 or SO_2 to be present in the Project Area, we have considered annual average NO_2 values in relation to the ecosystem effects criterion for completeness.

The WHO annual average NO_2 criterion is generally used in New Zealand for assessing human health effects for longer term exposures in the absence of an equivalent New Zealand guideline or standard.

3.5.4 Auckland Unitary Plan (Operative in part)

Auckland ambient air quality targets

The AUP(OP) sets Auckland Ambient Air Quality Targets (AAAQTs) for managing regional air quality in Auckland. In particular, the targets provide a 24 hour average criteria for $PM_{2.5}$ and annual average criteria for PM_{10}, $PM_{2.5}$ and NO_2. The averaging periods are related to exposure and each contaminant usually has a short-term (acute) limit and a long-term (chronic) limit. Contaminant concentrations for long-term and short-term average values are not comparable.

The AUP(OP) does not use the AAAQTs as pass or fail criteria, but notes that regard should be had to the criteria, so that significant adverse effects on human health, are avoided, and all other adverse effects are remedied or mitigated.

Table 5 sets out the AAAQTS relevant to the Project.

Table 5 – Auckland Ambient Air Quality Targets

Contaminant	Target	Averaging time
Particulate matter ($PM_{2.5}$)	25 μg/m³	24 hour
	10 μg/m³	Annual
Particulate matter (PM_{10})	20 μg/m³	Annual
Carbon monoxide (CO)	30 mg/m³	1 hour
Nitrogen dioxide (NO_2)	100 μg/m³	24 hour
	40 μg/m³	Annual

Earthworks rules

The AUP(OP) has the following rule to provide for earthworks as a permitted activity:

E14 Air quality

(A83) Earthworks and the construction, maintenance and repair of public roads and railways not meeting the general permitted activity standards

Where the permitted activity standards are as follows:

E14.6 Standards

E14.6.1 Permitted Standards
All activities listed as permitted in Table E14.4.1 Activity table must comply with the following general standards and specific standards where applicable.

E14.6.1.1 General standards
The following standards apply to all permitted activities that discharge contaminants into air except for:

- *mobile sources; and*
- *fire-fighting and other emergency response activities.*

1) *The discharge must not contain contaminants that cause, or are likely to cause, adverse effects on human health, property or the environment beyond the boundary of the premises where the activity takes place.*
2) *The discharge must not cause noxious, dangerous, offensive or objectionable odour, dust, particulate, smoke or ash, beyond the boundary of the premises where the activity takes place.*
3) *There must be no, dangerous, offensive or objectionable visible emissions.*
4) *There must be no spray drift or overspray beyond the boundary of the premises where the activity takes place.*

Note 1
When making a determination of adverse effects in relation to odour and dust, the FIDOL factors (frequency, intensity, duration, offensiveness and location) should be used. The use of the FIDOL factors provides a framework for making an objective and consistent assessment in relation to the degree of effects. The nature of the zone, predominant types of activities within any given area and amenity provisions for each zone, precinct or overlay will be taken into account when undertaking the assessment effects on the environment.

The Project's construction activities are covered by Rule A82 above and the permitted activity conditions need to be undertaken in a manner to comply with the relevant conditions. Based on the permitted activity conditions, the most relevant assessment criterion for the Project construction effects relates to no offensive or objectionable dust beyond the boundary. We have considered the FIDOL factors in making our assessment relating to the potential effects of construction dust.

Dust generating processes

The AUP(OP) contains rules for the discharge of contaminants to air from mineral extraction, crushing activities and dust from unsealed roads as below.

E14.4 Activity Table

(A94) Crushing of concrete, masonry products, minerals, ores and/or aggregates (not associated with quarrying activities) at a rate greater than 60 tonnes/hour is a restricted discretionary activity in the rural area

We understand that Project will exceed the threshold for restricted discretionary consent for rock crushing as it may be located within 200 m of a dwelling. An air discharge consent as discretionary activity is being sought for both of these activities as part of the Project.

Tunnel discharge rules

The AUP(OP) provides policies and rules regarding tunnel effects on air quality. An overall risk rating is to be used to assess whether the proposed motor vehicle tunnel is a permitted activity or a restricted discretionary activity. The AUP(OP) approach is directly linked to the Transport Agency Guide (2015) risk assessment method for tunnel air discharges.

The AUP(OP) has the following rule providing for tunnel discharges as a permitted activity:

(A116) Discharges to air from motor vehicle tunnels established from 30 September 2013 with a Low or Medium Risk Rating (as assessed under Table E14.6.1.18.1 and Table E14.6.1.18.2 in Standard E14.6.1.18)

The AUP(OP) has the following rule with regard to restricted discretionary tunnel activity:

(A117) Discharges to air from motor vehicle tunnels after 30 September 2013 with a High Risk Rating (as assessed under Table E14.6.1.18.1 and Table E14.6.1.18.2 in Standard E14.6.1.18)

Table 6 presents the risk assessment process and Table 7 the overall risk rating for assessing the activity status of tunnel air discharges. Tunnels allocated an overall risk rating of ‘Low’ or ‘Medium’ are a permitted activity and tunnels allocated an overall risk rating of ‘High’ are a restricted discretionary activity.

According to the Transport Agency Guide (2015), if a project including a tunnel is assessed as high risk, then further technical assessment to include a tunnel air quality effects assessment is required. If a medium risk is derived, then the additional assessment is also required, but using professional judgement, therefore dispersion modelling may not be necessary. If a project is predicted to result in a low risk from tunnel effects to air quality, further assessment is not required.

Table 6 – Table E14.6.1.18.1 Risk assessment process

Individual Rating	Is the Project in an area where PM_{10} National Environmental Standard Air Quality for PM_{10} is exceeded? OR Does the annual average nitrogen dioxide at the nearest equivalent roadside monitoring site exceed 30 µg/m³?	How many activities sensitive to air discharges are there located within 200 m of any point of discharge?	What is the annual average daily traffic flow in vehicles per day at the opening year?
Low	No	< 10	< 10,000
Medium	Not applicable	10 – 50	10,000 – 50,000
High	Yes	> 50	> 50,000

Table 7 – Table E14.6.1.18.2 Overall risk rating

Overall Rating	Individual Rating
Low	Two or more Low results in Table E14.6.1.18.1
Medium	Two or more Medium results in Table E14.6.1.18.1 OR One Low, one Medium and one High result in Table E14.6.1.18.1
High	Two or more High results in Table E14.6.1.18.1

The Project tunnel is assessed as low risk as in Section 5.2.3 of this report, and is therefore classified as a permitted activity as specified under Table E14.4.1 of the AUP(OP). Accordingly, the permitted activity standards as discussed above are applicable to the tunnel operation.

3.6 Criteria applied to the assessment

The relevant criterion for assessing the effects of dust from construction are as set out in *E14.6.1.1 General standards* of the AUP(OP) discussed above. The standards relate to human health and noxious, dangerous, offensive or objectionable dust beyond the boundary. The criterion relating to objectionable and offensive effects from dust is generally consistent with the criterion recommended in the MfE Dust Guide 2016.

For effects from operational phase the Transport Agency has recommended a set of criteria to help assess whether the predicted increased concentrations of road traffic contaminants from the Project are 'significant' (Transport Agency Guide 2015). If the road contribution is below 10% of the guideline value, and the road contribution plus background value is below 90% of the ambient air guideline value, then the risk is considered low. For low risk projects further air quality assessment work such as full air dispersion modelling, would not normally be required.

Section 5.2 of this report provides an assessment equivalent to a Tier 2 Transport Agency Guide (2015) level assessment for the operational phase of the Project. We applied the air quality significance criteria from the Transport Agency Guide (2015), set out in Table 8, to the operational phase assessment to identify whether the Project road emissions are deemed 'significant'. This work identified that further air quality assessment (Tier 3) was not required.

Table 8 – Transport Agency air quality significance criteria

Contaminant	Standard / Guideline µg/m³	Averaging time	Permissible project road contribution[1], µg/m³	Permissible cumulative contribution µg/m³
NO_2	40	Annual	4	36
PM_{10}	50	24 hour	5	45
$PM_{2.5}$	25	24 hour	2.5	22.5

Note:
1 – The project road contribution is the contaminant concentration predicted for the project road link(s) under consideration.

4 EXISTING ENVIRONMENT

Existing environment summary

The existing environment for the Project Area is generally rural in nature with good air quality and a low density of HSRs.

We identified the locations of 64 residential properties as HSRs for the construction and operational effects assessment. There are:

- 63 residential properties within 200 m of the proposed designation boundary, and
- one residential property within the proposed designation boundary at 161 Kraack that could be occupied during construction as it is located on the hill above the tunnel.

In addition, there are 9 residential properties outside of the proposed designation boundary that were considered for the construction effects assessment; of these 9:

- 7 residential properties are within 50 m of sealed access roads up to 500 m from the proposed designation boundary (for construction dust trackout assessment purposes); and
- 2 residential properties within 100 m of unsealed access roads.

The Ecology Assessment Report has identified ecological areas potentially sensitive to air contaminants from road operation and construction. The assessment of the potential effect on ecology has been undertaken in the Ecology Assessment Report. Ecosystem effects have not been specifically considered in this assessment of effects on air quality.

There are no other locations identified as HSRs for this Project, for example there are no schools or hospitals with the potential to be affected by air discharges from the Project.

The Project Area environment is characterised by:

- Hilly terrain requiring a series of cuts and fills for road construction;
- Prevailing winds are from the west to south-west sector, with winds above 5 m/s likely around 30% of the time; strong winds are predominant from the west to south-west; and
- Strong winds over 10 m/s are likely to be infrequent at around 2.5% of the time.

We reviewed data available from Auckland Council and the Transport Agency to characterise the existing air quality and assessed the likely background levels of contaminants. Based on the data we reviewed, we have assumed that air quality for the Project Area will be better than that measured in the Warkworth and Auckland urban areas i.e. without the peak concentrations observed in urban areas.

The following background concentrations of air contaminants have been used in the operational effects assessment, and are considered representative of likely worst case air quality in the Project Area:

- PM_{10}: 28.3 µg/m^3 as a 24 hour average
- $PM_{2.5}$: 14.2 µg/m^3 as a 24 hour average
- NO_2: 4 µg/m^3 as an annual average

4.1 Land use and topography

The Project is located in a largely rural area, which is primarily agricultural with pastoral farming, and there is also exotic forestry in the Central section. There are areas of rural residential land use throughout the Project area, mainly in the Northern and Southern sections.

The topography in the Project Area is predominately hill country, characterised by valleys and irregular ridgelines. The Pakiri Formation forms the majority of the steep rugged topography found in the forestry block (Matariki Forest) between Phillips Road and SH1 at Hōteo River Bridge. Deep river-formed valleys dominate the east coast of Northland, including the Warkworth, Wayby, Wellsford and Te Hana valleys.

A result of this topography is that the road will run through some cuttings, overpasses and bridges or viaducts that will affect the dispersion of emissions from vehicles operating on the road.

4.2 Highly Sensitive Receivers

The location and information on HSRs was taken from aerial imagery for the Project Area, building point data from Land Information New Zealand and property survey data undertaken by the Project team on 10 November 2017.

There are residential properties near to the Project Area which have been identified as HSRs. The identification of ecology areas sensitive to air contaminants from road operation and the assessment of the potential effect on ecology has been undertaken in the Ecology Assessment Report, therefore ecosystems have not been specifically considered as a HSR in the air quality effects assessment. No other locations have been identified as HSRs for the assessment; this is because no other HSRs as defined in the Transport Agency Guide (2015) (for example schools, hospitals etc.) are understood to be located within relevant distances to the Project Area.

4.2.1 Highly Sensitive Receivers within 200 m of the proposed designation boundary

Table 9 identifies the total number of HSRs within 200 m of the proposed designation boundary for assessing air quality effects for the construction and operation phases of the Project. The table also presents the distance of the nearest HSR to the proposed designation boundary (relevant for construction effects) and distance of the nearest HSR to the Indicative Alignment (relevant for operational effects).

Table 9 – HSRs near the Indicative Alignment and proposed designation boundary

Sector	Number of residences within 200 m of designation boundary	Approx. Distance of nearest HSR to designation boundary (m)	Distance of nearest HSR (outside of the proposed designation boundary) to Indicative Alignment road edge (m)
Northern	41	8	11
Central	2	1	112
Southern	20	15	40
Total	63 (+161 Kraack Rd which is within designation)		

It is assumed that all properties within the proposed designation boundary will be unoccupied during construction and operation phases of the Project. There is one residential property located within the proposed designation boundary at 161 Kraack Road. The Indicative Alignment will pass through the tunnel below this property therefore the house is understood to likely be occupied during construction and operation. 161 Kraack Road is therefore also considered to be a HSR for the air quality effects assessment, making a total of 64 HSRs considered in the air quality effects assessment in relation to the proposed designation boundary.

4.2.2 Highly Sensitive Receivers outside of the proposed designation boundary

Potential access roads for the construction phase of the Project are shown in Drawings A1-A4 in Appendix A of the Construction Traffic Assessment. These potential access roads have been considered in the construction effects assessment for the potential effect on HSRs from trackout dust and generated from unsealed roads.

Table 10 summarises the sealed access roads that extend outside of the proposed designation boundary where HSRs are located within 50 m of the road and 500 m from the proposed designation boundary (for construction dust trackout assessment purposes), and where HSRs are located within 100 m of unsealed access roads.

Table 10 – Potential construction access roads that could affect HSRs

Sealed Access Roads with the potential for construction dust trackout (up to 500 m from proposed designation boundary edge)			
Road	**Section**	**Number of HSRs within 50 m**	**Distance of nearest HSR to access road (m)**
SH1, north of Maeneene Road	Northern	2	20
Mangawhai Road	Northern	1	50
Whangaripo Valley Road	Northern	0	98
Wayby Valley Road	Northern	0	200+
SH1, south of Hōteo Bridge, to Warkworth	Central / Southern	1	30
Kaipara Flats Road – Carran Road to SH1	Southern	2	37

Carran Road	Southern	0	200+
Woodcocks Road	Southern	1	45
Unsealed access roads with potential to elevate dust			
Road	**Section**	**Number of HSRs within 100 m**	**Distance of nearest HSR to access road (m)**
Lower Silver Hill Road	Northern	0	–
Silver Hill Road	Northern	2	42
Road	**Section**	**Number of HSRs within 100 m**	**Distance of nearest HSR to access road (m)**
Farmers Lime Road	Northern	0	–
Note: Distances are approximate			

Overall there are approximately 7 HSRs within 50 m of the sections of sealed access roads with potential to have elevated dust from construction trackout, with the nearest HSR being 20 m from SH1, North of Maeneene Road. There are approximately 2 HSRs within 100 m of unsealed roads being used for construction site access, with the nearest being 42 m at Silver Hill Road.

4.2.3 HSR summary

The following have been identified as HSRs:

- 64 residential properties within 200 m of the proposed designation boundary for the construction and operational effects assessment. This is made up of
  - 63 residential properties within 200 m of the proposed designation boundary, and
  - one residential property within the proposed designation boundary.
- An additional 9 residential properties outside of the proposed designation boundary for the construction effects assessment. This is made up of:
  - 7 residential properties within 50 m of sealed access roads up to 500 m from the proposed designation boundary (for construction dust trackout assessment purposes); and
  - 2 residential properties within 100 m of unsealed access roads.

4.3 Meteorology

Wind speed and direction and rainfall are key determinants for potential for air quality impacts to occur from emissions during road construction and operation.

4.3.1 Wind

For construction effects, winds above 5 m/s will start to give rise to airborne dust from exposed surfaces, particularly after extended periods without rainfall, as noted in the MfE Dust Guide (2016). High wind speeds above 10 m/s have the most potential for excessive dust generation if winds are blowing towards the direction of HSRs.

The conditions most likely to produce the worst case effect in terms of dispersion of contaminants discharged from the road operation are light winds, particularly under stable atmospheric conditions (categories E and F[17]). For HSRs within close proximity to a ground level line source, like a road, the stability of the atmosphere is almost irrelevant, and the rate of dispersion is dominated by the strength of the winds. Light winds will have the effect of limiting dispersion of traffic discharges, resulting in higher concentrations of contaminants near the road. Strong winds result in greater dispersion of traffic emissions and lower concentrations.

The nearest full-time meteorological station to the Project is located approximately 3.2 km to the southeast of the southern end of the Project, and 2.2 km south of Warkworth. The data recorded at this meteorological station is indicative of the wind speeds and directions of the general area, although they do not take into account the influences of terrain along the Indicative Alignment, which may result in variations in wind speed and direction locally. This data is considered to be the best available indication of the likely rainfall frequency for the Project Area.

Figure 2 provides a windrose for the Warkworth meteorological station for data measured during the period January 2012 to December 2014, as it was decommissioned in February 2015. The data was obtained from the National Climate Database operated by NIWA.

On an annual basis, light winds blow relatively frequently from the west and south-west, but there is also a smaller component from the east. Strong winds greater than 5 m/s occur approximately 30% of the time, predominantly from a westerly direction but also occur from the east. Very strong winds greater than 10 m/s occur approximately 2.5% of the time from the west and south-west.

[17] Atmospheric stability is frequently characterised by one of six Pasquill Stability Classes, named A, B, C, D, E, and F with class A being the most unstable and class F being the most stable classification. More stable conditions result in less mixing of contaminants, and therefore higher concentrations near the source of emission.

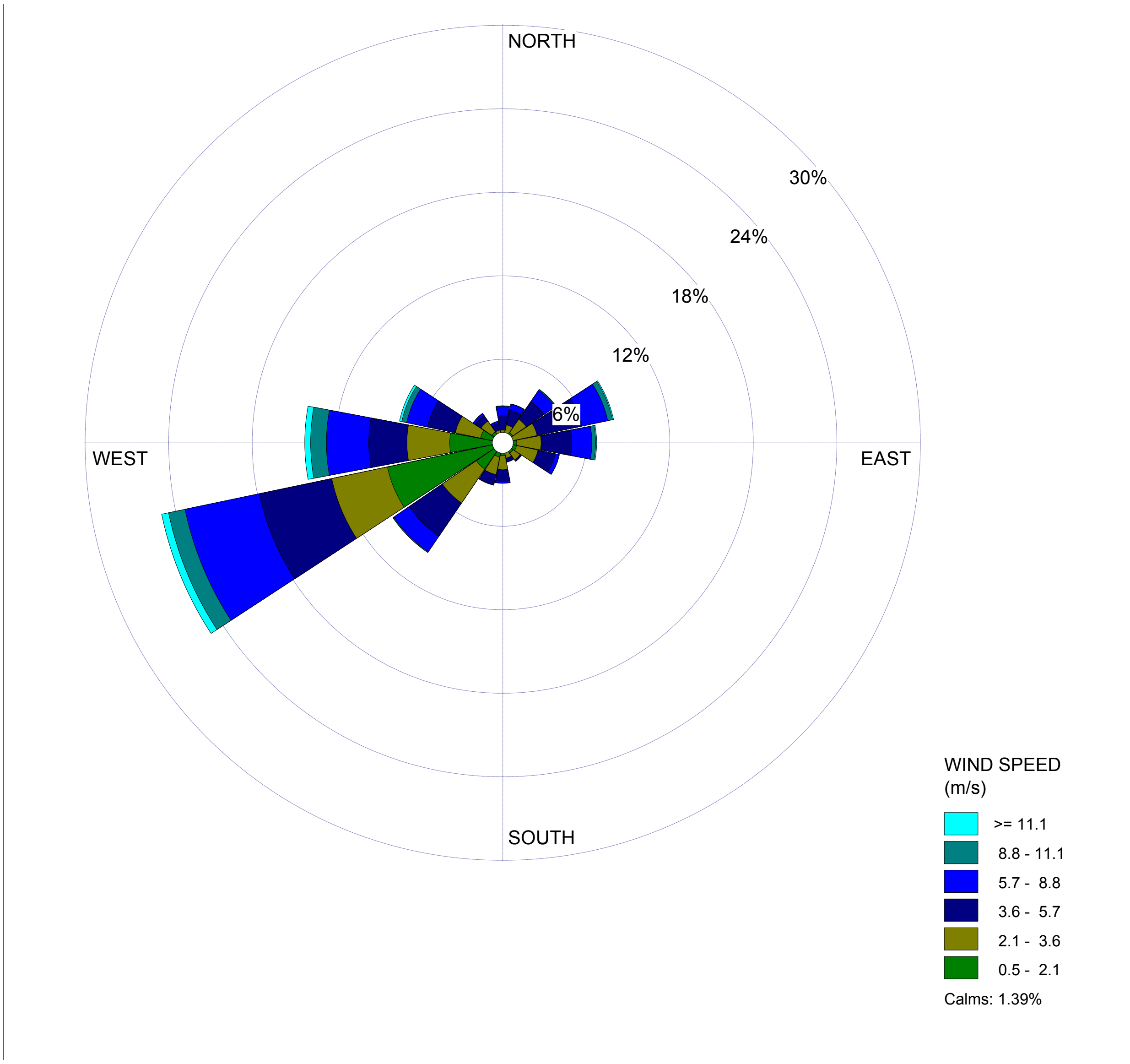

Figure 2 – Windrose as measured at Warkworth, 2012-2014

4.3.2 Rainfall

Auckland experiences a spatially distributed rainfall pattern with approximately 50% more precipitation in the Hunua and Waitakere ranges than in lower-lying parts of Auckland. Great Barrier Island and the area around Warkworth also have higher rainfall totals than urban Auckland and the east coast.

Table 11 presents the average number of days where more than 1 mm of rain was recorded at the Warkworth weather station. This data is considered to be a reasonable indication of the likely rainfall frequency for the Project Area.

Table 11 – Monthly frequency of wet days at Warkworth between 2012 and 2015

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	8	6	13	8	7	13	10	17	11	12	9	12
2013	2	2	8	13	15	15	6	15	11	7	10	9
2014	5	5	4	10	8	13	18	15	17	10	11	9

4.4 Existing ambient air quality

The area surrounding the Project is predominantly rural (mainly farming and forestry) with rural-residential developments. Consequently, background ambient air contaminant concentrations for the Project Area are low, which is typical of rural areas.

An airshed is a volume of air, bounded by geographical and/or meteorological constraints, within which activities discharge contaminants (Ministry for the Environment Ambient air quality guidelines: 2002 Update). The Project Area is outside of the nearest airshed set to manage air quality under the NESAQ, which is around the urban area of Warkworth, therefore air quality in the Project Area is considered to be generally good.

Contaminants emitted into air by vehicle traffic and road construction may also be emitted from industrial activities and from domestic activities. We are not aware of any air discharge permits within 500 m of the proposed designation boundary.

4.4.1 Auckland Council data

In Auckland, PM_{10} and $PM_{2.5}$ concentrations can sometimes exceed air quality targets in urban areas. The Auckland Council State of Auckland air quality report card[18] notes that recorded concentrations of PM_{10} have decreased over time whereas $PM_{2.5}$ concentrations have remained relatively stable. The data in this report has shown that 72% of the winter weekday PM_{10} is attributable to domestic sources (i.e. home heating), whereas during a summer weekday, 71% of all PM_{10} emissions are thought to be attributed to transport sources.

Ambient air monitoring sites operated by local authorities are typically located in urban or residential areas where people may be exposed to air pollution and/or where air quality is likely to be lower. The Council measures ambient air quality at a network of monitoring sites in the Auckland region. Most of the monitoring sites are in urban residential areas and are likely to experience higher concentrations of contaminants than what is experienced in the Project Area.

The nearest ambient air monitoring site to the Project was a temporary site located in Warkworth from 12 April 2007 to 21 November 2008, approximately 2.4 km to the south east of the southern end of the Project Area. The Warkworth monitoring site was located at a busy intersection in the vicinity of Hill Street and Sandspit Road where they intersect with SH1. The monitoring site measured PM_{10}, $PM_{2.5}$, and NO_2.

[18] Auckland Council, 2016 http://stateofauckland.aucklandcouncil.govt.nz/air-quality-report-card/auckland-reporting-area-2016/

In the Auckland region, ambient monitoring data for CO is available from suburban monitoring sites within Auckland City (at Takapuna and Henderson) for the same period as the Warkworth data. Referencing the Warkworth and Auckland data when collecting background concentrations for this assessment is therefore conservative given the generally rural nature of the Project Area.

Table 12 summarises the available Auckland Council data reviewed for the Project.

Table 12 – Auckland Council Ambient Air Quality indicative for the Project Area

Location (year of data)	Approx. distance to Project boundary (km)	PM_{10} µg/m³		$PM_{2.5}$ µg/m³		NO_2 µg/m³	CO mg/m³
		Maximum measured 24 hour average	Annual average	Maximum measured 24 hour average	Annual average	Annual average	Maximum measured one hour average
Warkworth (2007/2008)	3.4	39	17	18	9	18.2	–
Whangaparaoa (2012–2014)	26.5	35	11.3	11	4	1.4*	–
Orewa (2012–2014	18.9	45	14	–	–		–
Takapuna (2012/2016)	41.2	37	12.8	**31**	6.4	18.7	4.2
Henderson (2012/2016)	49.7	36	13	–	–	11	3.5
Patumahoe (2012/2016)	89.4	**276**	11.8	**47**	4.2	3.4	–
Assessment Criteria		50 NESAQ	20 NZAAQ	25 ARAQT	10 ARAQT	40 WHO	30 NZAAQG

* Whangaparaoa NO2 data from 11/2014 to 04/2015 only.

The closest monitoring station to the Project Area (Warkworth) did not exceed any air quality standard or guideline during the time of its operation for PM_{10}, $PM_{2.5}$ and NO_2. Measured $PM_{2.5}$ was relatively close to the criteria with an annual average concentration of 9 µg/m³ compared to the ARAQT of 10 µg/m³ as an annual average. We note, however, that this monitoring site was located in an urban environment whereas the Project Area is rural.

The Council had two ambient air monitoring stations classed as rural, at Whangaparaoa and Patumahoe. The Whangaparaoa rural monitoring station presents a more representative background concentration for the Project Area than an urban centre monitoring station, or one which is much further from the Project. The Whangaparaoa station was decommissioned in May 2015. Ambient monitoring data from the Whangaparaoa station before its decommissioning indicate that PM_{10} concentrations were less than 35 µg/m³ as a 24 hour average, and $PM_{2.5}$ concentrations are less than 11 µg/m³ as a 24 hour average. Annual average concentrations at this station for PM_{10}, $PM_{2.5}$ and NO_2 were well below the standards and guideline values.

There was an exceedance of the 24 hour average PM_{10} NESAQ standard of 50 µg/m³ on one day in 2013 at the Patumahoe monitoring station. There was also an exceedance of the 24 hour average $PM_{2.5}$ ARAQT of 25 µg/m³ at Patumahoe in 2013. Takapuna has exceeded the

$PM_{2.5}$ ARAQT every year between 2012 and 2015. These monitoring locations are not considered representative of air quality in the Project Area. There were no exceedances of the standards and guidelines for PM_{10}, $PM_{2.5}$ or NO_2 annual average concentrations at any other monitoring stations. The one hour average CO guideline value was also not exceeded at any of the locations for which monitoring data are reported.

4.4.2 Transport Agency data

Default background values

The Transport Agency has an online interactive map[19] displaying predicted background concentrations of PM_{10} and NO_2. The mapped air quality concentrations are able to be used as default background concentrations for assessments of effects on air quality. Data are available for PM_{10} as a24 hour average; and for NO_2 as a 24 hour average, annual average, and 1 hour average). The background values are used with estimates of concentrations from a project estimate the cumulative effect on air quality i.e. road contribution plus background. The default background air quality values provided in the online interactive map are intended to be conservative, as noted in the Transport Agency Background Guide (2012)[20]. If the predicted cumulative concentration is less than the relevant assessment criteria (shown in Table 7), further assessment is not generally required.

Table 13 shows the estimated concentrations from the Transport Agency map for the rural area surrounding the Project and the Agency values for Warkworth and Wellsford; the rural area classification from the table is relevant across the entire Project Area. Default values are not provided for $PM_{2.5}$ therefore for the purposes of the assessment, a ratio of 50% of PM_{10} as $PM_{2.5}$ has been assumed. This ratio of PM_{10} to $PM_{2.5}$ is consistent with monitoring data analysed for the Auckland monitoring stations included in Table 12 above, from Auckland Council.

Table 13 – Estimated background concentrations using the Transport Agency Air Quality Background Map

Area	PM_{10} µg/m³	NO_2 µg/m³		
	24 hour average	24 hour annual average	Annual average	1 hour average
Project – rural	28.3	23	4	37
Warkworth/Wellsford	37.5	38	13	58

Monitoring data (NO_2)

The Transport Agency has a national network of NO_2 passive monitors to provide annual average NO_2 measurement data. Table 14 presents the annual average NO_2 measured in the towns of Wellsford and Warkworth and further south to Orewa and Albany.

[19] Transport Agency Interactive Background Maps https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/planning-and-assessment/background-air-quality/.

[20] Transport Agency Draft Background Guide https://www.nzta.govt.nz/assets/Highways-Information-Portal/Technical-disciplines/Air-and-climate/Standards/NZTA-draft-background-guide.pdf.

The passive sampling results indicate that air quality in Wellsford is better than at Warkworth, which is likely due to the higher traffic volumes and greater congestion experienced in Warkworth, compared to Wellsford. The more recent annual average air quality data recorded at Orewa and Albany are well below the 40 $\mu g/m^3$ WHO criteria for human health. This is despite both of these monitoring locations being situated near state highways with a high level of AADT (estimated 40,000 AADT on SH1 in a main urban area with estimated background levels of 16 $\mu g/m^3$ annual average NO_2).[21]

Table 14 – Passive sampling results for annual average NO_2

Site ref	Area	Distance to Project (km)	Annual average NO_2 $\mu g/m^3$								
			2007	2008	2009	2010	2011	2012	2013	2014	2015
AUC003	Warkworth – Mahurangi College	2.5	15.6	17.9	19.5	–	–	–	–	–	–
AUC002	Wellsford – Rodney St	7.9	11.3	13.8	12.0	–	–	–	–	–	–
AUC004	Orewa – Grand Dr	19.2	12.3	15.4	10.9	10.8	10.7	10.0	31.9	10.8	12.5
AUC005	Albany – Oteha Valley Rd	33.7	23.7	25.8	28.1	28.4	29.5	–	12.2	27.3	29.4
WHO annual average criteria			**40**								

The Transport Agency undertook ambient air monitoring in the vicinity of the tunnel portals for Johnstone's Hill Tunnel and the Terrace Tunnel in Wellington; this data is summarised in Appendix C.

4.4.3 Background data used in the assessment

We expect that annual average concentrations of NO_2 along the Indicative Alignment would be better (i.e. lower) than those measured in the urban areas of Warkworth, Wellsford, Orewa and Albany.

Following a review of available Auckland Council and Transport Agency air quality background data, we have used the default PM_{10} and NO_2 concentrations recommended by the Transport Agency for the Project Area (as in Table 13) for the operational effects assessment. We have used this data as it likely to be more representative of the rural nature of the Project Area than the nearest available monitoring data, while still expected to be conservative. $PM_{2.5}$ background concentrations have been derived by taking 50% of the default PM_{10} background concentration provided by the Transport Agency, which is consistent with the ratio measured at co-located monitoring stations for $PM_{2.5}$ and PM_{10} elsewhere in the Auckland region.

[21] Transport Agency Estimated AADT values of State Highway https://www.nzta.govt.nz/roads-and-rail/highways-information-portal/technical-disciplines/air-quality-climate/planning-and-assessment/background-air-quality/

Background concentrations used in the assessment are presented in Table 15. A comparison of the two most relevant monitoring stations measuring annual mean NO_2, and 24 hourly average PM_{10} and $PM_{2.5}$ data by Auckland Council (Whangaparoa and Patumahoe) with the Transport Agency default background values has been undertaken. Use of the Transport Agency default values would give a conservative background value for annual mean NO_2, and an average PM_{10} and $PM_{2.5}$ background value.

Table 15 – Background contaminant concentrations used in the air quality operational effects assessment

Contaminant	Averaging period	Concentration $\mu g/m^3$
PM_{10}	24 hour average	28.3
$PM_{2.5}$	24 hour average	14.2
NO_2	Annual average	4

5 ASSESSMENT OF EFFECTS

Assessment of effects summary

This section presents the findings of the assessment of effects on air quality of the construction and operational phases of the Project.

Construction Phase

The construction phase of the Project has the potential to primarily generate dust, particularly from earthworks, cut and fill operations, trackout along potential access roads, and from unsealed access roads. The primary effects of dust generation are potential health effects and nuisance.

A number of HSRs have been identified as being potentially adversely affected by dust during construction. This is based on the assumption that any construction activities may be located anywhere within the proposed designation boundary, with the exception of the mobile crushing plant which has been assessed on where the activity will be reasonably expected to be located. The potentially affected HSRs are identified as:

- 74 Wyllie Rd, Streamlands, 211 Kaipara Flats Rd, 130 Kaipara Flats Rd, 161 Kraack Rd, Dome Forest, 145 Kraack Rd, Dome Forest, 177 Rustybrook Rd, Wellsford, 47 Borrows Rd, Wellsford, 35 Vipond Road, Wellsford, 704 SH-1, Wellsford, 542 SH-1, Topuni, 490 SH-1, Wellsford, 131 Kaipara Flats Rd, 139 Vipond Road, 129 Vipond Road, 17 Maeneene Rd, Wellsford and 33 Maeneene Rd, Wellsford due to their potential proximity (less than 50 m from the designation boundary) to construction activities that could occur anywhere within the proposed designation boundary.

- Two residential properties on SH1 north of Maeneene Road, one residential properties on Mangawhai Road, one residential properties on SH1 south of Hōteo Bridge to Warkworth, two residential properties on Kaipara Flats Road between Carran Road and SH1, and one residential properties on Woodcocks Road. This is due to their proximity to access roads and trackout dust risk from construction activities extending up to 500 m from the proposed designation boundary.

- Two residential properties on Silver Hill Road due to their proximity to unsealed access roads and dust risk from vehicles.
- 25 residential properties within the Northern Section and 11 residential properties within the Southern Section – due to their potentially close proximity to mobile rock crushing.

Based on the potentially large number of HSRs that may be affected by dust from the Project, the effects of construction on air quality is assessed as being potentially significant and mitigation is recommended.

Operational Phase

A Tier 2 Screening Modelling level of assessment has been applied to assess the potential effects of air quality from the operational phase of the project.

There are 64 residential properties defined as HSRs for the operational effects assessment. The potential effects at the worst-case HSR locations have been assessed. The assessment demonstrates that the Project will maintain air quality at acceptable levels throughout the largely rural environment of the Project Area with very low levels of increase in contaminant concentrations, which are below the Transport Agency criteria for Project contribution, and well below for cumulative contribution.

The Project tunnels are also assessed as having acceptable impacts on air quality with concentrations of contaminants reducing to low levels within a short distance of the portals.

A sensitivity analysis for the effects of operation was undertaken if the Indicative Alignment were to be moved within the designation boundary, even if a HSR was located 5m from the Indicative Alignment road edge (for the road section with greatest traffic flow), air quality guidelines and standards would still be met when considered cumulatively with the background air quality. Similarly, even if traffic flow increases by as much as 100%, the significance criteria will still be comfortably complied with and cumulative air quality concentrations would still be predicted to be well within air quality standards and guidelines.

We also considered the possibility of the Indicative Alignment tunnel portals being situated at any location within the proposed designation boundary at final design stage. Should the tunnel portals be located within 200 m of a HSR, the potential air quality risk of the tunnel may increase to medium or high risk. If the separation distance is lower than 200 m further along in the design process, it is recommended that a suitably qualified air quality specialist be engaged to assess the risk to air quality and undertake air quality dispersion modelling of the discharges from the tunnel portals, if required.

Within the road network affected by the Project, there will be a benefit from improved air quality due to reduced traffic and congestion on the existing SH1, in particular through the townships of Wellsford and Te Hana, where community exposure to vehicle emissions will lower as a result of the Project.

In summary, we consider the environmental effects of the operational phase of the Project on air quality will be less than minor. Compliance with relevant air quality guidelines and standards, in particular the AAAQTs and the NESAQ will be achieved with the operation of the Project. Considering the reduction of road transport emissions along SH1 near a higher density of HSRs resulting from the Project operation, the operational phase of Project is considered to have a positive effect on overall air quality.

5.1 Assessment of construction air quality effects

5.1.1 Construction methodology

Section 5 of the AEE details three Project construction sections and the extent of the earthworks and other activities likely to occur in each sector. The total earthworks cut volumes have been estimated at approximately 4.5 million m^3 in the Northern Section, 6 million m^3 in the Central Section, and 1.9 million m^3 in the Southern Section.

The construction period is indicated to be 7 years in duration, and earthworks would be principally undertaken 7 days a week, with more volume of earthworks likely in summer months. During winter it could be expected that weather and shorter daylight hours would slow construction activities and the Project will be dominated by the substantial earthworks operations that are susceptible to weather. Hours of operation are to be as follows:

a) Generally, sun up to sun down;

b) 7 days per week – however production will slow during inclement weather; and

c) 24/7 shifts for tunnel excavations.

Construction activities are proposed to occur within the proposed designation boundary. These include construction compounds, cut/fill earthworks, blasting activities, soil disposal sites, borrow sites, access roads and haul routes, and mobile rock crushing. For the purposes of this assessment, all of these activities have been assumed to be able to be located anywhere within the proposed designation boundary, with the exception of mobile rock crushing. The location of mobile rock crushing will be limited to where it may reasonably be expected for the crushing to occur.

Potential access roads are shown in Drawings 9 – 12 in Appendix A of the Construction Traffic Assessment; those which are proposed outside of the proposed designation boundary have been included in the assessment accordingly.

Based on the current construction design, there is a cut/fill balance for the Northern Section. All material cut during construction is therefore to remain within the construction area, i.e. no material will need to be disposed of offsite, which will minimise the vehicle movements on access roads. There is a predicted excess of material in the Central Section, and a shortfall of fill material in the Southern Section. Therefore, transporting of material between Central and Southern Sections, and from nearby quarry sources will be required and vehicle movement on access roads is likely to be higher in these sections.

For Project areas where the construction of bridges or viaducts is anticipated, the potential for dust is considered to be low because there is minimal disturbance of land.

The Construction Traffic Assessment Report provides the projected traffic movements of both heavy and light vehicles accessing the main site office (assumed possible location within the Southern Section) and the Northern, Central and Southern Sections.

Construction traffic on the roading network is predicted to be the following for the 6.5-year construction period:

- 576-660 light vehicles per day (vpd) with 585-1086 heavy vpd in the Northern Section, for years when hauling occurs;

- 432-488 light vpd with 150-400 heavy vpd in the Central Section; and

- 502-578 light vpd with 287-752 heavy vpd in the Southern Section, assuming that the main site office is located in this area.

There are also 40-56 anticipated visitors per day in addition to the light vpd across the Project Area.

Mobile crushing plant

The mobile crushing plant is anticipated to have a capacity of up to 300 tonnes per hour (tph) and accordingly requires a resource consent for discharges to air. Dust is potentially generated from the size reduction operations and the conveying of crushed materials. The potential for dust emissions will largely depend on the moisture content of the materials and the amount of fine particulate matter present.

We understand that the mobile crushing plant could be reasonably expected to be operated at locations where excavated materials require crushing in order to be used as fill. We are advised that Pakiri Formation rock is highly likely to need crushing. Limestone, and possibly stronger bands within the mudstones, may also need processing by mobile crushing plant if they cannot be broken down by normal compaction plant. Consequently, areas of the Project where mobile crushing plant could be located have been identified as:

- Northern Section – anywhere in cut areas as several cuts are in limestone and other cuts may have bands of stronger mudstone
- Central Section – anywhere in cut areas as Pakiri Formation rock will be encountered in all cuts
- Southern Section – anywhere in cut areas between the southern portal of the tunnel and Bridge 22 as Pakiri Formation rock will be encountered in these cuts.

5.1.2 Potential effects of Project construction dust

The potential effects of air quality during the Project construction will be health effects from exposure to inhalable particulate matter, and dust which has the potential to affect amenity and be considered offensive or objectionable to the extent that there is an adverse effect (for example excessive dust deposits on houses, cars or washing). Potential health effects from inhalable particulate matter are discussed in Section 2.2.

Excessive dust deposition can also cause stress related conditions for some residential properties. Dust can have effects on visibility, although these impacts are typically near the source and do not pose a wider effect. While the visibility of dust is more of an aesthetic concern, much of the public perception of air quality directly relates to visibility.

Given the rural nature of the Project Area, dwellings may rely on roof water collection for their water supply. Roof water collection systems may be affected by excessive dust causing increased suspended solids in the water supply. Increased suspended solids (turbidity) are more of an aesthetic than a health concern.

The potential for dust emissions will largely depend on the moisture content of the materials and the amount of fines present. Determining whether dust is offensive or objectionable to the extent that there is an adverse effect is assessed by considering the FIDOL factors as discussed earlier in this report.

Vegetation (flora) near a dust source may also be affected from dust deposition including reduced photosynthetic potential (reduced growth and crop yield), reduced effectiveness of pesticides and increased potential for diseases and pests. As the effects of dust are generally related to deposited dust, the effects are generally restricted close to the dust source. In turn, fauna living in any impacted vegetation would also be affected. Some fauna is understood to be more susceptible to dust or other air quality changes. The effect of dust deposition on ecological receptors has been assessed in the Ecology Assessment Report.

There are electricity transmission lines at Te Hana Interchange. Construction dust has the potential to cause a line to flashover/fault from dust deposition if dust mitigation measures are inadequate. 'Flashover' is the term used to describe a momentary, but major electric arc; a flashover or contact with the electricity transmission lines, may result in an outage of electricity supply to communities, people and industry[22].

Susceptibility to effects of dust from Project construction will decrease with distance from the earthworks and associated construction activities.

5.1.3 Construction dust effects assessment

The effects of dust from Project construction at HSRs will be greatest immediately downwind under strong winds and dry conditions. The meteorology of the Project Area, as discussed in Section 4.3, indicates that strong winds are predominantly from the west, which would cause increased risk of dust deposition to residences to the east of the corridor.

Wind data measured at Warkworth indicates that winds above 5 m/s occur relatively often, approximately 30% of the time and winds stronger than 10 m/s occur relatively infrequently at 2.5% of the time. HSRs to the east of the proposed designation boundary are subject to potentially significant adverse effects of dust from the prevailing winds and the strongest wind, i.e. those greater than 10 m/s. The Warkworth area has a relatively high rainfall compared to other parts of Auckland therefore ground could be expected to be damp and dust less likely to be elevated in ambient air.

HSRs with a separation distance of more than 200 m from the proposed designation boundary will likely experience less than minor impacts, even without mitigation measures for dust management.

There are 64 HSRs susceptible to potential effects from construction activities occurring within the proposed designation boundary. The distance of the nearest HSR to the proposed designation boundary is the residential property at 145 Kraack Road, Dome Forest. 161 Kraack Road is located within the proposed designation boundary, however, it is considered unlikely that any construction activities will be located nearer than 20 m to this HSR. 145 Kraack Road is therefore considered appropriate to use as the worst-case HSR for potential construction effects.

Table 16 below indicates that there are eight HSRs in total which fall within 20 m, and seven HSRs within 50 m of any of the proposed construction activities identified in Section 5.1.1, above. Figure 6 to Figure 9 in Appendix D display the HSRs within 200 m of the proposed designation boundary.

The Northern Section of the Indicative Alignment has 10 HSRs located within 50 m from potential dust producing construction activities, six of these being within 20 m. As there is

[22] Ministry for the Environment (2010) National Policy Statement of Electricity Transmission: further guidance on risks of development near high-voltage transmission lines publication. Relevant text The Problems with Development near High-voltage Transmission Lines available at: http://www.mfe.govt.nz/publications/rma/national-policy-statement-electricity-transmission-further-guidance-risks

a 4.5 million m^3 volume of earthworks approximated in this Section, the potential for adverse effects from dust being experienced downwind of construction activities is significant. The HSRs identified as being nearby (i.e. within 50 m) and downwind of potential dust producing activities are; 177 Rustybrook Rd, Wellsford, 47 Borrows Rd, Wellsford, 35 Vipond Road, Wellsford, 704 SH-1, Wellsford, 542 SH-1, Topuni, 490 SH-1, Wellsford, 139 Vipond Road, 129 Vipond Road, 17 Maeneene Rd, Wellsford and 33 Maeneene Rd, Wellsford in the Northern Section.

The Central Section has one HSR within 20 m of the proposed designation boundary, the residential property at 145 Kraack Rd, Dome Forest, and one property within the proposed designation boundary, 161 Kraack Rd, Dome Forest. Although 161 Kraack Road is located within the proposed designation boundary at height and above the proposed tunnels, it is considered unlikely that any construction activities will be located close enough to affect this HSR. Accordingly, we consider that dust will likely have a no more than minor effect on the HSRs considered in this report i.e. excluding ecological receptors, in the Central Section.

The Southern Section has four HSRs located within 50 m of the proposed designation boundary and construction activities, one of these is located within 20 m from the boundary. There is the smallest volume of earthworks predicted in this Section, however, the earthworks volume is still proposed to be 1.9 million m^3 so the potential for adverse effects from dust downwind of construction activities is assessed as significant. The HSRs identified as being nearby (i.e. within 50 m) and downwind of potential dust producing activities are residential properties 74 Wyllie Road and, 130,131 and 211 Kaipara Flats Road.

There are no large residential housing estates identified within 200 m of the proposed designation boundary due to the rural nature of the area. Therefore, while some individual dwellings have the potential to be significantly adversely affected large numbers of HSRs will not be affected all at the same time.

HSRs more than 50 m from construction areas are less likely to be significantly affected by dust deposition, particularly given the application of good industry practice management discussed in Section 6 of this report.

Table 16 – Residential properties near the proposed designation boundary

Section	Number of residences within 20 m	Number of residences within 50 m	Number of residences within 200 m (not including those within 50 and 20m)	Approx. Distance of nearest residence to proposed Designation boundary (m)
Northern	6	4	31	8
Central	1	0	1	1
Southern	1	3	16	15
Total	**8***	**7**	**48**	

Note an additional property, 161 Kraack Road, is located within the proposed designation boundary.

The HSRs within 200 m of the potential mobile rock crushing activities are as follows:

- Northern Section – there are 25 HSRs within 200 m, three HSRs within 50 m and two within 20m of the proposed cut/fill areas where the mobile rock crusher has potential to be operated.

- Central Section – there are no HSRs within 200 m of the proposed cut/fill areas where the mobile rock crusher has potential to be used.

- Southern Section – there are eleven HSRs within 200 m and one HSR within 50 m of the proposed cut/fill areas where the mobile rock crusher has potential to be used.

The mobile rock crusher has the potential for adverse effects on air quality both from dust and fine particulate matter discharges if located within a close proximity of HSRs.

Table 10 in Section 4.2 of this report identifies 9 HSRs within potential access roads used for construction, which will extend outside of the proposed designation boundary, with HSRs as close as 20 m from the road edge. There are 7 of these HSRs identified with potential to be impacted by construction trackout dust from sealed roads, and 2 HSRs within 100 m of unsealed roads identified to be used for accessing the Project during construction.

We consider that the potential for dust effects from construction trackout and from unsealed roads for HSRs along the roads identified in Table 10 as having potentially adverse effects, and have accordingly recommended mitigation.

5.1.4 Summary

Much of the Project is relatively remote, but there are some HSRs that are nearby and potentially affected by dust from construction activities within the proposed designation boundary, and construction traffic on identified access roads that are located outside of the proposed designation boundary.

Those HSRs we have identified as being potentially adversely affected by dust from construction are:

- 177 Rustybrook Rd, Wellsford, 47 Borrows Rd, Wellsford, 35 Vipond Road, Wellsford, 704 SH-1, Wellsford, 542 SH-1, Topuni, 490 SH-1, Wellsford, 139 Vipond Road, 129 Vipond Road, 17 Maeneene Rd, Wellsford and 33 Maeneene Rd, Wellsford (Northern Section) (Figure 6 and Figure 7 in Appendix D) – due to their proximity to any construction activity occurring within the proposed designation boundary;

- 74 Wyllie Road, 130,131 and 211 Kaipara Flats Road ,145 Kraack Rd, Dome Forest, and one property within the designation boundary (161 Kraack Rd, Dome Forest (Central and Southern Section) (Figure 9 and Figure 10 in Appendix D) – due to their proximity to any construction activity occurring within the proposed designation boundary;

- Two residential properties on SH1, north of Maeneene Road extending up to 500 m from the proposed designation boundary; and one residential properties on Mangawhai Road extending up to 500 m from the proposed designation boundary – due to their proximity to access roads and risk to impact from trackout dust from construction activities in the proposed designation boundary in the Northern Section;

- One residential properties on SH1, south of Hōteo Bridge, to Warkworth extending up to 500 m from the proposed designation boundary – due to their proximity to access roads and risk to impact from trackout dust from construction activities in the proposed designation boundary in the Central / Southern Section;

- Two residential properties on Kaipara Flats Road between Carran Road and SH1; and one residential properties on Woodcocks Road, extending up to 500 m from the proposed designation boundary – due to their proximity to access roads and risk to impact from trackout dust from construction activities in the proposed designation boundary in the Southern Section;

- Two residential properties on Silver Hill Road – due to their proximity to access roads and risk to impact from dust from unsealed roads in the Northern Section; and

- 25 residential properties within the Northern Section and eleven residential properties within the Southern Section – due to their close proximity to mobile rock crushing.

We have accordingly recommended mitigation measures for dust discharges from the construction phase.

5.2 Assessment of operational air quality effects

5.2.1 Network effects of the Project

Table 23 in Appendix B of this report sets out the forecast AADT and percentage of HCVs for the opening and design years for the Project and for SH1 'with Project' and 'without Project' for 2036 and for the 2046 design year. Traffic on the Indicative Alignment (the section of the Indicative Alignment with greatest traffic flow) for the Project south of Wayby Valley Road is predicted to be in the order of 20,000 vpd in 2036 and 25,0000 vpd in 2046.

The main operational effect of the Project on the transportation network will be the movement of traffic from SH1 to the Indicative Alignment, with some Project roads moving more traffic from SH1 than others. For example, SH1 South of Wayby Road, is predicted to fall from 28,591 AADT in the 'Without Project 2046' scenario, to 4,135 AADT in the 'With Project 2046' scenario. This reduction of traffic on the existing SH1 will be a benefit to the existing HSRs along this route as exposure to contaminant concentrations will be lower.

Contaminant concentrations will, however, increase at locations along the Indicative Alignment at HSRs where there is currently a minimal contribution from road transport emissions. For example, at 177 Rustybrook Road, there are minimal emissions predicted from road sources with very low AADTS in the 'Without Project' scenarios while traffic flows are predicted to be 19,936 AADT in the 'With Project 2046' scenario. While air quality will be reduced, the assessment of effects shows it will still be acceptable.

In the 'Without Project' scenarios, all traffic would continue to travel on SH1, leading to increased traffic and congestion along that route, which includes the townships of Wellsford and Te Hana. Consequently, in the 'Without Project' scenarios in these areas, there would be increased air quality emissions and therefore a potential for increased exposure to air contaminants in Wellsford and Te Hana townships and at other HSRs along existing SH1, especially with projected growth in traffic over time.

5.2.2 Road emissions estimation

Traffic operating on the Project road will be predominantly free flowing and generally involving warm running at constant speeds of 80 km/h or more along most of the new road. The posted speed limit for the new road will be 100 km/h. We used a vehicle speed of 80 km/h in the Transport Agency Screening Model to account for periods of slower traffic due to congestion or steeper sections of the new road. This approach is generally more conservative for the particulate matter assessment because these emissions tend to increase with decreasing average speed.

The Transport Agency Screening Model incorporates emission rates for PM_{10} based on VEPM Version 5.1 and includes particulate matter from combustion and tyre and brake wear. The equations in the Screening Model for NO_2 are based on empirical data for Auckland from work undertaken by NIWA[23]. When using VEPM, PM emission factors are predicted to decrease with time due to the introduction of national controls and changes in vehicle technology, but NO_2 emission factors are not projected to change with time as there is no evidence for this a decrease in NO_2 emissions from vehicles[24]. The Screening Model does not estimate $PM_{2.5}$ emissions, so we have assumed that all PM_{10} emissions are $PM_{2.5}$ for the assessment, which will be slightly conservative due to the inclusion of tyre and brake wear emissions, which will include a component of particulate matter that is greater in size than $PM_{2.5}$.

5.2.3 Operational effects assessment of Indicative Alignment

Identification of HSRs in worst-case locations

There are 64 HSRs within 200 m of the proposed designation boundary that are considered as potentially affected from the Project operation, including 161 Kraack Road located within the proposed designation boundary. As described in Section 3.4, we have assessed worst-case HSR locations to present a worst-case assessment of effects on air quality from the operational phase. The worst-case HSRs are based on those HSR which have the most potential to be adversely affected by the Project. Our assessment has not sought to quantify the effects on HSRs that will benefit from the Project operation.

The nearest HSR to the road edge of the Indicative Alignment for the assessment of potential operational effects is residential property, 129 Vipond Road. Vipond Road, however, has little traffic flow and will therefore not be representative of worst-case emissions at HSRs. The nearest HSR to the Indicative Alignment road edge with high traffic flows is a distance of 165 m at residential property 74 Wyllie Road, to the south of the Warkworth Interchange. If the Indicative Alignment were to shift within the proposed designation boundary, then the closest HSR has potential to be closer than this distance. 74 Wyllie Road has therefore been used to represent the HSR with the worst-case location due to the highest traffic flows.

Two further HSRs were chosen for their worst-case locations at 177 Rustybrook Road and 211 Kaipara Flats Road. The Transport Agency Screening Model was used to assess the effects of the Project on these worst-case HSRs locations. These HSRs are detailed in Table 17 with an explanation of why they are relevant to assess the worst-case. Locations of HSRs relative to the road links are shown in Figure 3 to Figure 5.

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23 NZTA air quality screening model users' notes, June 2014.

24 VEPM 5.1 User Guide, 2013 https://www.nzta.govt.nz/assets/Highways-Information-Portal/Technical-disciplines/Air-and-climate/Planning-and-assessment/Vehicle-emissions-prediction-model/NZTA-Vehicle-Emissions-Prediction-Model-Guide-v1.0-FINAL-270214.pdf

Table 17 – HSRs assessed for the operational phase

HSR location	Distance to Indicative Alignment	Distance to proposed designation boundary	Description of nearby road emissions
74 Wyllie Road	165 m	30 m	The Pūhoi to Warkworth Project (under construction) is located approximately 143 m to the east of this HSR and will form part of the existing environment. The Project traffic is proposed to use the Pūhoi to Warkworth section of SH1, and traffic emissions are proposed to decrease slightly with the Project at this location. This location has been chosen to represent worst-case as it is likely to experience the highest air quality road emission concentrations surrounding the Project Area, due to the highest traffic volumes of all road links included in the Traffic Assessment passing by this point.
177 Rustybrook Road	124 m	9 m	Introduction of the Indicative Alignment to the east of this location is predicted to increase emissions at this HSR as a result of the Project.
211 Kaipara Flats Road	106 m	34 m	Introduction of the Warkworth Interchange east of this location is predicted to increase emissions at this HSR as a result of the Project.

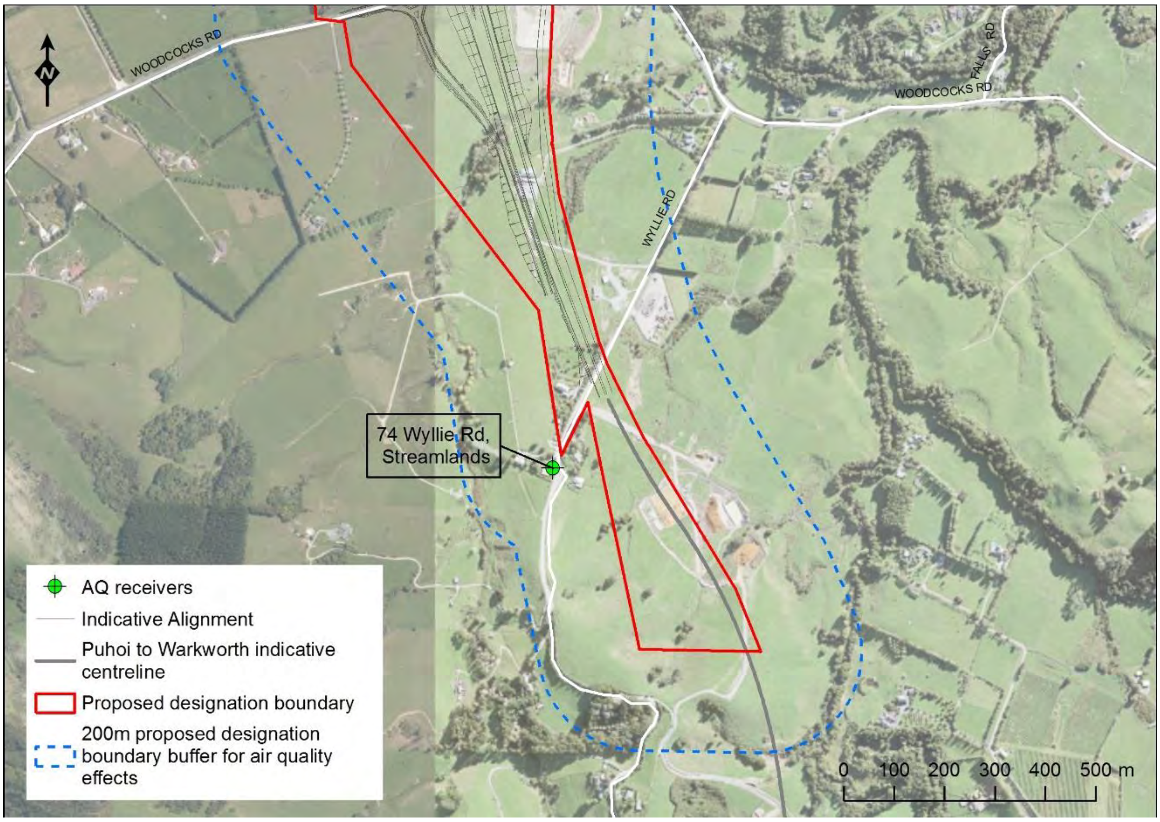

Figure 3 – 74 Wyllie Road – Highly Sensitive Receiver included in the operational effects assessment

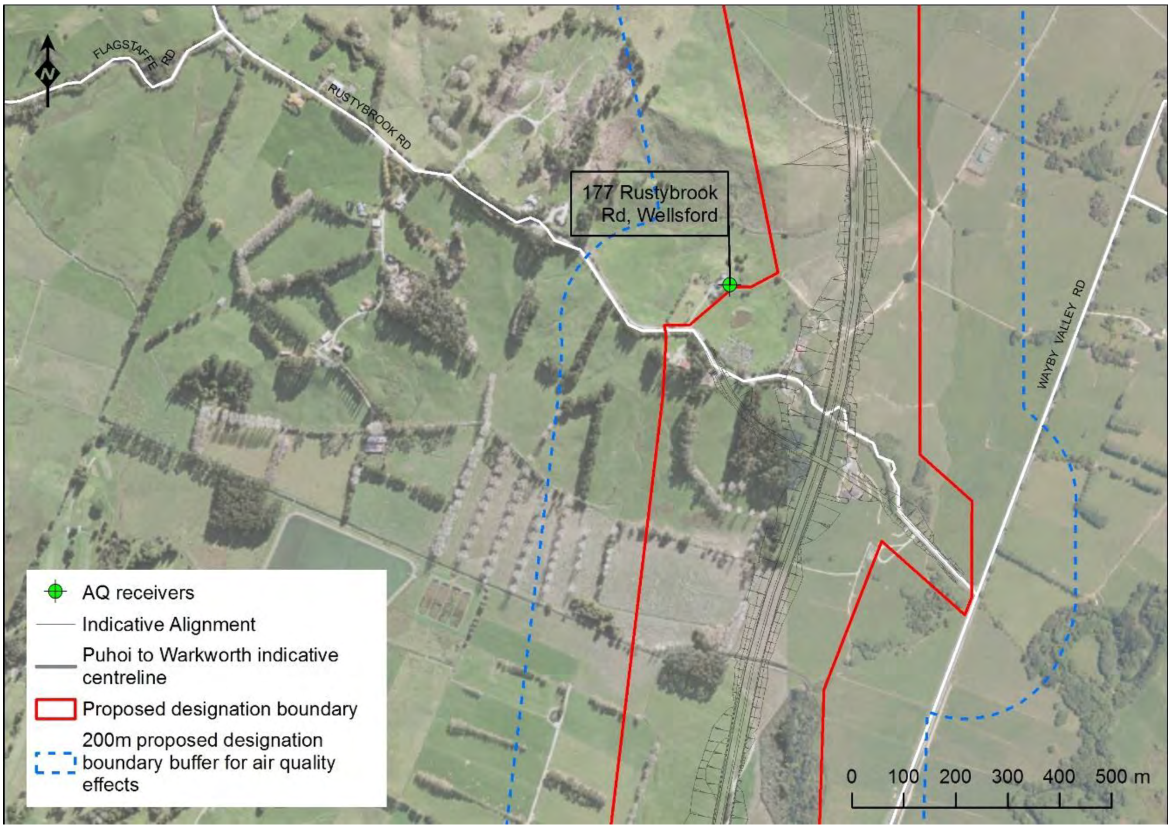

Figure 4 – 177 Rustybrook Road – Highly Sensitive Receiver included in the operational effects assessment

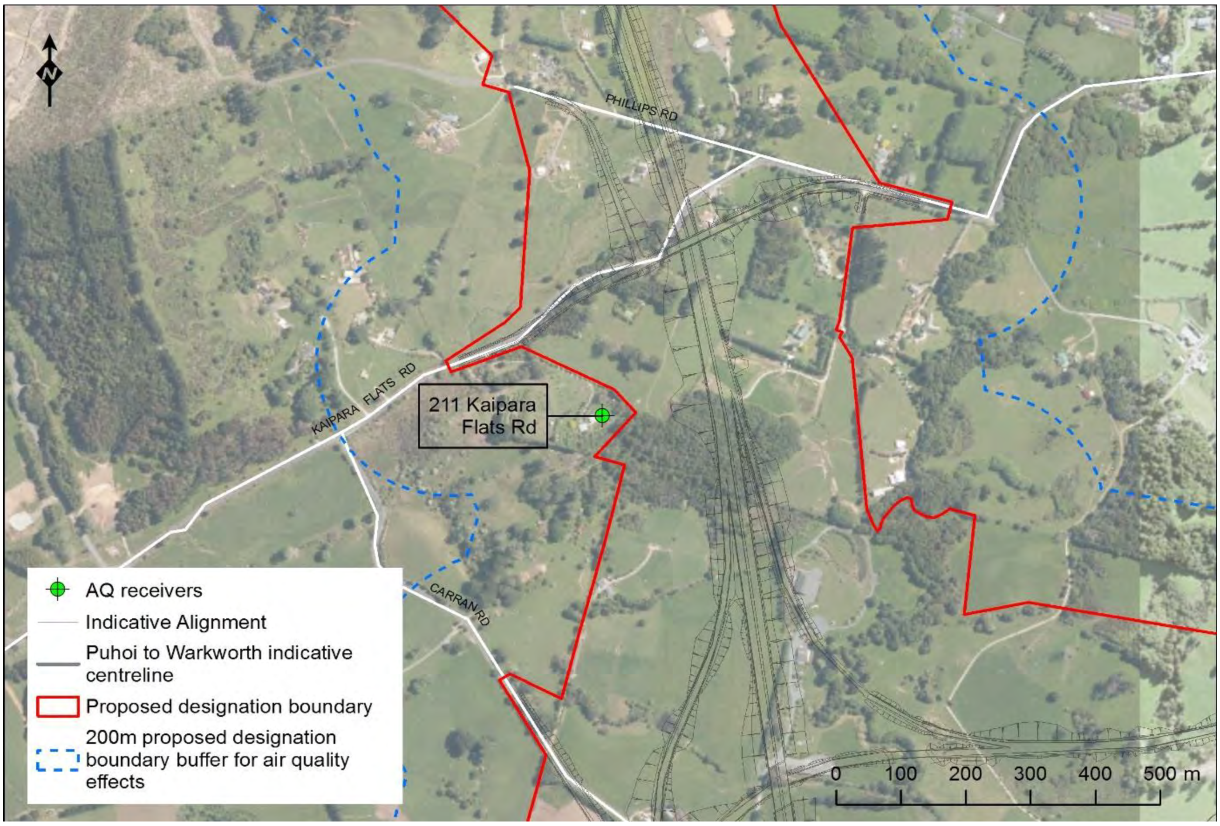

Figure 5 – 211 Kaipara Flats Road – Highly Sensitive Receiver Included in the operational effects assessment

Assessment of operational effects on worst-case HSRs

Table 18 presents a summary of the air quality screening model results for each worst-case HSR, including the road contribution, plus the assessed background air quality. The table also shows the road contribution change between 'With Project' and 'Without Project' 2036 and 2046 scenarios for comparison with the significance criteria. Where HSRs were located nearby to more than one road link, such as at a Project interchange, the cumulative effects of these roads were also included.

Table 18 – Summary of screening model outputs for each worst-case HSR by scenario

Assessment scenario	24 hour average PM_{10} (µg/m³)		24 hour average $PM_{2.5}$ (µg/m³)		Annual average NO_2 (µg/m³)	
	Road Contribution	(+BG)	Road Contribution	(+BG)	Road Contribution	(+BG)
74 Wyllie Road						
Base 2016	0	28.3	0	14.2	0	4
Without Project 2036	0.1	28.4	0.1	14.3	0.9	4.9
With Project 2036	0.1	28.4	0.1	14.3	0.8	4.8
Road Contribution Change 2036	0	–	0	–	-0.1	–
Without Project 2046	0.1	28.4	0.1	14.3	1.1	5.1
With Project 2046	0.1	28.4	0.1	14.3	1.1	5.1
Road Contribution Change 2046	0	–	0	–	0	–
177 Rustybrook Road						
Base 2016	0	28.3	0	14.2	0	4
Without Project 2036	0	28.3	0	14.2	0	4
With Project 2036	0	28.3	0	14.2	0.4	4.4
Road Contribution Change 2036	0	–	0	–	+0.4	–
Without Project 2046	0	28.3	0	14.2	0	4
With Project 2046	0	28.3	0	14.2	0.5	4.5
Road Contribution Change 2046	0	–	0	–	+0.5	–
211 Kaipara Flats Road						
Base 2016	0	28.3	0	14.2	0	4
Without Project 2036	0	28.3	0	14.2	0	4
With Project 2036	0	28.3	0	14.2	0.6	4.6
Road Contribution Change 2036	0	–	0	–	+0.6	–
Without Project 2046	0	28.3	0	14.2	0	4

Assessment scenario	24 hour average PM_{10} ($\mu g/m^3$)		24 hour average $PM_{2.5}$ ($\mu g/m^3$)		Annual average NO_2 ($\mu g/m^3$)	
	Road Contribution	(+BG)	Road Contribution	(+BG)	Road Contribution	(+BG)
With Project 2046	0	28.3	0	14.2	0.8	4.8
Road Contribution Change 2046	0	–	0	–	+0.8	–
Significance Criteria	**5**	**45**	**2.5**	**22.5**	**4**	**36**
Note: BG = background.						

The HSR location where the highest increase between the 'With Project' and 'Without Project' scenarios is predicted as a result of the Project is at 211 Kaipara Flats Road, where the screening model predicts no increase for 24 hour average PM_{10} and $PM_{2.5}$, and a 0.8 $\mu g/m^3$ increase for annual mean NO_2 (2% of the relevant air quality guideline, 40 $\mu g/m^3$). The cumulative effect on air quality is predicted to be 4.8 $\mu g/m^3$ (12% of the relevant air quality guideline, 40 $\mu g/m^3$). This assessment is based on the Indicative Alignment, at a separation distance of 165 m from the HSR.

With reference to the significance criteria shown in Table 8, the Project is well below the threshold for project contribution and for cumulative contribution. The operational air quality risk is therefore deemed to be low for the Indicative Alignment.

Operational effects sensitivity analysis

Movement of the Indicative Alignment within the proposed designation boundary

We understood that there is potential that the Indicative Alignment could be shifted within the proposed designation boundary during final design stage for the Project. Such a movement has the potential to result in HSRs being closer to the Indicative Alignment than assessed above. We understand that it is unlikely that the Indicative Alignment design will be moved as far as the edge of the proposed designation boundary. For example, the P-W Project is a committed development and is already in construction phase, so it is unlikely that an alignment move towards 74 Wyllie Road will occur. Nevertheless, we have adopted a conservative approach to the sensitivity analysis and have considered air quality effects for the worst-case HSRs that have the potential to be impacted by a movement of the Indicative Alignment as far as the proposed designation boundary.

Air quality effects have been considered for the 'With Project 2046' scenario for HSRs 177 Rustybrook Road, and 130 Kaipara Flats Road, as shown in Table 19. These HSRs have the highest potential to be impacted by a change in Project design causing movement of the Indicative Alignment.

The results indicate that the PM_{10} and $PM_{2.5}$ Project road contribution for both HSRs is below the Transport Agency significance criteria. The significance criteria for NO_2 road contribution would be exceeded if the road alignment is on the edge of the designation boundary at distances less than 10 m from the proposed designation boundary for 177 Rustybrook Road and less than 15 m from the proposed designation boundary for 130 Kaipara Flats Road. As the HSRs are approximately 10 m and 15 m from the proposed designation boundary, the significance criteria threshold would not be exceeded at these locations.

Table 19 – Summary of screening model outputs for each HSR for sensitivity analysis

Distance from road edge	24 hour average PM_{10} (µg/m^3)		24 hour average $PM_{2.5}$ (µg/m^3)		Annual average NO_2 (µg/m^3)	
	Road Contribution	(+BG)	Road Contribution	(+BG)	Road Contribution	(+BG)
177 Rustybrook Road (10 m from proposed designation boundary)						
Actual (210 m)	0	28.3	0	14.2	0.5	4.5
30m	0.6	28.9	0.6	14.8	1.7	5.7
20m	0.8	29.1	0.8	15.0	2.2	6.2
15m	0.9	29.2	0.9	15.1	2.6	6.6
10m	1.1	29.4	1.1	15.3	3.4	7.4
5m	1.5	29.8	1.5	15.7	**5.4**	9.4
130 Kaipara Flats Road (15 m from proposed designation boundary)						
Actual (300 m)	0.3	28.6	0.3	14.5	0.9	4.9
30m	1.0	29.3	1.0	15.2	2.5	6.5
20m	1.2	29.5	1.2	15.4	3.1	7.1
15m	1.4	29.7	1.4	15.6	3.7	7.7
10m	1.7	30	1.7	15.9	**4.6**	8.6
5m	2.1	30.4	2.1	16.3	**7.1**	11.1
Significance Criteria	**5**	**45**	**2.5**	**22.5**	**4**	**36**
Note: BG = background. Road contribution in **bold** are those which exceed the significance criteria thresholds.						

Based on the sensitivity analysis results in Table 19 above, even if a residential property was located 5 m from the road edge of the Indicative Alignment with the highest traffic flows, air quality guidelines and standards would still be easily met when considered cumulatively with the background air quality described in Section 4.

Higher volumes of traffic

We have undertaken a sensitivity analysis of the traffic flow to assess the potential effects if there is more growth than currently predicted in the Auckland Region traffic forecasts., We assessed the potential increased traffic flow for the Indicative Alignment across the section with the largest volume of traffic i.e. at 74 Wyllie Road. Table 20 presents the results for the traffic sensitivity analysis.

Table 20 shows that should traffic flow increase by as much as 100% (i.e. from approximately 35,000 AADT to 70,000 AADT), the significance criteria will still be comfortably met and cumulative air quality concentrations would still be predicted to be well within air quality standards and guidelines.

Table 20 – Sensitivity analysis of traffic flows for 74 Wyllie Road for the 'With Project 2046' Scenario

AADT	24 hour average PM_{10} (µg/m³)		24 hour average $PM_{2.5}$ (µg/m³)		Annual average NO_2 (µg/m³)	
	Road Contribution	(+BG)	Road Contribution	(+BG)	Road Contribution	(+BG)
Current predicted traffic – 35,353	0.1	28.4	0.1	14.3	1.1	5.1
Increase to 40,000	0.1	28.4	0.1	14.3	1.2	5.2
Increase to 50,000	0.1	28.4	0.1	14.3	1.5	5.5
Increase to 60,000	0.2	28.5	0.2	14.4	1.8	5.8
Increase to 70,000	0.2	28.5	0.2	14.4	2.1	6.1
Significance Criteria	**5**	**45**	**2.5**	**22.5**	**4**	**36**

Assessment of tunnel air quality effects

The AUP(OP) has a risk assessment process for determining the need for a resource consent for road tunnels. The AUP(OP) framework is presented in Table 6 and Table 7 in this report and we have applied this framework to assess the potential air quality risk of the tunnels and the need for detailed assessment of the effects on air quality. In applying the framework, we have considered the background air quality, the separation distance of the closest HSR to the tunnel portals, and the AADT for the Indicative Alignment at the tunnels as follows:

- The background air quality within the Project tunnel vicinity – as summarised in Section 4– air quality is good and there are no HSRs within 200 m of the tunnel portals, therefore we rate the air quality tunnel risk as 'low'.
- The closest HSR is at 127 Kraack Road, 275 m from the northern tunnel portal. We therefore rate the air quality risk from the tunnel discharge to be low.
- The AADT predicted for 2036 for the W2W South of Wayby Valley Road link is 20,155, which is in the 10,000 to 50,000 (medium) range, therefore, the rating of air quality risk for the proposed Project tunnel traffic data is assigned a medium risk.

Taking into the account of the above, the proposed tunnel for the Project is assessed as 'low' risk overall and as such, a detailed assessment of the effects on air quality from tunnel portal discharges is not required.

Accordingly, the permitted activity conditions as discussed in Section 3.5.4 are applicable to the tunnel operation.

A general discussion of tunnel portal discharges and some indicative air quality monitoring data is provided in Appendix C to provide an indication of the scale of the potential operational air quality effects from tunnels. The tunnel monitoring data reviewed confirms the low risk associated with the operation of the Project tunnels, and that tunnel operation of the Indicative Alignment will not adversely affect air quality outside of the tunnels, particularly at locations where people are likely to be exposed.

As discussed in the operational effects sensitivity analysis above, we understand that the Indicative Alignment tunnel portals could be situated at any location within the proposed designation boundary at final design stage. Should the tunnel portals be located within 200 m of a HSR, the potential air quality risk of the tunnel may increase to medium or high risk. If this situation arises further along in the design process, it is recommended that a suitably qualified air quality specialist be engaged to assess the risk to air quality and undertake air quality dispersion modelling of the portals, if required.

We note that New Zealand has an ambient air quality guideline value for ecosystem effects of 30 µg/m^3 as an annual average. The Ecology Assessment Report discusses the potential effect of operational tunnel portal emissions on ecosystems.

5.2.4 Summary of operational effects

Worst-case HSRs locations have been assessed. Worst-case HSRs locations potentially adversely affected by the Project operation have negligible increases in 24 hour average PM_{10} and $PM_{2.5}$, and a small increase in annual mean NO_2 predicted. For concentrations of annual mean NO_2, a maximum increase of a 0.8 µg/m^3 (or 2% of the relevant air quality guideline, 40 µg/m^3) is predicted.

The majority of HSRs included in the operational phase assessment are located more than 80 m from the Indicative Alignment, being outside of the proposed designation boundary.

The Project's operational impacts on air quality are below the thresholds for project contribution and well below for cumulative contribution, when compared with the Transport Agency significance criteria presented in Table 8. Cumulative road contribution and background concentrations are predicted to be well within air quality standards and guidelines. The Project tunnels have also been assessed as low risk under the AUP(OP) rule framework. The operational air quality risk is therefore deemed to be low for the Indicative Alignment and the method (Tier 2) approach undertaken here is considered appropriate for the Project.

Two sensitivity analyses have been undertaken. The first sensitivity analysis considered a movement of the Indicative Alignment anywhere within the proposed designation boundary. This evaluated the potential for the Indicative Alignment to be closer to HSRs than assessed, in the event of design changes. The sensitivity analysis indicates that the PM_{10} and $PM_{2.5}$ contribution of the Project for all HSRs are below the Transport Agency's significance criteria. The significance criteria for NO_2 road contribution would be exceeded at distances less than 10 m from the proposed designation boundary if the edge of the road alignment was at the designation boundary. There are no HSRs within 10 m of the boundary where movement of the Indicative Alignment would be possible, therefore the significance criteria threshold would not be exceeded for NO_2 road contribution either. Even if a HSR was located 5 m from the road edge of the Indicative Alignment with the highest traffic flow, air quality guidelines and standards would still be met when considered cumulatively with the background air quality described in Section 4.

As part of this sensitivity analysis, we considered the possibility of the Indicative Alignment tunnel portals being situated at any location within the proposed designation boundary at final design stage. Should the tunnel portals be located within 200 m of a HSR, the potential air quality risk of the tunnel may increase to medium or high risk. If the separation distance is lower than 200 m further along in the design process, it is recommended that a suitably qualified air quality specialist be engaged to assess the risk to air quality and undertake air quality dispersion modelling of the portals, if required.

Our second sensitivity analysis considered an increase in traffic flow on the Indicative Alignment. Our assessment shows that even if traffic flow increases by as much as 100%, the significance criteria will still be comfortably met and cumulative air quality concentrations would still be predicted to be well within air quality standards and guidelines. While not specifically quantified, there is a benefit to air quality from the operational phase of the Project due to a reduction in exposure to vehicle emissions along the existing SH1 and, in particular, within the communities of Wellsford and Te Hana.

In summary, we consider the effects of the operational phase of the Project on air quality to be less than minor and considering the reduction of road transport emissions along SH1 near a higher density of HSRs (i.e. townships of Wellsford and Te Hana), the Project is considered to have a positive effect on overall air quality.

6 RECOMMENDED MITIGATION

Recommended mitigation summary

There are a number of HSRs particularly close to sources of dust, including from construction activities within the proposed designation boundary, and along sealed and unsealed accessed roads outside of the proposed designation boundary. Project construction activities have the potential to give rise to dust emissions that could have moderate to significant adverse environmental effects, should no mitigation be implemented.

We recommend a set of general mitigation measures for construction air quality effects across the Project Area, and some specific HSR locations which will require mitigation from dust generating activities that occur within the proposed designation boundary. These specific locations are at 74 Wyllie Rd, Streamlands, 211 Kaipara Flats Rd, 130 Kaipara Flats Rd, 161 Kraack Rd, Dome Forest, 145 Kraack Rd, Dome Forest, 177 Rustybrook Rd, Wellsford, 47 Borrows Rd, Wellsford, 35 Vipond Road, Wellsford, 704 SH-1, Wellsford, 542 SH-1, Topuni, 490 SH-1, Wellsford, 131 Kaipara Flats Rd, 139 Vipond Road, 129 Vipond Road, 17 Maeneene Rd, Wellsford and 33 Maeneene Rd, Wellsford

We also recommend sealing Silver Hill Road and Lower Silver Hill Road roads if they are to be used for regular construction access, and implementing wheel wash facilities for vehicles using the following roads: SH1 north of Maeneene Road, Mangawhai Road, SH1 south of Hōteo Bridge to Warkworth, Kaipara Flats Road between Carran Road and SH1 and Woodcocks Road. Systems for dust suppression will need to be incorporated into the design and management of the mobile crushing plant. These systems could include enclosure of dust sources and extraction to control equipment or water suppression. In addition to this standard mitigation, a minimum separation distance of 100 m is recommended.

For the construction phase, a comprehensive Construction Air Quality Management Plan (CAQMP) should be developed following further design development and prior to construction activities commencing. The CAQMP should incorporate procedures for daily visual monitoring and recording of activities, and for responding to dust complaints in order to ensure that the appropriate mix of controls are put in place and adapted as necessary to suit the conditions. If an exceptional event should occur such that controls fail or are inadequately applied, cleaning services to mitigate adverse effects from dust deposition onto neighbouring properties should be provided. In such circumstances, additional dust monitoring may be needed to be undertaken to provide information to better apply dust controls and avoid future incidents.

We also recommend a range of monitoring measures and trigger levels to manage dust risk.

Once operational, the Project will have minor impacts on air quality. We therefore consider that no further mitigation measures are needed for the Project operation because the potential effects have been appropriately mitigated through the Project design.

6.1 Construction effects

6.1.1 Construction dust management

The construction phase of the Project has the potential to have significant adverse effects from dust discharges where construction activities could be undertaken in close proximity to HSRs.

Our assessment has assumed that construction activities and associated areas could be located anywhere within the proposed designation boundary. The general mitigation measures that we recommend be adopted as needed to avoid significant adverse effects from dust are as follows:

- Construct semi-permanent working areas, construction site access and haul roads with an appropriate base, keep metalled, and damp using watering trucks or fixed sprinkler systems during dry weather;
- Seal access roads where there are residential dwellings closer than 50 m separation;
- For sealed access roads, maintain surface using sweepers or vacuum trucks to limit dust build-up;
- Metal or re-vegetate and cordon cleared areas not required for construction access or for parking;
- Water as necessary, or preferably metal excavated areas exposed during dry windy conditions;
- Limit vehicle speeds to less than 15 kph on unsealed areas close to sensitive areas. The MfE Dust Guide (2016) indicates that limiting vehicle speed has a linear effect on increasing dust emissions and recommends a 10-15 kph speed limit to minimise dust from vehicle movements on unsealed areas;
- Train construction staff to make them aware of the sensitivity of the receiving environment and the need to take appropriate precautions;
- Use vehicle wheel wash facilities and/or any material tracked out from the site onto public roads, to be removed by scraping and/or washing if creating a dust issue;
- Load and unload trucks in a manner that minimises the discharge of dust;
- During dry windy conditions, loads may need to be wetted prior to loading or unloading to minimise dust generation;
- For locations close to HSRs, limit earthworks as far as practical when there are high winds in conjunction with dry conditions;
- Stage the earthworks as much as practicable to limit the exposed surface area at any one time;

- Install wind fencing of suitable length and height, particularly adjacent to sensitive areas. Note the effectiveness of wind fencing is greatest when perpendicular to the prevailing wind conditions and of a porosity of 50%;

- Manage exposed areas including stockpiles of topsoil, sand, and other potentially dusty materials by keeping surfaces damp, allowing to crust over, protect by wind barriers, or cover as appropriate. Define stockpile margins to minimise spread onto access areas and limit stockpile heights if uncovered or unprotected. Vegetate semi-permanent stockpiles;

- Consider the need for cleaning services for residences nearest the construction corridor in the event that dust discharges cannot be adequately controlled;

- Re-vegetate exposed surfaces whenever practicable;

- Provide water sprays to dampen down haul roads and stockpiles in dry conditions;

- Provide dust suppression and/or enclosure to control dust from the mobile rock crushing plant;

- Cover or dampen loads of potentially dusty material whenever practicable, and limit load sizes to avoid spillage; and

- Consider the need for the provision of drinking water for residences where drinking water supply is affected.

Specific mitigation measures are likely to be required at HSRs locations and we make the following recommendations based on the assessment of construction effects:

- Adopt a range of measures from those listed and adaptively manage as necessary to minimise dust particularly where activities are scheduled to occur within 50 m of HSR and in particular the following properties:

    - 129 and 139 Vipond Road;

    - 127, 145 and 161 Kraack Road;

    - 130 and 131 Kaipara Flats Road;

- Sealing Silver Hill Road and Lower Silver Hill Road roads, if these roads are to be used as a regular access route for the Project construction.

- Provide vehicle wheel wash facilities for construction vehicles accessing construction areas using the following sealed roads:

    - SH1, north of Maeneene Road;

    - Mangawhai Road;

    - SH1, south of Hōteo Bridge, to Warkworth;

    - Kaipara Flats Road between Carran Road and SH1; and

- Woodcocks Road.

- 25 residential properties within the Northern Section and nine residential properties within the Southern Section are within close proximity to potential mobile rock crushing. Systems for dust suppression will need to be incorporated into the design and management of the crushing plant. These systems could include enclosure of dust sources and extraction to control equipment or water suppression. In addition to this standard mitigation, a minimum separation distance to HSRs of 100 m is recommended.

The recommended dust mitigation measures above will contribute to minimising the Project's potential effects on flora and fauna, however, specific mitigation such as wind protection fencing may be appropriate for earthworks activities being undertaken very close to any identified sensitive locations in the Ecology Assessment Report and could be applied where needed through identification in a management plan.

Based on experience with dust management and the MfE Dust Guide (2016), we recommend that a Construction Air Quality Management Plan (CAQMP) be developed for the Project once the construction activities and associated areas are at a more detailed design stage. We recommend that the CAQMP should identify procedures for implementing site dust controls, including identifying responsibilities for the monitoring recommended in Section 6.1.2 below, as follows:

- What has to be done and why;
- Who has to do it and/or see that it is done;
- How it will be done;
- The desired outcomes; and
- How these outcomes will be monitored and procedures for acting on any issues identified.

Good practice measures for dust control via a CAQMP will be sufficient to avoid significant adverse effects for the majority of the time and the majority of the route. There are, however, many variables, in particular wind direction and strength, sunshine or rainfall, and the management methods that may be applied. It is therefore difficult to be certain that significant adverse effects will be able to be avoided under all circumstances.

6.1.2 Construction phase air quality monitoring

Dust monitoring is recommended to assist in the management of dust risk and air quality effects from construction. Three methods of monitoring are recommended:

- Visual inspection and record keeping on a daily basis;
- Weather observations; and
- Dust complaint investigation and reporting.

Monitoring of wind speed, wind direction, air temperature and rainfall is recommended to assist with decision making for applying the appropriate level of controls and to assist with complaint investigation. The MfE Dust Guide (2016) indicates that wind speeds of greater than 5 m/s can be used as a trigger for increasing the level of dust control, and wind speeds above 10 m/s may be a signal for work to cease.

Complaint investigation and reporting would test the effectiveness of the dust mitigation measures applied through a CAQMP, and provide an indicator as to whether improvements are required to a management plan and/or the mix of measures being applied under particular circumstances. For example, additional watering or wind fencing may be necessary for some locations if other measures are causing reasonable complaints. We therefore recommend that a specific dust complaint response procedure be developed as part of a CAQMP and that this be communicated to potentially affected parties prior to commencement of construction activities in a particular zone, including contact numbers for site staff.

Good practice measures for dust control via a CAQMP will be sufficient to avoid significant adverse effects for the majority of the time and the majority of the route. There are, however, many variables, in particular wind direction and strength, sunshine or rainfall, and the management methods that may be applied. It is therefore difficult to be certain that significant adverse effects will be able to be avoided under all circumstances.

If monitoring via the methods identified above are not able to avoid significant adverse effects on a regular basis (which can be measured by complainants remaining unsatisfied with actions taken or complaints are otherwise difficult to resolve), dust measurement can be undertaken. Monitoring of deposited dust or Total Suspended Particulates (TSPs) are two options in this situation. While measurement of deposited dust is generally simple and inexpensive, the sampling period is generally too long (minimum 15 days) to allow for quick response to dust emission problems. The measurement of TSPs is preferred because it can give real time results and can be used for immediate response to dust issues. The dust trigger levels presented below in Table 21 can be applied to monitoring data to indicate whether remedial action or additional mitigation should be applied.

No specific monitoring of the rock crusher discharges is recommended other than visual assessment.

Table 21 – Suggested trigger levels for Total Suspended Particulate (TSP)

Trigger	Averaging Period	Trigger level for Highly Sensitive Area
Short-term	5 min	250 $\mu g/m^3$
Short-term	1 hour	200 $\mu g/m^3$
Daily	24 hours (rolling average)	60 $\mu g/m^3$
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
Source: MfE Good Practice Guide for Assessing and Managing Dust (2016)		

6.2 Operational effects

We consider that specific mitigation measures for the operational effects of the Project are not required because the potential adverse effects assessed for the Indicative Alignment are minor. In the event that the Indicative Alignment is shifted within the proposed designation boundary, reducing the separation distance of the road to any HSRs, or if Project traffic flow increases above the AADT levels that have been assessed, the air quality will still remain well below relevant guidelines and standards.

7 CONCLUSIONS

Conclusions summary

The assessment of construction and operational effects of the Project has been undertaken with reference to relevant air quality guidance by the Transport Agency, MfE, and relevant provisions of the AUP(OP). We have applied relevant assessment criteria from the NESAQ, NZAAQG and the AUP(OP).

We have identified the HSR locations which have the potential to be adversely affected by air discharges from the construction and operation of the new road. We have undertaken a review of background air quality assess the potential for cumulative effects on air quality.

Our assessment of construction effects of the Project has identified that construction activities will generate dust that may impact HSRs in close proximity to the construction areas within the proposed designation boundary and local roads that may be used for access which extend outside of the proposed designation boundary. The construction effects assessment has been undertaken assuming that any construction activity, or associated area, could be located anywhere within the proposed designation boundary, with the exception of the mobile rock crushing plant which we have assessed as being located within the cut areas. The effect on air quality during the construction phase (without mitigation) is assessed as potentially significant, therefore we have recommended industry good practice mitigation and controls for dust.

We recommend a set of general mitigation measures for construction air quality effects across the Project Area, and some specific HSR locations, which will require mitigation from dust generating activities. These activities occur both within the proposed designation boundary, and also from potential access roads outside of the proposed designation boundary. Additional measures at particular HSR locations may include wind fencing, including at sensitive ecosystems as identified by the Ecology Assessment Report, and sealing of unsealed access roads where there are HSRs within 100 m of the road. Systems for dust suppression will need to be incorporated into the design and management of the mobile crushing plant. These systems could include enclosure of dust sources and extraction to control equipment or water suppression. In addition to this standard mitigation, a minimum separation distance of 100 m is recommended.

Due to the effects assessment assuming that any construction activity or associated area could be located anywhere within the proposed designation boundary, the creation of a Construction Air Quality Management Plan at a later design stage is considered essential to mitigate air quality effects from construction. We recommend mitigation measures and monitoring via visual observations with a complaint response procedure. With these measures in place we consider that air quality effects from construction will be minor or otherwise mitigated as far as practicable.

Our assessment of operational effects of the Project involved the identification of worst-case HSR locations. The assessment demonstrates that the Project will maintain air quality at acceptable levels throughout the largely rural environment of the Project Area. The effect of the Project's operation on air quality is assessed as less than minor. Predicted concentrations are below the Transport Agency criteria for Project contribution, and well below the relevant air quality guidelines and standards when considered cumulatively with the background air quality.

The Project tunnels have also been assessed as low risk. The operational air quality risk is therefore deemed to be low for the Indicative Alignment and the method (Tier 2) approach undertaken here is considered appropriate for the Project.

Following an operational effects sensitivity analysis, even if a HSR was located 5 m from the Indicative Alignment road edge (the road with greatest traffic flow), air quality guidelines and standards would still be met when considered cumulatively with the background air quality. Similarly, even if traffic flow increases by as much as 100%, the significance criteria will still be comfortably complied with and cumulative air quality concentrations would still be predicted to be well within air quality standards and guidelines.

As part of this sensitivity analysis, we considered the possibility of the Indicative Alignment tunnel portals being situated at any location within the proposed designation boundary at final design stage. Should the tunnel portals be located within 200 m of a HSR, the potential air quality risk of the tunnel may increase to medium or high risk. If the separation distance is lower than 200 m at a later design stage, it is recommended that a suitably qualified air quality specialist be engaged assess the risk to air quality and undertake air quality dispersion modelling of the portals, if required.

The operation of the Project will result in increased concentrations of contaminants in ambient air along the Indicative Alignment, but this level of increase will have less than minor effects on human health and the environment due to:

- the low predicted concentrations of contaminants from traffic as compared to the relevant air quality guidelines and standards;
- the low background concentrations of contaminants in the area; and
- the generally rural nature of the surrounding environment with good separation distances to HSRs.

The Project also has a positive effect on air quality taking into account the effects on the wider road network. While this effect has not been quantified, there will be a reduction in exposure to vehicle emissions at HSRs due to network effects. This reduction will be due to the movement of traffic flow and consequently, operational air quality emissions, from areas along SH1 such as the townships of Wellsford and Te Hana onto the Indicative Alignment.

In summary, we consider the effects of the operational phase of the Project on air quality to be less than minor with some positive effects along the existing SH1. The Project operation will achieve compliance with relevant air quality guidelines and standards, in particular the AAAQTs and the NESAQ. Considering the reduction of road transport emissions along the existing SH1 near a higher density of HSRs (i.e. townships of Wellsford and Te Hana), the Project is considered to have a positive effect on overall air quality.

APPENDIX A – RESIDENTIAL PROPERTIES WITHIN PROPOSED DESIGNATION BOUNDARY EXCLUDED FROM ASSESSMENT

Table 22 – Residential properties excluded from the assessment

Property	X	Y
70 Wyllie Rd, Warkworth	1746187	5969047
4 Wyllie Rd, Warkworth	1746106	5969493
434 Woodcocks Rd, Streamlands	1745747	5969975
438 Woodcocks Rd, Streamlands	1745738	5970074
152 Carran Rd, Warkworth	1745986	5970184
151 Carran Rd, Warkworth	1746038	5970237
141 Carran Rd, Warkworth	1746144	5970355
108 Carran Rd, Warkworth	1745724	5970433
113 Carran Rd, Warkworth	1745813	5970556
119 Carran Rd, Streamlands	1745961	5970580
83 Carran Rd, Warkworth	1745695	5970717
63 Carran Rd, Warkworth	1745575	5971102
171 Kaipara Flats Rd	1745611	5971544
157 Kaipara Flats Rd	1745777	5971708
141 Kaipara Flats Rd	1745903	5971628
157A Kaipara Flats Rd, Warkworth	1745714	5971690
27 Phillips Rd, Dome Forrest	1745479	5971769
11 Phillips Rd, Streamlands	1745617	5971777
6 Phillips Rd, Dome Valley	1745747	5971824
154 Kaipara Flats Rd, Dome Valley	1745835	5971872
30 Phillips Rd, Dome Valley	1745485	5971923
156 Kaipara Flats Rd, Dome Valley	1745710	5971972
18 Phillips Rd, Warkworth	1745504	5972098
1207 SH1, Wayby Valley	1739458	5977482
1282 SH1, Wayby Valley	1739140	5978179
133 Wayby Valley Rd, Wellsford	1739065	5979616
30 Robertson Rd, Wellsford	1738966	5979913
20 Robertson Rd, Wayby Valley	1739042	5979933
230 Rustybrook Rd, Wellsford	1739323	5980864
16 Robertson Rd, Wayby Valley	1739066	5979881
199 Rustybrook Rd, Wayby Valley	1739237	5981101
118 Whangaripo Valley Rd, Wellsford	1738888	5982783
17 Borrows Rd, Wellsford	1738940	5983201

Property	X	Y
170 Whangaripo Valley Rd, Wellsford	1739181	5983147
12 Borrows Rd, Wellsford	1739079	5983511
37 Borrows Rd, Wellsford	1738938	5983634
35 Borrows Rd, Wellsford	1739053	5983974
50 Farmers Lime Rd, Wellsford	1739111	5984124
29 Farmers Lime Rd, Wellsford	1739156	5984682
15 Farmers Lime Rd, Wellsford	1738977	5984740
312 Silver Hill Rd, Wellsford	1738191	5987556
122 Mangawhai Rd, Wellsford	1736918	5988973
173 Carran Rd	1746151	5969989
99 Carran Rd	1745870	5970974
135 Kaipara Flats Rd	1745871	5971508
1282 SH1, Wayby Valley	1739196	5978130
200 Rustybrook Rd, Wellsford	1739225	5981028
159 Whangaripo Valley Rd, Wellsford	1739051	5983191
12 Borrows Rd, Wellsford	1739087	5983523
314 Silver Hill Road	1738322	5987603
558 SH-1 Warkworth	1735866	5989272
106 Rustybrook Rd	1739012	5981097
75A Wyllie Road, Warkworth	1746211	5968919
75B Wyllie Road, Warkworth	1746215	5968872
Note: X, Y coordinates are in NZGD 2000 NZTM.		

APPENDIX B – TRAFFIC DATA

Table 23 – Traffic data in average annual daily traffic and percentage heavy commercial vehicles for the With and Without Project in opening (2036) and design (2046) years

Location	AADT (Actual Flows)											
	2016		2036					2046				
	Base		Without Project		With Project		AADT Diff	Without Project		With Project		AADT Diff
	AADT	HCV%	AADT	HCV%	AADT	HCV%		AADT	HCV%	AADT	HCV%	
Existing Network roads												
SH1 South of Woodcocks Road (South of McKinney Rd)	23035	6	14637	7	14962	6	325	17385	8	17465	8	80
Woodcocks Road	4920	13	7995	12	8076	13	82	9261	13	9065	12	-196
SH1 south of Hill Street	26084	10	22326	14	21495	13	-830	24875	15	24549	16	-326
Sandspit Road (East of Park Ln)	9300	9	17009	8	17021	7	12	16954	10	16946	10	-8
Matakana Road (North of Matakana Link Rd)	7638	11	11068	10	11072	10	4	11776	11	11781	11	5
SH1 South of Goatley Road	15813	13	13615	17	12292	18	-1323	17552	18	17024	18	-527
Goatley Road	958	34	2110	53	2108	53	-2	2334	56	2332	56	-2
Kaipara Flats Road	1154	31	2419	49	2406	50	-13	3156	46	2964	53	-192
SH1 South of Wayby Valley Road	14065	11	23986	11	3853	15	-20134	28591	11	4135	15	-24456
Wayby Valley Road	626	22	743	25	747	24	3	778	24	776	24	-2
SH1 South of Centennial Park Rd	13438	11	23243	11	7574	7	-15669	27813	10	8047	6	-19766
Kaipara Coast Hwy	2685	10	2923	5	3012	6	89	3347	4	3414	5	67
Whangaripo Valley Rd (Matheson Road extension)	2193	13	1643	9	1717	9	74	1663	10	1712	8	49
SH1 South of School Road	16500	11	24326	11	9066	6	-15260	28012	10	9531	6	-18481
School Road	1231	18	1384	16	1274	14	-110	1860	15	1274	13	-586
SH1 South of Silver Hill Road	14363	13	21602	13	5795	13	-15807	26053	12	6086	12	-19966
Silver Hill Road	0	0	0	0	0	0	0	0	0	0	0	0
Whakapirau Road	1195	34	1385	36	1288	38	-97	1545	26	1263	37	-282

Location	AADT (Actual Flows)											
	2016		2036					2046				
	Base		Without Project		With Project		AADT Diff	Without Project		With Project		AADT Diff
	AADT	HCV%	AADT	HCV%	AADT	HCV%		AADT	HCV%	AADT	HCV%	
SH1 South of Mangawhai Road	11475	14	18145	15	2501	26	-15644	22548	13	2707	23	-19841
Mangawhai Road	1201	36	1143	49	1194	47	51	1086	47	1183	46	98
SH1 South of Ross Road	10391	11	17107	13	17101	13	-6	21568	11	21560	11	-8
P2W North of Pūhoi Road	0	0	27890	1	26693	1	-1197	35932	1	35353	1	-579
P2W South of SH1	0	0	27890	1	0	0	-27890	35932	1	0	0	-35932
Project roads												
P2W South of SH1	0	0	0	0	25175	9	25175	0	0	32626	8	32626
Carran Road Re-Alignment	745	36	1861	51	1757	52	-104	2599	40	2095	44	-504
W2W Warkworth Interchange Through	0	0	0	0	10838	0	10838	0	0	13675	0	13675
W2W Warkworth Interchange on ramp	0	0	0	0	11224	9	11224	0	0	14654	8	14654
W2W Warkworth Interchange off ramp	0	0	0	0	13951	9	13951	0	0	17972	8	17972
Kaipara Flats Road East of W2W	1154	31	2419	49	2406	50	-13	3156	46	2964	53	-192
Kaipara Flats Road West of W2W	1154	31	2419	49	2406	50	-13	3156	46	2964	53	-192
W2W South of Wayby Valley Road	0	0	0	0	20155	11	20155	0	0	24618	10	24618
W2W Wayby Valley Interchange Through	0	0	0	0	15595	13	15595	0	0	19839	11	19839
W2W Wayby Valley Road on ramp	0	0	0	0	3320	5	3320	0	0	3523	4	3523
W2W Wayby Valley Road off ramp	0	0	0	0	1334	7	1334	0	0	1354	8	1354
Wayby Valley Road West of W2W	0	0	0	0	4099	3	4099	0	0	4296	3	4296
Wayby Valley Road East of W2W	0	0	0	0	747	24	747	0	0	776	24	776
Rustybrook Road	0	0	0	0	3	0	2	7	3	3	0	-4
Farmers Lime Road	317	29	261	30	139	58	-123	285	26	149	51	-136
W2W South of Mangawhai (South of Silver Hill Rd)	0	0	0	0	15690	13	15690	0	0	19936	12	19936
W2W Mangawhai Interchange Through	0	0	0	0	15690	13	15690	0	0	19936	12	19936

Location	AADT (Actual Flows)											
	2016		2036					2046				
	Base		Without Project		With Project		AADT Diff	Without Project		With Project		AADT Diff
	AADT	HCV%	AADT	HCV%	AADT	HCV%		AADT	HCV%	AADT	HCV%	
W2W Mangawhai Interchange on ramp	0	0	0	0	637	7	637	0	0	668	7	668
W2W Mangawhai Interchange off ramp	0	0	0	0	775	6	775	0	0	957	5	957
W2W North of Mangawhai Road	0	0	0	0	17101	13	17101	0	0	21560	11	21560
Note: Annual average daily traffic (AADT), heavy commercial vehicle (HCV). AADT diff column shows the AADT difference between the With and Without Project scenarios.												

APPENDIX C – MONITORING DATA FROM TUNNEL PORTAL EMISSION STUDIES

Data from two tunnel portal emission monitoring studies, one at Johnstone's Hill Tunnels and the other at the Terrace Tunnel in Wellington, has been used in order to infer potential effects from portal emissions.

The Transport Agency undertook passive NO_2 sampling over a three-month period in conjunction with the operation of the Johnstone's Hill Tunnels[25], which directly links to the P-W project at the southern end. The tunnels are 380 m long, have longitudinal ventilation (a system using jet fans and a mass of air in a tunnel, causing fresh air to flow into the tunnel), with both tunnels built to carry two lanes each. However, during monitoring, the northbound tunnel only had one lane open due to the merging of the traffic into a single lane after the tunnel.

Passive NO_2 monitoring was undertaken at 50 m intervals at five locations before the tunnel (facing a northbound direction) and five locations after the tunnel. The AADT for the Johnstone's Hill Tunnels during monitoring was 14,000 vehicles per day and the proportion of heavy commercial vehicles (HCVs) was 9.5%. It was noted that the northbound tunnel was likely to be more prone to congestion and therefore experience higher contaminant concentrations than the southbound tunnel[26]. Table 24 summarises the Johnstone's Hill tunnel monitoring NO_2 data at the northern end of the northbound tunnel with distance "downwind" of the tunnel portal.

External air quality near the northern exit of the tunnel exceeds the WHO annual average 40 $\mu g/m^3$ guideline for NO_2, however, in the Transport Agency Johnstone's Hill Tunnels 2013 report it is noted that this exceedance is due to seasonal effects. Using an adjustment factor, the annual average at the site can be calculated to be within an estimated range of 25.8 to 35.0 $\mu g/m^3$ for the 10 m from portal monitoring location.

Table 24 – Monthly passive sampling results for NO2 (µg/m3) at Northbound Johnstone's Hill Tunnels in 2010

Site reference	Distance from northern side of tunnel portal	April	May	June
AUC165	10 m	43.2	40.2	34.8
AUC166	50 m	24.8	22.5	19.5
AUC167	100 m	23.6	22.3	22.4
AUC168	150 m	19.5	17.2	18.3
AUC169	200 m	16.8	18.5	16.6

The Johnstone's Hill Tunnels monitoring study was limited in duration (only for three months), but the data are useful to characterise the dispersion pattern from the tunnel portals for this Project, which it is assumed will operate in a similar way to those at Johnstone's Hill. The data show that measured levels drop off relatively quickly, within 50 m of the portal. We have augmented the Johnstone's Hill Tunnels data with data from

[25] Transport Agency 2013, Johnstone's Hill tunnel air quality monitoring March to July 2010, Summary Reports.

[26] Transport Agency 2013, Johnstone's Hill tunnel air quality monitoring March to July 2010, Summary Reports.

the Terrace Tunnel, which has a higher AADT and is longer than the Johnstone's Hill Tunnels.

Table 25 shows the NO_2 monthly average passive monitoring results "upwind" of the Johnstone's Hill Tunnels. At these locations the monitoring sites are less impacted by portal emissions. It appears that the results from 100 to 200 m are fairly consistent at around 10 µg/m³, and most likely represent the operation of the road without the tunnels. Based on an assumption that the road operation is contributing about 10 μg/m³, it appears that the values in Table 24 above that the tunnel portal discharge plume still has a measurable effect out to 200 m "downwind" of the portal.

Table 25 – Monthly passive sampling results for NO2 (μg/m3) at Southbound Johnstone's Hill Tunnels in 2010

Site reference	Distance from southern side of tunnel portal	April	May	June
AUC153	200 m	10.7	12.1	9.0
AUC154	150 m	11.1	13.9	9.2
AUC155	100 m	11.7	13.4	10.4
AUC156	50 m	16.0	21.0	18.7
AUC157	At Northbound Tunnel Entrance	28.0	32.5	37.9

Johnstone's Hill Tunnels are only about one-third the length of the proposed tunnels for the Project. The two-way AADT through the Project tunnels is projected at 24,618 for 2046, equal to a one-way AADT of approximately 12,000 in each direction. The Project one way AADT of 12,000 can be compared to a one-way AADT of 7,000 for Johnstone's Hill Tunnels where the proportion of HCVs in 2010 was 9.5%.

Table 26 presents monitoring data for the Terrace Tunnel.

Table 26 – Annual average NO2 monitoring data for the Terrace Tunnel portals (2010)

Site reference	Distance	Annual Average NO_2 (μg/m³)
WEL015	30 m E of portal	19.6
WEL016	At northern portal (road level)	54.2
WEL017	Above northern portal	30.3
WEL018	60 m north of southern Terrace Tunnel portal	20.5
WEL019	SSE of Terrace Tunnel portal (road level, old off-ramp)	27.2

The Terrace Tunnel data has a two-way tunnel AADT of 45,000 but the NO_2 annual average is well below the WHO criteria of 40 µg/m³ within a relatively short distance of the portal.

APPENDIX D – DRAWINGS SHOWING RESIDENTIAL PROPERTIES WITHIN 200 M OF THE DESIGNATION BOUNDARY

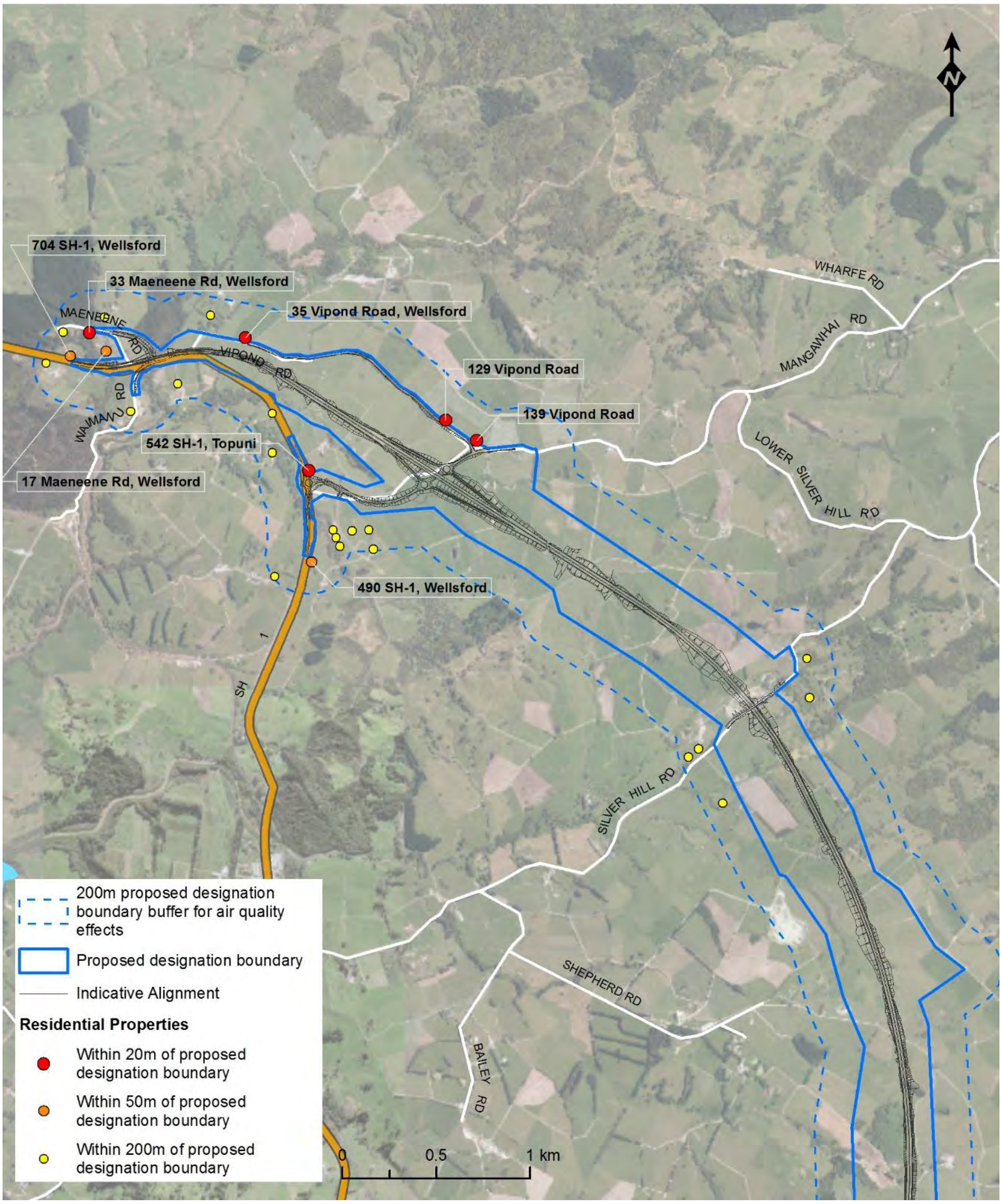

Figure 6 – Residential properties within 200 m of the designation boundary (figure 1 of 5).

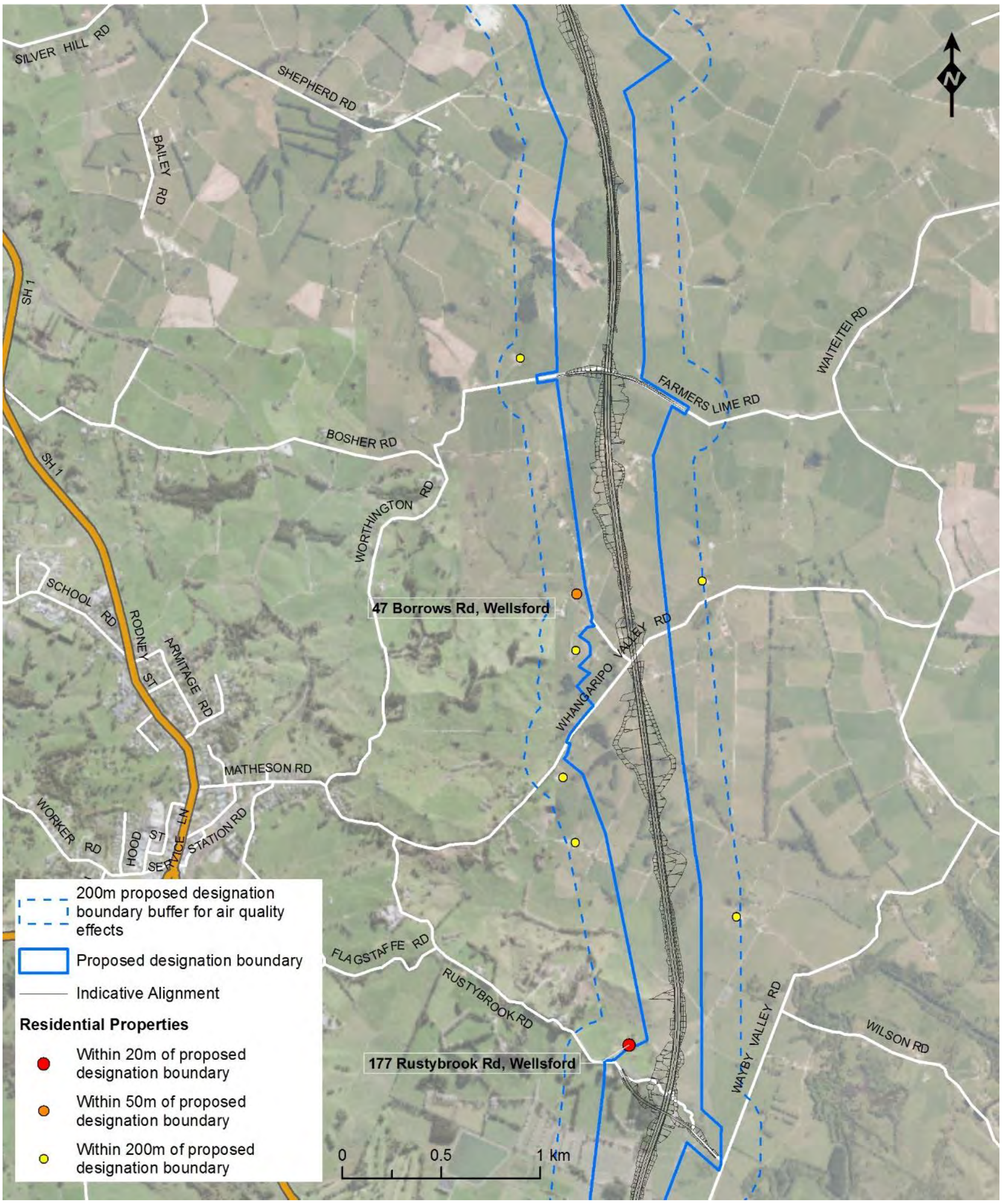

Figure 7 – Residential properties within 200 m of the designation boundary (figure 2 of 5).

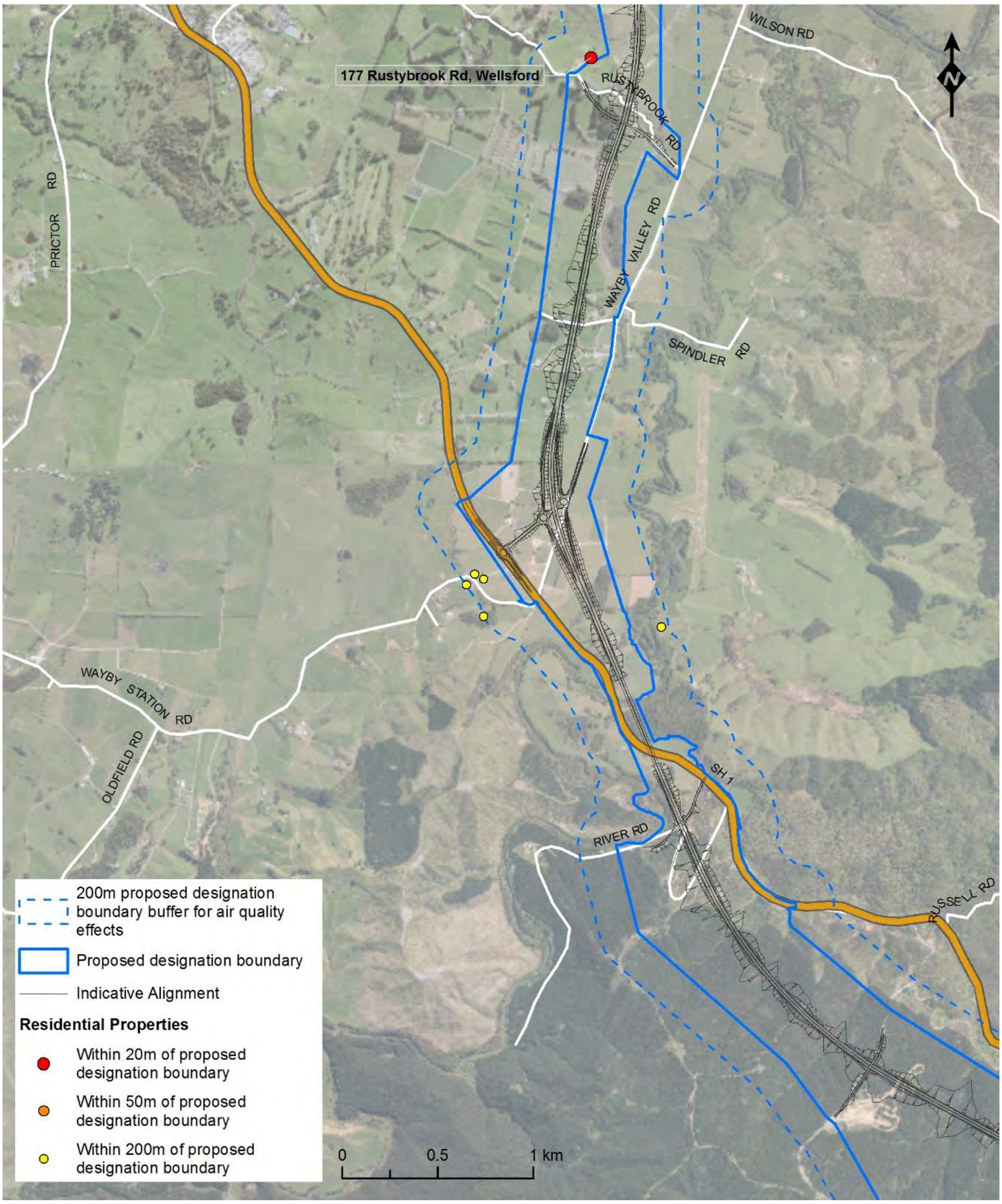

Figure 8 – Residential properties within 200 m of the designation boundary (figure 3 of 5).

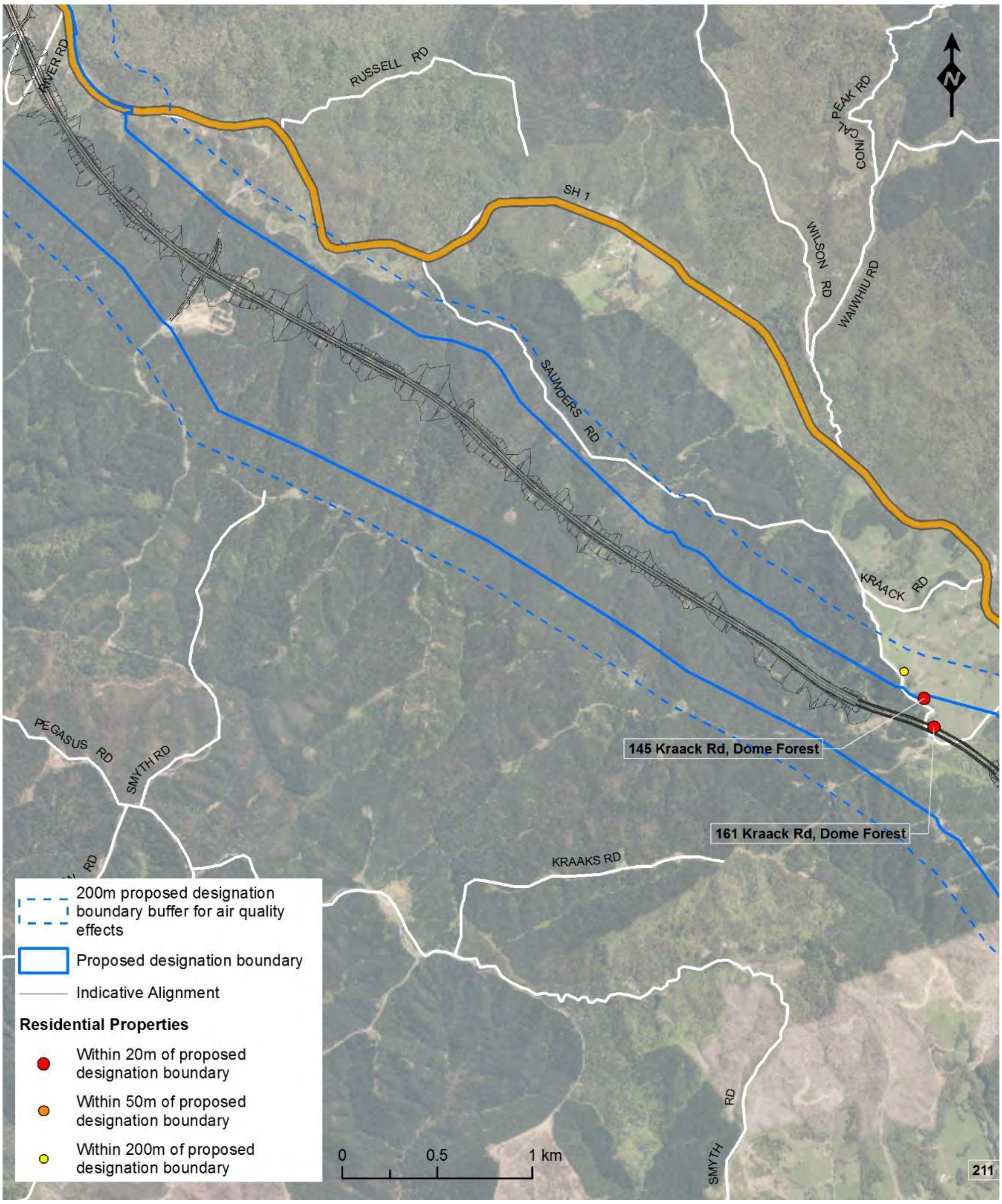

Figure 9 – Residential properties within 200 m of the designation boundary (figure 4 of 5).

GHD JACOBS

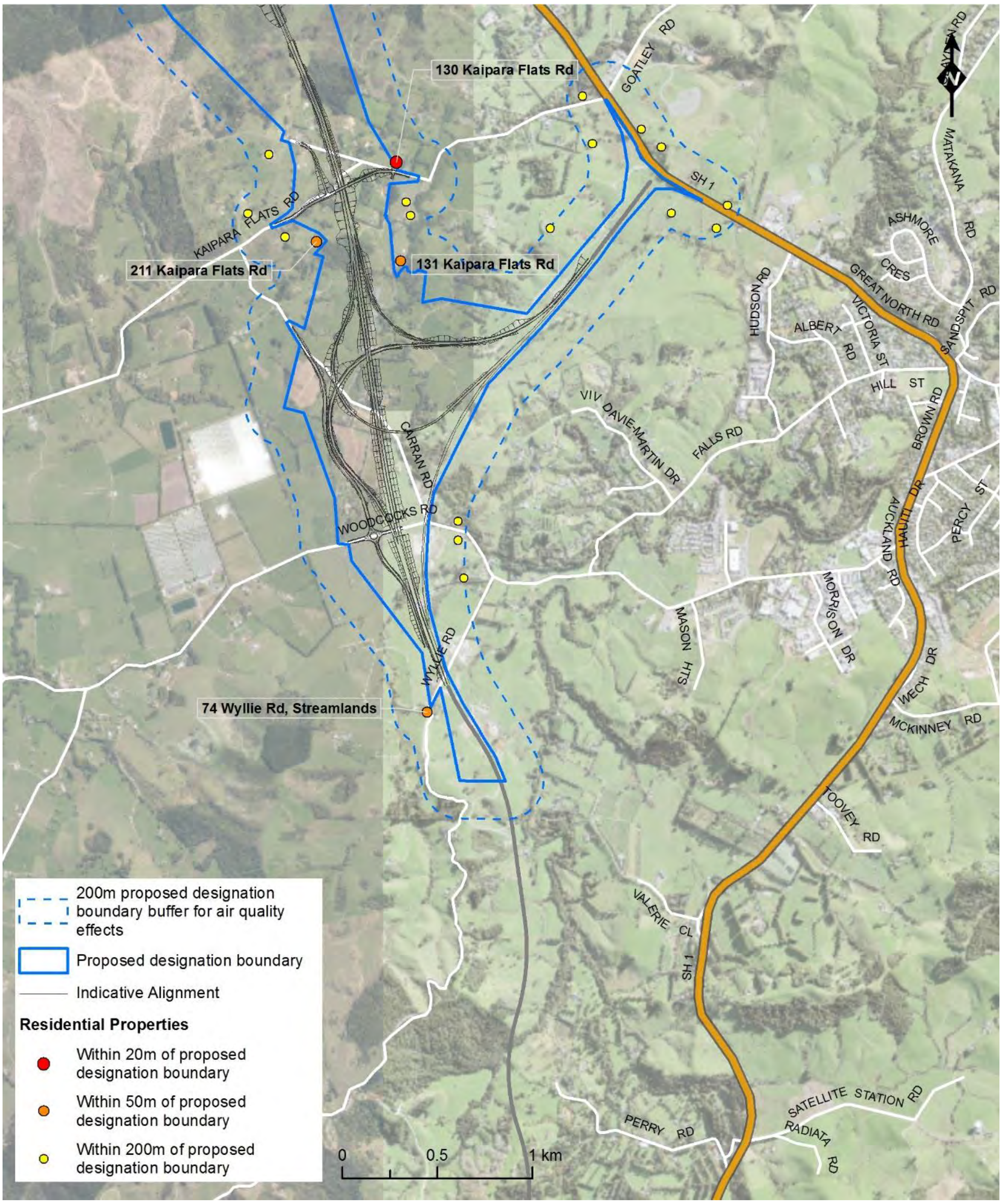

Figure 10 – Residential properties within 200 m of the designation boundary (figure 5 of 5).

GHD JACOBS