IN THE MATTER OF	The Resource Management Act 1991
AND	
IN THE MATTER OF	applications for resource consents in relation to Te Ahu a Turanga; Manawatū Tararua Highway Project
BY	**NEW ZEALAND TRANSPORT AGENCY** Applicant

TE AHU A TURANGA: TECHNICAL ASSESSMENT E

AIR QUALITY

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INTRODUCTION

1. My full name is **Richard Leslie Chilton**. I am an air quality scientist at Tonkin & Taylor Limited, Environmental and Engineering Consultants ("**T+T**"), and I am the author of this report.

2. I have been providing advice on air quality matters related to Te Ahu a Turanga; Manawatū Tararua Highway Project (the "**Project**") to the alliance that has been engaged to deliver the Project[1] (the "**Alliance**"), and ultimately Waka Kotahi NZ Transport Agency ("**Transport Agency**"), since October 2019.

3. My contributions include:

   (a) the preparation of this air quality technical assessment; and

   (b) review of the proposed Dust Management Procedure, to be included as Appendix 3 of the proposed Erosion and Sediment Control Plan ("**ESCP**") (**Volume VII: Management Plans**).

Qualifications and experience

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

   (a) I hold the qualifications of a Bachelor of Science (Geography) and a Master of Science (Honours) in Environmental Science specialising in air pollution meteorology. Both degrees are from the University of Canterbury;

   (b) I am a member of the Clean Air Society of Australia and New Zealand and am a Certified Air Quality Professional;

   (c) I hold the positions of Senior Air Quality Scientist and Team Leader Air Quality at T+T. I have 20 years' professional experience as an air quality scientist;

   (d) I have previously been employed in the following positions:

      (i) General Manager Christchurch and Principal Air Quality Scientist at Golder Associates (NZ) Limited (2006-2018);

      (ii) Air Quality Consultant at Bureau Veritas (London, 2004-2005);

      (iii) Technical Officer – Air Quality at London Borough of Greenwich (London, 2004);

[1] The alliance delivery model is a relationship-style arrangement, that brings together the client and one or more parties to work together to deliver a project, sharing project risks and rewards. A hybrid alliance model is being used to deliver the Project. Parties to the Alliance include the Transport Agency, Fulton Hogan, HEB Construction Limited, Aurecon Limited, WSP, Rangitāne o Manawatū, Rangitāne ki Tamaki Nui-ā-Rua, Ngāti Kahungunu o Tamaki nui-ā-Rua and Te Runanga o Raukawa.

(iv) Air Quality Officer at Auckland Regional Council (1999-2004).

5. I have been extensively involved in assessing discharges to air from industrial and linear transport / roading projects, undertaking science related projects for regional councils, as well as regional air quality policy reviews for industrial and council clients. In addition to the above, my experience includes work within the dairy, mining and quarrying, waste management, manufacturing, urban development, power and agricultural sectors.

Code of conduct

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

Purpose and scope of assessment

7. The purpose of my assessment is to inform the regional resource consenting process by assessing the potential adverse air quality effects on the surrounding environment associated with the construction of the Project (described through this report as the "**Main Works**").[2] The key air discharge arising from the Main Works will be dust emissions associated with earthworks and construction activities.

8. My assessment considers mitigation and management practices that I expect to control dust emissions so that offensive or objectionable dust effects beyond the proposed designation boundary do not occur. In this respect, my assessment has been prepared on the basis that the notices of requirement ("**NoRs**") for the Project will be modified to provide for a more northerly alignment of the Project (the "**Northern Alignment**").

9. My assessment is based on the detailed design information as contained within the Design and Construction Report in Volume II of the application ("**DCR**").

Assumptions and exclusions in this assessment

10. My assessment considers the air quality effects (principally dust) arising from the Main Works of the Project. The scope of my assessment has not included

[2] "Main Works" refers to the Project works as described in this application (to differentiate from the enabling works, for which resource consents are being sought separately).

an assessment of operational effects of the highway or any of the proposed enabling works for the Project ("**Enabling Works**"),[3] which I understand will be addressed separately if required. I understand that the Main Works will not generally overlap in time or location with the Enabling Works, and therefore I consider there will be no appreciable cumulative air quality effects arising from the Enabling Works.

11. I understand and have assumed that there will be no asphalt plant or concrete batching plant set up on site for this Project.

EXECUTIVE SUMMARY

12. The Transport Agency is proposing to construct an approximately 11.5 km road between Ashhurst and Woodville via a route over the Ruahine Ranges. The Project is intended to replace the indefinitely closed section of State Highway 3 ("**SH3**") through the Manawatū Gorge.

13. Earthworks associated with the route of the proposed road (the "**Alignment**") and the proposed spoil sites to be constructed as part of the Main Works (together, the "**Earthworks Footprint**") may give rise to dust emissions that could impact on sensitive locations and activities.

14. The main environmental effects of dust emissions are nuisance, soiling and abrasion effects. Dust can also affect vegetation where very high levels of deposited dust occur.

15. I consider the main sources of dust associated with the Project will be from the movement of vehicles along unpaved surfaces during dry weather. Wind erosion of dust from exposed dry surfaces, particularly fill and spoil sites, may also be a significant emission source at times given the high wind environment of the Ruahine Ranges.

16. The Project Area is predominantly rural and insensitive to dust impacts with the exception of some particular isolated sensitive locations/activities, such as residential dwellings, wind turbines and ecologically sensitive areas, including Horizons Regional Council One Plan ("**One Plan**") Schedule F habitats (rare, threatened, or at-risk ecological habitats). In addition, the National Grid Transmission Line traverses along Woodlands Road and over the proposed roundabout at the eastern end of the Project, close to Woodville.

[3] The Transport Agency is separately seeking a number of resource consents for enabling works for the Project, to be progressed in a series of packages in advance of the Main Works.

17. I have assessed the potential dust effects using a qualitative approach in line with Ministry for the Environment guidance (MfE 2016).[4] A two-step approach was used as follows:

(a) First, a screening assessment was undertaken to identify potentially sensitive locations within a certain distance from the potentially dust generating sources.

(b) Second, a more detailed "**FIDOL**" assessment for those locations identified in the initial screening evaluation was undertaken. The FIDOL assessment is an objective framework that considers the frequency, intensity, duration, and offensiveness of dust impacts at sensitive locations.

18. The FIDOL assessment is informed by reviewing the exposure of sensitive locations to strong winds from the direction of the Earthworks Footprint. The outcome of the FIDOL assessment is used to categorise general locations where the risk of adverse dust impacts are potentially high and to inform the degree of mitigation control and monitoring required.

19. The following summarises the findings of my assessment. Locations that I describe are shown in **Figure E.1** and the Air Quality Plans in **Appendix E.4**.

(a) Without implementation of appropriate control measures, there are a small number of sensitive residential locations in the vicinity of the Woodville Roundabout that would be at risk of being exposed to dust impacts. However, I consider that the mitigation measures I have recommended will enable dust levels to be controlled in order to avoid offensive or objectionable effects. Furthermore, continuous monitoring of dust will enable early warning of elevated dust levels and a proactive implementation of response should elevated dust levels occur.

(b) Four of the Te Āpiti Wind Farm turbines (TAP09, TAP10, TAP46 and TAP49) are close to the potential dust sources associated with the Project and likely to be frequently exposed to strong winds from the direction of potential dust generating construction and earthwork activities. It is my understanding that the key consideration regarding dust impacts is the possible effect of deposited dust on the aerodynamic performance of the turbine blades. However, the closest point of these blades to the ground is at least 30 m above ground level. The mitigation measures I have recommended, along with the height of the turbine blades above ground

[4] NZTA 2019, Page 5

level, will mean that dust impacts on these turbines should be less than minor. Dust deposition monitoring that I have recommended, to be undertaken in the vicinity of the four turbines in question, will enable dust deposition rates to be confirmed. Where deposition rates exceed a pre-determined trigger level, a review of dust management should be implemented with modification to management measures as required.

(c) Without implementation of appropriate control measures, there are six sensitive ecological receptor areas that would be at risk of being exposed to dust impacts. These areas include:

(i) Schedule F areas, which I have labelled F2, F4 and F7; and

(ii) additional ecological receptor areas identified by the Alliance's team of ecological experts, which I have labelled E1, E2 and E4.

I expect that the dust mitigation measures I have recommended should minimise any potential dust deposition effects in the identified areas to levels that are less than minor. Ongoing deposition monitoring to be undertaken in each of these areas will enable the performance of those measures to be evaluated and changes to be made to mitigation should the need arise.

(d) I have reviewed the proposed Dust Management Procedure, to form part of the ESCP, and consider that it reflects the mitigation methods and monitoring I have recommended. Provided my recommendations are implemented through the Dust Management Procedure, I expect that adverse dust effects should be appropriately managed and offensive or objectionable dust effects avoided.

PROJECT DESCRIPTION

20. The Project comprises the construction, operation, use, maintenance and improvement of approximately 11.5km of State highway connecting Ashhurst and Woodville via a route over the Ruahine Range. The purpose of the Project is to replace the indefinitely closed existing SH3 through the Manawatū Gorge (the "**Manawatū Gorge Route**").

21. The Project comprises a median separated carriageway that includes two lanes in each direction over the majority of the route and will connect with State Highway 57 ("**SH57**") east of Ashhurst and SH3 west of Woodville (via proposed roundabouts). A shared use path for cyclists and pedestrian users is proposed as well as a number of new bridge structures including a bridge crossing over the Manawatū River ("**Manawatū River Bridge (BR02)**").

22. The design and detail of each of the elements of the Project and associated construction activities are described in:

(a) Section 3 of the Assessment of Environmental Effects (**Volume I**);

(b) the DCR contained in **Volume II;** and

(c) the Drawing Set (contained in **Volume III**).

23. The elements of the Project that are particularly relevant to my assessment are the footprint of earthworks associated with the route of the proposed road (the "**Alignment**") and the proposed spoil sites to be constructed as part of the Main Works (together, the "**Earthworks Footprint**"). Information on the construction methodology, earthworks volumes, construction duration and sequencing, and typical hours of work each day are provided in the DCR and this information has informed this assessment.

NATURE OF DISCHARGES

24. The main discharge to air associated with the Project's construction will be dust. Combustion emissions, such as nitrogen dioxide (NO_2) and carbon monoxide (CO), will occur from the operation of construction machinery. However, the Transport Agency's '*Guide to assessing air quality impacts from State highway projects'* ("**NZTA 2019**") advises that dust is the main air pollutant from road construction activities and that exhaust emissions from earthworks and construction machinery are typically negligible.[5] I agree with this, given the low level of construction related traffic/machinery and associated low background concentrations of combustion related contaminants. For this reason, I have not considered combustion emissions further in this assessment.

25. Concerns regarding dust emissions mainly relate to nuisance and soiling effects. Nuisance dust effects are most commonly associated with coarse particles larger than 20 micrometres (µm)[6] and can include the following effects:

(a) soiling of clean surfaces;

(b) dust deposits on vegetation;

(c) contamination of roof-collected water supplies; and

(d) visibility impacts.

[5] NZTA 2019, Page 8
[6] 1 µm equals 1/100,000th of a metre

26. The potential health effects of dust are related to the size of the dust particles. Human health effects of airborne dust are mainly associated with fine particles that are ten microns (10 µm) or smaller (PM_{10}).

27. There is very little information that I am aware of on the effects of dust on flora and fauna. The only study I am aware of regarding flora is by McCrae (1984).[7] This study describes effects on plant life that can occur where prolonged and very high levels of dust deposition on plant surfaces occur, resulting in:

    (a) reduced photosynthesis through reduced light penetration, reduced growth rates and plant health;

    (b) increased incidence of pests and diseases (dust acts as a medium for their growth); and

    (c) reduced pesticide effectiveness, through reduced contact.

28. For a relatively short-term activity such as the proposed earthworks, I would expect any reduced plant growth would only be for the duration of the Main Works and would be relieved intermittently during construction following periods of rainfall when any deposited material would be washed off plant surfaces. Notwithstanding this, I have confirmed with the Alliance's team of ecologists (as described later in this report) ecologically significant areas along the Alignment and have taken a precautionary approach by treating them as sensitive locations.

29. The key factors influencing the discharge of dust associated with earthworks and construction activities are as follows:

    (a) the amount of fine material in the soil being handled. Coarse material with very little fine material content is unlikely to give rise to dust emissions whereas soil or aggregate with a high fines content will pose a greater risk of dust emissions;

    (b) the moisture content of the material. A high moisture content will act to bind dust particles and control emissions;

    (c) strong winds blowing across exposed surfaces on dry days resulting in entrainment of dusty material; and

    (d) the extent of exposed areas.

30. In my experience, the most significant source of dust associated with earthworks and construction projects arises from the movement of vehicles

[7] McCrae 1984, *An Assessment of the effects of Road Dust on Agricultural Production Systems*

along unpaved surfaces during dry weather. This occurs because of the action of the wheels disturbing dust from the unpaved surface. Dust from vehicle movements can occur irrespective of wind speed conditions but the scale of dust emissions will be dependent on the moisture content and proportion of fine material in the haul road / surface, as well as the number of wheels and weight and speed of vehicles.

31. Because of the relatively high wind environment of the Ruahine Ranges (which I discuss later), wind erosion of dust from exposed dry surfaces, particularly fill and spoil sites, is also potentially a significant emission source at times.

32. Other less significant sources of dust that may be associated with the Project include the following:

    (a) vegetation removal;

    (b) piling operations (although I expect this to be a small and localised source, as I explain later);

    (c) excavator or motor-scraper cutting and shaping of ground;

    (d) pavement construction (grading, compaction etc.);

    (e) forming and compaction of fill and spoil sites; and

    (f) handling and stockpiling of dusty material.

EXISTING ENVIRONMENT

33. In the description of the existing environment below, I have assumed the existing environment does not include any confirmed designations for the Project (noting that the NoRs for the Project remain subject to appeal).

Sensitive Receivers

34. I have examined the Project corridor (i.e. the area proposed to be designated) and immediate surrounds within which construction activities will take place (the "**Project Area**"). The Project Area is predominantly rural and insensitive to dust impacts with the exception of some particular isolated sensitive locations/activities, such as residential dwellings, wind turbines and ecologically sensitive areas.

35. In order to consider potential dust nuisance effects on sensitive locations/activities, I have considered locations and activities within 200 m of proposed Earthworks Footprint, consistent with the Transport Agency's

guidance (NZTA 2019).[8] This guidance is consistent with other separation distance guidance for similar dust generating activities[9]. The key concern in relation to these receptors will be dust nuisance, and deposition or soiling of surfaces.

36. In order to consider deposition effects, I have considered locations/activities 100 m or less from the Earthworks Footprint. This is consistent with guidance in the Ministry for the Environment's '*Good Practice Guide for Assessing and Managing Dust'* (MfE 2016). This Guide states that large dust particles (i.e., 30 to 100 microns in size) do not remain suspended in the air beyond 100 metres.[10] For example, the MfE Guide states that a 100 micron particle would only be blown about 10 m during a 5 m/s wind; and a 30 micron particle would only be blown about 100 m.[11] These larger particles are generally responsible for more obvious deposits on clean surfaces. On balance, I consider any appreciable dust deposition effects will be limited to within 100 m of the Earthworks Footprint.

37. The sensitive locations/activities I have identified are broadly described as follows, while the location of the receptors is shown in **Figure E.1** and the Air Quality Plans in **Appendix E.4**:

    (a) Eight residences within 200 m of the Earthworks Footprint in the vicinity of Ashhurst (one residence[12]) and Woodville (seven residences). (labelled as "R" sites).

    (b) Individual wind turbines associated with the Te Āpiti Wind Farm, where those turbines are located within 100 m of the Earthworks Footprint, including within 100 m of spoil sites (labelled as "TAP" sites). From my review of published literature (e.g., Salem et al 2013, El-Din & Diab 2016, Khalfallah & Koliub 2007), I understand the main consideration for wind turbines is the deposition of dust on the turbine blades, in-turn affecting the aerodynamic performance of the turbines and their ability to generate electricity.

    (c) Areas of AgResearch's Ballantrae Hill Country Research Station ("**Ballantrae Farm**") within 100 m of the Earthworks Footprint. The Ballantrae Farm is bisected by the Project towards the eastern extent of the Ruahine Range. From my review of material presented and

[8] NZTA 2019, Page 23
[9] E.g. EPA Victoria 2013.
[10] MfE 2016, Page 16
[11] MfE 2016, Page 16
[12] Two more potentially affected residences were identified on the Ashhurst side of the Project. However, I have not considered these residences as I understand these properties are to be purchased as part of the Project.

considered as part of the hearing on the NoRs, I understand that AgResearch has concerns that dust may contaminate or affect its ongoing field trials. Figure E.1 and the Air Quality Plans in Appendix E.4 show two representative locations where potential effects have been assessed (labelled as "B1" and "B2").

(d) The National Grid Transmission Line, which traverses along Woodlands Road and over the proposed roundabout at the eastern end of the Project, close to Woodville. From reviewing the material presented and considered as part of the hearing on the NoRs, I understand the key concern is that high levels of dust have the potential to cause arcing across conductors.

(e) Various ecological areas along the Project's Alignment, particularly at the western end, where sensitive fauna and flora may be affected by dust deposition. Following discussions that I have had with the Alliance’s ecological experts[13], I have focused on locations identified by those experts as representative of the Horizons Regional Council One Plan (“**One Plan**”) Schedule F areas within 100 m of the Earthworks Footprint where I understand there to be rare, threatened, or at-risk ecological habitats that may be sensitive to dust deposition effects (labelled as "F" sites). In addition to these locations and as advised by the ecological team, I have assessed a location representative of the QEII Trust Open Space Covenant on part of the J & G Bolton Ltd property as well as a number of other locations identified by the ecological experts where I understand there to be old growth forest or divaricating shrubland where sensitive invertebrate species may be present (all labelled as "E" sites).

[13] Josh Markham (Project Ecologist Terrestrial), Justine Quinn (Project Ecologist Freshwater), Duncan Law (Project Ecologist) and Georgia Cummings (Project Ecologist).

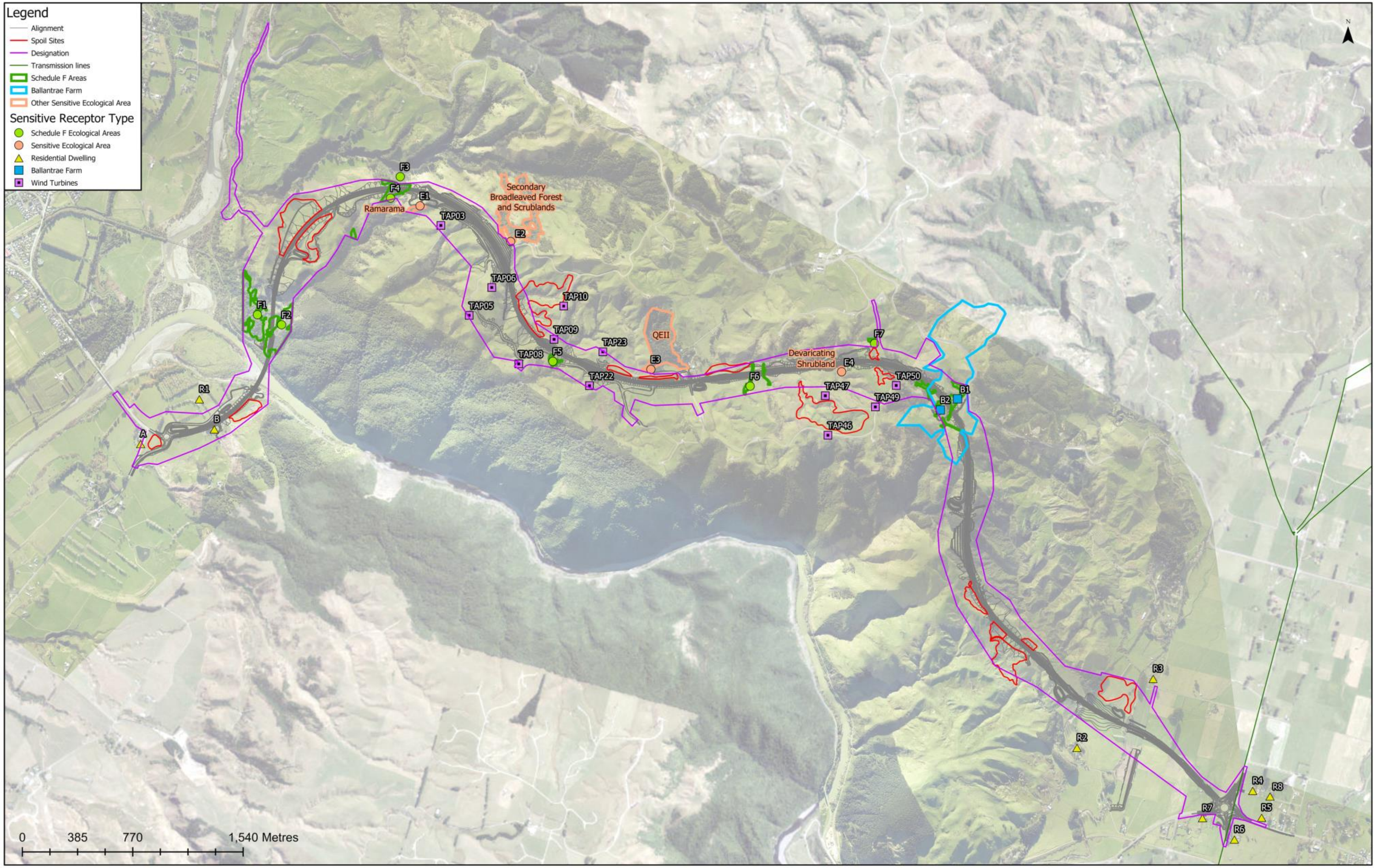

Figure E.1: Sensitive locations / activities (see also Appendix E.4)

Meteorology and Topography

38. The occurrence of strong winds during dry weather can exacerbate dust emissions from earthworks operations. Furthermore, the orientation of sensitive locations to dust sources and the degree that they are downwind under strong, dry wind conditions will affect the exposure of identified sensitive locations to potential dust impacts.

39. The Alignment traverses the southern end of the Ruahine Range immediately north of the Manawatū Gorge, passing through the Te Āpiti Wind Farm. Due to the elevated topography and exposed nature of this location, it will be particularly susceptible to sustained periods of high winds, making the location suitable for a wind farm but also providing frequent conditions for the generation of windblown dust from exposed surfaces.

40. There is no publicly available meteorological data that I am aware of that is representative of the Project site, although I am aware that Meridian is likely to have such data in relation to Te Āpiti Wind Farm. To address the absence of publicly available observed data, I have undertaken meteorological modelling with models routinely used in New Zealand for air quality assessments (the MM5[14] and CALMET[15] models). Details of this modelling are provided in **Appendix E.1**.

41. The CALMET model was run for the year 2017, with resulting hourly wind data extracted for four representative locations along the Alignment (labelled as ‘Ashhurst’, ‘Ruahine Range’, ‘Ballantrae’, and ‘Woodville’). To check the output from the CALMET model, a comparison of the model output was made with data from other wind monitoring locations where available (described further in **Appendix E.1**).

42. A summary of the data for these four locations is presented as wind roses in **Figure E.2**. Wind roses graphically summarise wind speed and direction data over a period of time. The petals of the wind rose show the direction that winds come from – their length indicating the frequency of winds from that direction. The different colour bands within each petal indicates the frequency distribution of wind speeds for each direction.

43. The modelled wind data for 'Ruahine Range' (displayed in **Figure E.2**) in this general location is presented as a wind rose in **Figure E.3**, with more detailed wind roses also individually provided in **Appendix E.2**. This shows a high

[14] Fifth-Generation Pen State/NCAR Mesoscale Model.
[15] CALMET is the meteorological companion model of the CALPUFF air dispersion modelling suite. It is a diagnostic three-dimensional meteorological model. (Scire et al, 2000)

frequency of winds, and particularly strong winds, from the west to northwest. Winds from the north are very infrequent, with winds from the east and southeast occurring for a small percentage of time. This wind pattern will be of relevance to the exposure of sensitive locations to dust from Project sources.

44. Wind erosion of material from exposed surfaces can start to occur when hourly average wind speeds reach 5 m/s and significantly increase for hourly average winds above 10 m/s (AWMA 2000). In practice, it is my experience that appreciable wind erosion starts to occur when hourly winds are 7 m/s or more and I generally refer to such winds as ‘strong winds’.

45. **Figure E.4** is a further wind rose showing only strong winds that are 7 m/s (hourly average) or greater and clearly demonstrates the prevalence of strong winds from the west. While dust can be generated under any dry weather conditions, strong winds are generally a worst-case situation as they can erode dusty material from exposed surfaces and provide for faster drying of surfaces.

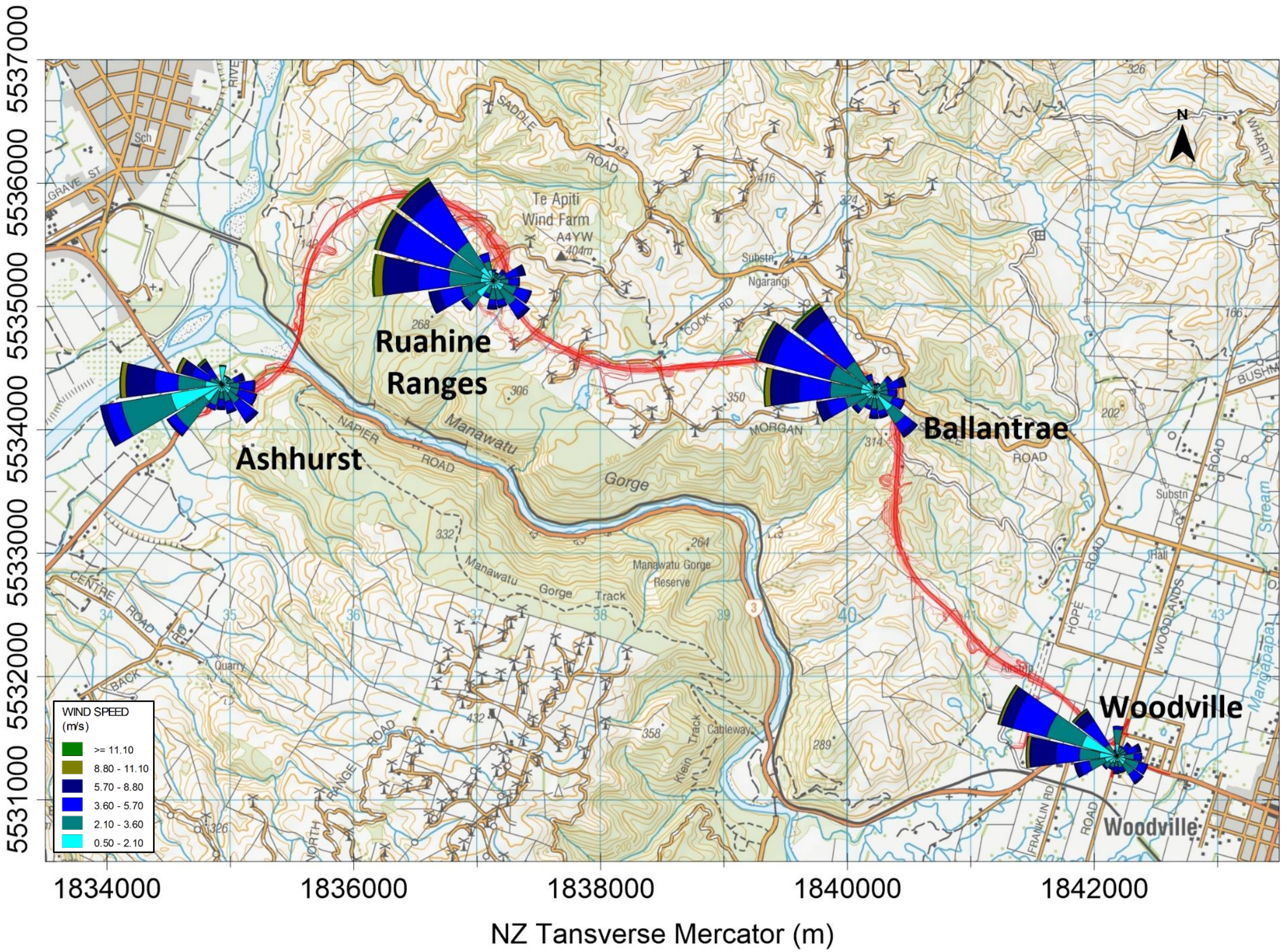

Figure E.2: Overlay of wind roses generated by CALMET for locations along the Alignment (year 2017). Proposed Alignment shown in red.

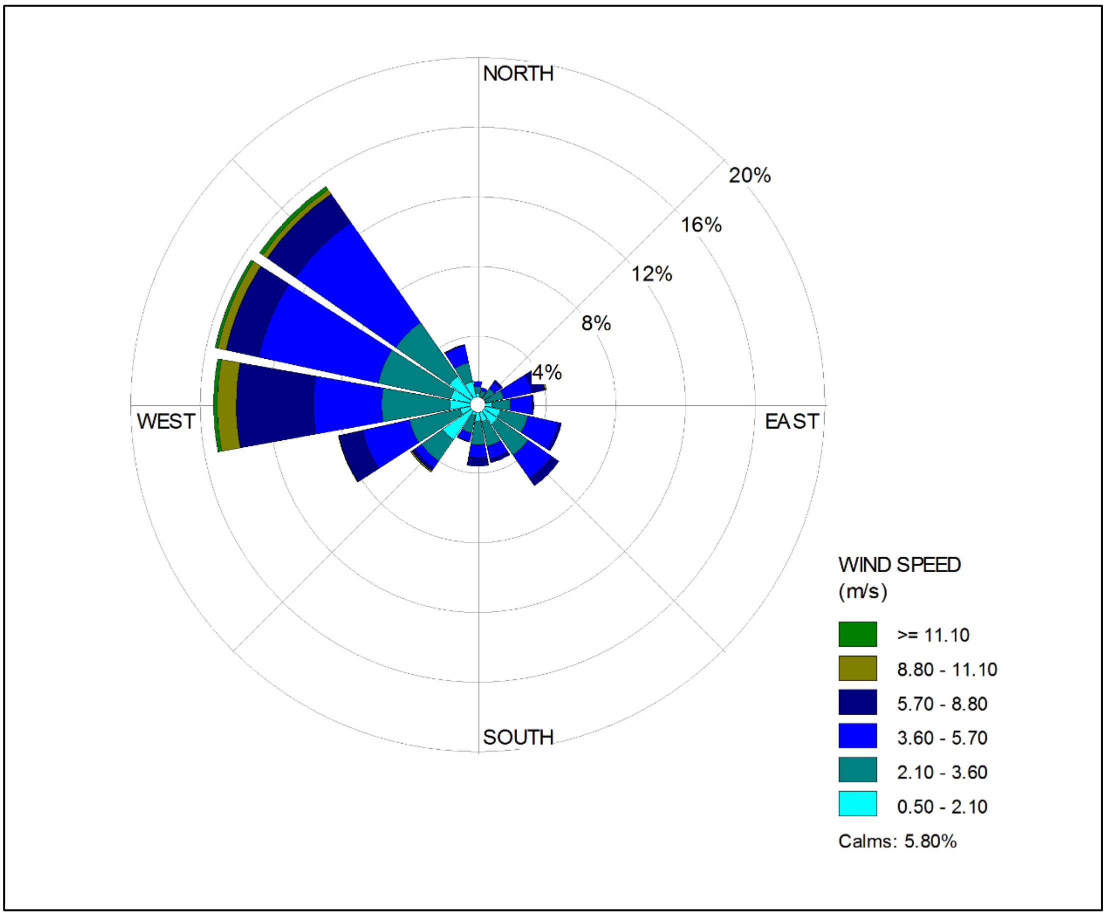

Figure E.3: CALMET generated wind rose (hourly average winds) for Ruahine Range – Year 2017.

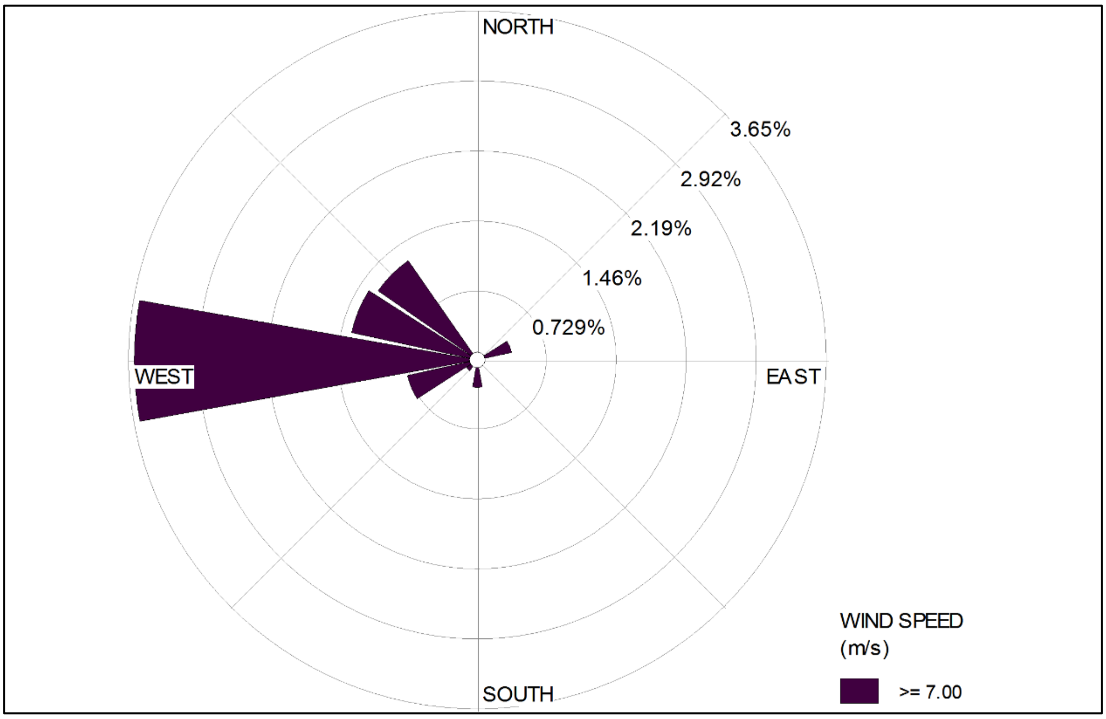

Figure E.4: CALMET generated wind rose of hourly average winds ≥7 m/s (strong winds) for Ruahine Range – Year 2017

Background air quality

46. Background air quality refers to the level of airborne contaminant in the Project Area prior to the Project being constructed. I consider it reasonable to assume background contaminant (most notably dust and fine particulate matter (PM_{10})) levels will be low given the largely rural location of the Project, which is absent of any appreciable anthropogenic emission sources.

47. Ambient air quality measurements at rural locations are not commonly undertaken. However, in the absence of Project site-specific measurement data, the Transport Agency provides an interactive 'background air quality map'[16] for estimating background PM_{10} concentrations based on geography. This tool identifies that the Papatawa area (within which the Project is predominantly located) has a predicted maximum 24-hour average PM_{10} concentration of approximately 19 µg/m³. This is just under half of the Resource Management (National Environmental Standard for Air Quality) Regulations 2004 ("**NES$_{AQ}$**") standard for PM_{10} of 50 µg/m³, which is consistent with my expectation of good air quality for the Project Area. A screenshot of the Transport Agency tool centred on the Project Area is provided in **Figure E.5**.

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

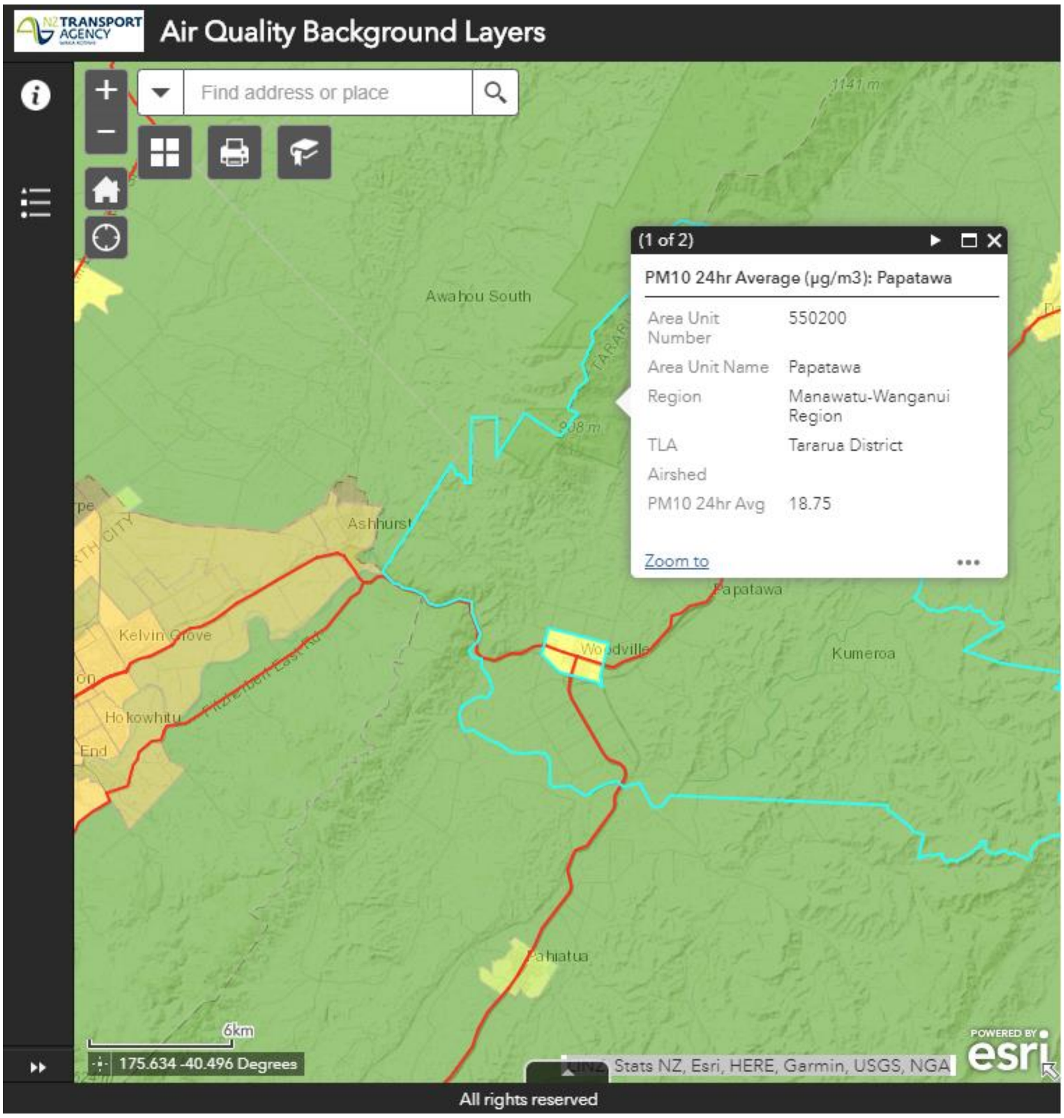

Figure E.5: Background Air Quality from the Transport Agency background air quality map.

METHODOLOGY

Background

48. I have familiarised myself with the technical assessments previously prepared by the Transport Agency in support of the NoRs. Notably, the Assessment of Effects on the Environment for the NoRs largely defers consideration of potential dust effects as being an issue to be more comprehensively dealt with at the regional resource consenting stage. That said, several conditions were recommended and carried through to the Transport Agency's decision on the NoRs, and subsequently to the version of conditions agreed by the parties to the appeals on the NoRs and lodged with the Environment Court in October 2019 ("**Designation Conditions**"):

    (a) Te Āpiti Wind Farm – Designation Condition T1 requires the preparation of Te Āpiti Wind Farm Management Plan, which has the objective of setting out measures to avoid where practicable the potential effects of the Project on wind farm operations and, where avoidance is not possible, setting out measures to remedy or mitigate such effects. This Management Plan must (amongst other things) confirm measures to manage the effects of dust that may damage the turbines, substation or overhead electricity transmission lines.

(b) The National Grid – Designation Condition T2 requires the preparation of a National Grid Management Plan, which has the objective of avoiding, remedying, or mitigating the potential effects of the Project on the operation and maintenance of the Mangamaire – Woodville A 110 kV transmission line. This Management Plan must (amongst other things) confirm measures to manage the effects of dust that may damage the National Grid Transmission lines. This will include managing the risk that high levels of dust may cause arcing of insulators (as insulators are considered to be part of a transmission line).

(c) The Ballantrae Farm – Designation Condition T3 requires the preparation of a Ballantrae Research Station and Fertiliser Trial Management Plan, which has an objective of avoiding, remedying, or mitigating the potential adverse effects of the Project on Ballantrae Farms operations and the current long-term fertiliser and grazing trial. This Management Plan must set out measures to be implemented to minimise dust from enabling and construction works impacting on the long-term fertiliser and grazing trial farmlets.

49. The Hearing Panel's Territorial Authority Recommendation Report on the NoRs (May 2019) also records that "*several submitters raise concerns about... construction dust....*"[17]

50. When I come to consider mitigation for the Project, I have sought to build on the mitigation proposed to date through the Designation Conditions. I explain this further below.

Qualitative FIDOL approach

51. NZTA 2019 sets out guidance for assessing air quality effects from state highway projects, which in turn refers to MfE 2016.[18]

52. The key consideration when assessing nuisance dust effects is whether the discharge gives rise to an 'offensive or objectionable' effect beyond the

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[17] Territorial Authority Recommendation Report, May 2019, paragraph 91, page 10.
[18] NZTA 2019, Page 5

proposed designation boundary by considering the FIDOL factors, which are detailed further below.

53. There are no quantitative standards or guidelines for general dust effects in New Zealand due to its subjective nature. Neither are there any published standards or guidelines regarding dust effects on wind turbines or electrical infrastructure as far as I am aware. Similarly, there are no specific New Zealand guidelines regarding dust effects on ecologically significant sites that I am aware of. However, the UK Design Manual for Roads and Bridges states[19]:

> *"Dust or particles falling onto plants can physically smother the leaves affecting photosynthesis, respiration and transpiration. The literature suggests that the most sensitive species appear to be affected by dust deposition at levels above 1,000 mg/m^2/day which is five times greater than the level at which most dust deposition may start to cause a perceptible nuisance to humans. Most species appear to be unaffected until dust deposition rates are at levels considerably higher than this".*

54. Given the above, I consider a conservative and appropriate approach is to assess these other receptor types in a manner consistent with assessing 'offensive or objectionable' nuisance effects.

55. This assessment therefore considers whether 'offensive or objectionable' effects are likely to occur in accordance with guidance in MfE 2016 and Section 15.3 of the One Plan. The assessment comprises an initial screening to identify potentially sensitive locations within a certain distance from the potentially dust generating sources, followed by a more detailed assessment for those locations identified in the initial screening evaluation.

56. The detailed assessment of identified locations evaluates the risk of impacts based on a consideration of five factors, being frequency, intensity, duration, offensiveness and location (the "**FIDOL factors**") for each location from unmitigated sources of dust. The FIDOL factors provide an objective framework for evaluating dust effects and are described as follows:

    (a) <u>Frequency</u>: The frequency of exposure to dust impacts experienced at a given location. The frequency of exposure depends on both the frequency of occurrence of discharges and the frequency of weather conditions that could transport any discharge towards a sensitive location.

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[19] DMRB HA 207/07. Design Manual for Roads and Bridges – Air Quality – Volume 11, Section 3, Part 1. The Highways Agency, Transport Scotland, Welsh Assembly Government, The Department of Regional Development Northern Ireland.

(b) Intensity: The intensity of dust impacts depends on the degree to which dust sources are controlled but also the separation distance between a source and the receptor.

(c) Duration: The duration of exposure depends on how long a sensitive location may be exposed to dust from a source.

(d) Offensiveness: The offensiveness of dust relates to the nature of the dust in terms of its character or ability to soil or cause abrasion of surfaces.

(e) Location: The location factor relates to the sensitivity of the location being assessed, and is typically expressed as low, medium or high. With regard to receptor types, I have attributed the following sensitivities to dust impacts:

(i) Residential dwellings: high sensitivity;

(ii) Pastoral grazing land/forestry: low sensitivity;

(iii) Wind turbines: moderate sensitivity;

(iv) Ecologically sensitive areas, including Schedule F and locations within the Ballantrae Farm: moderate to high sensitivity;

(v) Transmission lines: moderate sensitivity.

57. The FIDOL assessment is informed by a review of exposure of sensitive locations to certain wind conditions to inform the potential frequency and duration of potential effects. This focuses on the occurrence of strong winds during dry weather, as these are typically the most conducive weather conditions for causing significant unmitigated dust emissions from earthworks and construction activities.

58. I have used the outcome of the FIDOL assessment to categorise general locations where the risk of adverse dust impacts are high and to inform the degree of mitigation control and monitoring that I consider necessary to ensure acceptable off-site dust impacts (i.e. measures needed to ensure dust impacts are not offensive or objectionable).

59. In addition to referring to the guidance in MfE 2016, NZTA 2019 has its own ‘Dust Risk Index’, which can be used to classify the dust risk associated with a road construction project as low, medium or high. For completeness I have evaluated the Project against this Dust Risk Index in **Appendix E.3**, which confirms the Project as having a high-risk of dust impacts. NZTA 2019 advises that a ‘Construction Air Quality Management Plan’ ("**CAQMP**") is necessary in these cases. For this Project a CAQMP is not proposed, because potential dust

effects will instead be addressed by the Dust Management Procedure included as Appendix 3 of the ESCP. I comment further on the appropriateness of the proposed Dust Management Procedure when I discuss mitigation measures.

STATUTORY CONSIDERATIONS, INCLUDING NATIONAL STANDARDS, REGIONAL AND DISTRICT PLANS, AND OTHER RELEVANT POLICIES

National Environmental Standards for Air Quality

60. The Resource Management (National Environmental Standards for Air Quality) Regulations 2004 ("**NES_{AQ}**") includes air quality standards for PM10, nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO) and ozone (O_3). Dust from construction earthworks will include PM_{10} emissions, as will combustion emissions from vehicles and machinery. Combustion emissions will also include small amounts of NO_2, CO and SO_2.

61. In all cases, I expect that cumulative contaminant concentrations arising from the Project will remain well within the NES_{AQ} ambient air quality standards and therefore will achieve the requirements of Regulation 13 of the NES_{AQ}. This is based on the relatively remote location, lack of background emission sources in the wider area, and minimal contribution from the Project.

62. Regulation 17 of the NES_{AQ} relates to resource consent applications to discharges of PM_{10} into polluted airsheds and places certain restrictions on regional councils in granting consents in 'polluted airsheds'. In this instance, the Project is not within, or near to, any polluted airshed. Accordingly, I consider the restrictions of Regulation 17 do not apply to this Project.

The One Plan – Regional Policy Statement

63. Part 1 of the One Plan sets out the Regional Policy Statement ("**RPS**"), with Section 7 pertaining to 'Air'. Objectives and policies of the RPS that I consider are relevant to the Project are summarised as follows:

    (a) Objective 7-1: A standard of ambient air quality is maintained which is not detrimental to amenity values, human health, property or the life-supporting capacity of air and meets the national ambient air quality standards provided for in the NES_{AQ}.

    (b) Objective 7-2(b): PM_{10} levels in areas other than Taihape and Taumarunui are managed to ensure compliance with the NES_{AQ} standard for PM_{10}.

    (c) Policy 7-1: The NES_{AQ} air quality standards as set out in Table 7.1 of the One Plan must be adopted as ambient air quality standards for the Region and ambient air quality must be:" *(a) maintained or enhanced in those areas which meet the standards,… in accordance with the air quality* *categories and designated responses in Table 7.2.*" Table 7.2 sets out the "designated response" in locations with "acceptable" air quality (where ambient concentrations are up to 66% of the NES_{AQ}) as being to "maintain". I consider that the ambient air quality of the Project Area is "acceptable" and thus the Project must "maintain" the ambient air quality of the area.

(d) Policy 7-2: Ambient air quality must be managed in accordance with the regional standards set out in Table 7.3, notably that *"a discharge must not cause any noxious, offensive or objectionable dust beyond the property boundary"*.

(e) Policy 7-3: Discharges of contaminants into air will be generally allowed, provided:

(i) the effects of the discharge are consistent with the approach set out in Policy 7-1 for implementing the NES_{AQ}; and

(ii) the discharge is consistent with the regional standards set out in Policy 7-2.

The One Plan – Regional Plan - Chapter 15 – Discharges to Air

64. Chapter 15 of the One Plan sets out the objectives and policies relating to air discharges. Objective 15-1 sets the expectation of managing air quality so that it is not detrimental to amenity values and managing PM_{10} levels in areas where the NES_{AQ} is currently achieved to ensure its ongoing compliance.

65. Policy 15-2 instructs the Regional Council to have regard to a range of matters when making decisions on resource consent applications, which relevant include (to summarise):

(a) The objectives and policies of Chapter 7;

(b) Guidelines in Section 15.3 for managing offensive or objectionable effects (such as from dust emissions);

(c) National regulations and guidelines (in this case the NES_{AQ} and MfE Good Practice Guide for assessing dust);

(d) The location of the discharge and its effects on sensitive areas; and

(e) The appropriateness of adopting the best practicable option ("**BPO**").

66. Section 15.3 of the One Plan sets out guidance for managing noxious, dangerous, offensive and objectionable effects. It makes specific reference to the FIDOL factors and a previous edition of the MfE Good Practice Guide for

Assessing Dust. The MfE Good Practice Guide was updated in 2016 and I consider the use of the more recent guide to be appropriate and consistent with the intent set out in Section 15.3.

ASSESSMENT OF EFFECTS

67. I have broken my assessment into four broad geographical areas along the Alignment, which are distinct in terms of their locations but also the types of sensitive receptors within each. These four areas are:

    (a) Ashhurst Area: the western-most extent of the Alignment near Ashhurst where the Alignment crosses the Manawatū River and climbs its way up the western flank and onto the Ruahine range;

    (b) Ruahine Range Area: the extent of the Alignment that crosses the Ruahine range, passing through the Te Āpiti Wind Farm;

    (c) Ballantrae Area: the area in the vicinity of the Ballantrae Farm, which also includes a number of Te Āpiti Wind Farm turbines; and

    (d) Woodville Area: the eastern-most extent of the Alignment where the Alignment drops down the eastern flank of the Ruahine ranges towards Woodville.

68. The assessment considers the impacts on sensitive locations adjacent to potential dust generating sources within the Earthworks Footprint.

Ashhurst Area

69. There are three existing residences close to the western extent of the Project near Ashhurst, although two of these will be purchased as part of the Project. I have not considered the two properties to be purchased further in my assessment other than to note their location in **Figure E.1** and **Sheet 1 of Appendix E.4**, where I denote them as locations A and B. The remaining residence is shown in **Figure E.1** and **Sheet 1 of Appendix E.4** as R1. **Table E**.1 provides an evaluation of the individual FIDOL factors for this receptor.

Table E.1: Ashhurst Area FIDOL evaluation

Factor	Evaluation
Frequency	Frequency of exposure to dust impacts depends on the frequency of discharge occurring from the dust generating activity and the frequency that a sensitive location is downwind of a dust generating activity. In this instance, I have assumed that dust generation will occur continuously. Therefore, the key determinant for the frequency of exposure will be the frequency of strong wind blowing towards the receptor. **Figure E.6** provides a summary of the frequency of exposure of each receptor to strong winds from the direction of the potential dust sources associated with the Project (within 200 m). The frequency of strong winds is calculated based on winds that are 7 m/s or greater that blow from the direction of potential dust sources (including spoil sites) within 200 m towards the receptor. Details of the wind bearings used in the calculation are provided in Appendix E.5. This consideration of strong wind frequency alone is expected to be conservative given that it does not take account of rainfall periods when dust emissions will be reduced. From this table, it is evident that Receptor 1 will experience relatively infrequent exposure (1% or less). This reflects Receptor 1 being predominately upwind of works during prevailing wind conditions.
Intensity	The intensity of impacts depends of the scale of emissions from the dust source and the distance a sensitive location is from that source. In terms of separation, Receptor 1 has a moderate setback being at least 150 m from potential dust sources associated with the Project and therefore would only be exposed to low to moderate dust intensities from uncontrolled dust sources.
Duration	The duration of impacts is a function of the duration that dust generating activities are undertaken and the duration that a sensitive location may be downwind of those activities. In this instance I have conservatively assumed that potential sources will operate for the duration of works within an area. The duration of wind events is largely linked to the frequency that a given sensitive location is downwind of a dust sources.
Offensiveness	The offensiveness factor relates to the nature of the dust that may be generated. In this instance, the dust will be largely inert soil and aggregate derived dust, typical of dust generated in the wider receiving environment. As such, I do not consider that the dust will be especially offensive in character when compared with the likes of coal dust or other hazardous dusts.
Location	In terms of the location, I consider Receptor 1 to have a high degree of sensitivity to dust impacts. However, the surrounding rural land has a comparatively low sensitivity to dust impacts.

70. Based on the above FIDOL evaluation, I consider the single residence (R1) has a low risk of dust nuisance effects. Later in this report, I consider mitigation measures that I expect can be used to control dust deposition nuisance effects on this receptor to acceptable levels.

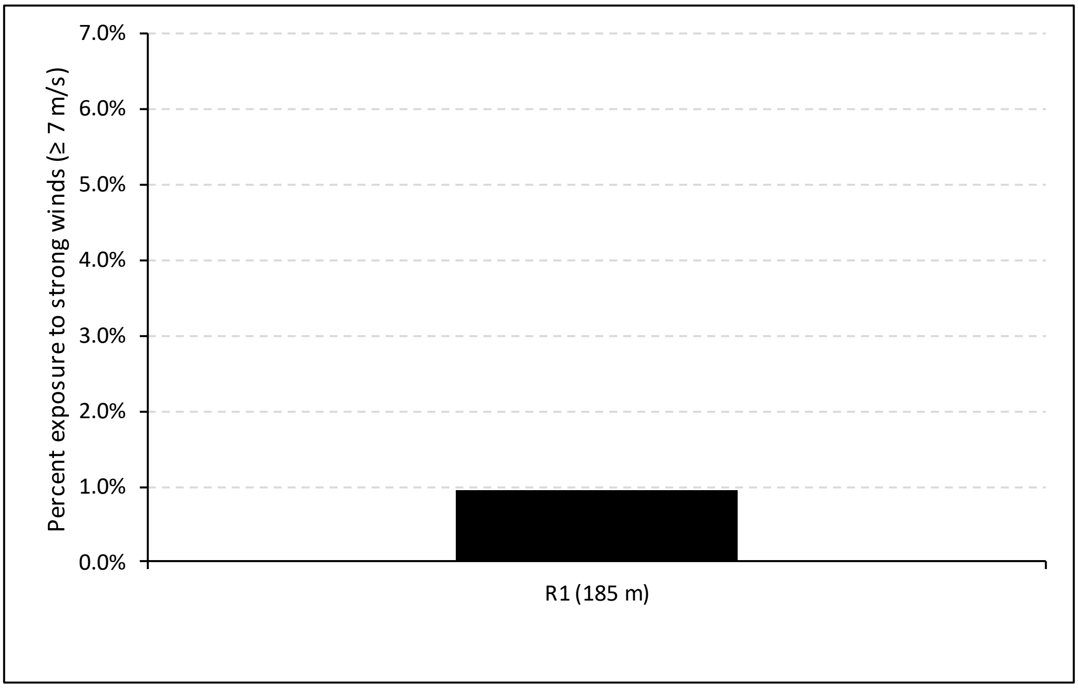

Figure E.6: Ashhurst Area - exposure of sensitive receptors to strong winds from the direction of the Project.

Ruahine Range Area

71. Dust sensitive receptors in what I describe as the 'Ruahine Range Area' include the Te Āpiti Windfarm turbines and sensitive ecological areas within 100 m of construction/earthworks activities. The location of these receptors are shown in **Figure E.1** and **Sheets 2 and 3 of Appendix E.4**. From my review of the area I am not aware of any residential dwellings or other similar high-sensitivity receptors.

72. I understand that each turbine has a tower measuring 70 m high, on top of which is located a nacelle (housing the generator) to which three blades are fixed. Each blade is 35 m in length, meaning the outer-most tip of the blade will come no closer than about 35 m from the ground. In practice, I consider the height above the ground that the closest blades will come to will help further separate the sensitive components of the turbines (blades and nacelle) from any plume of dust. In **Sheets 2 and 3 of Appendix E.4** I identify the turbines by their name (i.e., TAP03, TAP06, TAP05, TAP08, TAP09, TAP10, TAP22 and TAP23).

73. In terms of ecological receptor locations, I have focused on general locations within the Schedule F areas or other areas as advised by the ecological team (as described in paragraph 37(e) above). In each case I have used a single location that I consider will be broadly representative of wind exposure for each sensitive area from the direction of the Project. For this reason, these ecological receptor locations are shown as specific points rather than the entire footprint of the corresponding sensitive area. This is to ensure that the wind exposure I have calculated for any given location is not unduly overstated. The locations that relate to Schedule F areas are nominally delineated as receptors (F1 to F5) with the other sensitive ecological areas delineated as receptors E1, E2, and E3.

74. My evaluation of each of the FIDOL factors in relation to the sensitive locations in the Ruahine Range Area is provided in **Table E.2**.

Table E.2: Ruahine Range Area FIDOL evaluation

Factor	Evaluation
Frequency	**Figure E.7** provides a summary of the frequency of exposure of each receptor to strong winds from the direction of the potential dust sources associated with the Project (within 100 m) in the Ruahine Range Area. The frequency of strong winds is calculated based on winds that are 7 m/s or greater that blow from the direction of potential dust sources (including spoil sites) within 100 m towards the receptor. Details of the wind bearings used in the calculation are provided in Appendix E.5. This consideration of strong wind frequency alone is expected to be conservative given that it does not take account of rainfall periods when dust emissions will be reduced. Of note are wind turbines TAP09 and TAP10, and ecological receptors F1, F4, E1 and E2, which are all exposed to strong winds from the directions of potential dust sources associated with the Project for between 5 % and 7% of the time. This reflects the relative close proximity of these receptors to the potential dust sources but more significantly that they are orientated in a way that means they are downwind of the Project during prevailing strong westerly winds. The remaining receptors all have relatively low frequencies of exposure to strong winds (≤ 2%).

Factor	Evaluation
Intensity	The intensity of potential dust deposition effects will be a function of both the frequency of exposure to strong winds and setback distance at the receptor location. Given this context I consider that: • Wind turbines TAP02, TAP05, TAP08, TAP22 and TAP23 are likely to experience low levels of accumulated deposition (separation distances greater than 50 m and frequency of exposure is ≤ 2%). • Wind turbines TAP09 and TAP10 may be exposed to moderate to high levels of potential dust deposition from unmitigated sources (≤ 50 m setback and ≥ 5% exposure to strong winds). • Ecological receptors F1, F3, F5, and E3 are likely to experience negligible levels of potential dust deposition due to their very low frequency of exposure to strong winds from the Project and moderate separation distances (≥50 m and ≤1 % exposure). • Ecological receptors F4, E1 and E2 may experience moderate levels of dust deposition intensity from unmitigated sources due to their relative close proximity (40 m) and high level of exposure (5.5% to 7%) to strong dry winds. • Ecological Receptor F2, although being frequently exposed and relatively close, is in an area where the Manawatū River Bridge (BR02) and Eco Bridge (BR03) will pass, the construction of which will generate significantly less dust than earthworks that will be undertaken over the remainder of the route.
Duration	As noted in the section regarding the Ashhurst Area, the duration of wind events is largely linked to the frequency that a given sensitive location is downwind of potential dust sources.
Offensiveness	As described in the FIDOL evaluation for the Ashhurst Area, I do not consider that the dust will be especially offensive in character when compared with the likes of coal dust or other hazardous dusts.
Location	In terms of location, consideration has been given to the wind turbines and sensitive ecological areas along this section of the Alignment. There are no residences in this area and I consider the surrounding pastoral farm land to be insensitive to dust impacts.

75. Based on the above FIDOL evaluation, I consider wind turbines TAP09 and TAP10, along with ecological receptor F2, F4, E1 and E2 may experience moderate to high levels of dust deposition if dust from construction activities is not well managed. Later in this report, I consider mitigation measures that I expect can be used to control dust deposition effects to acceptable levels.

76. The western extent of the Alignment includes the Manawatū River Bridge (BR02) which connects to the Eco Bridge (BR03). The construction of the Eco Bridge (BR03) (most notably the foundations) will have minimal dust emissions when compared with large scale earthworks across other parts of the Earthworks Footprint. Consequently, this will minimise any dust impacts on the identified Schedule F areas in this location (Receptors F1 and F2).

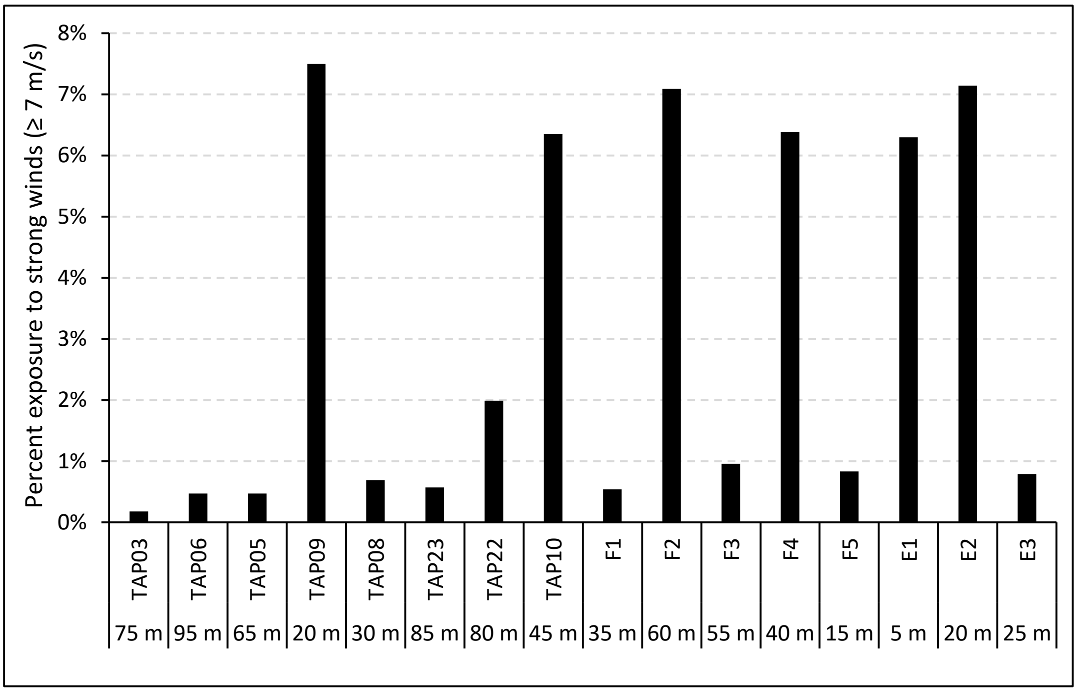

Figure E.7: Ruahine Range Area - exposure of sensitive receptors to strong winds from the direction of the Project.

Ballantrae Area

77. The area I have described as the 'Ballantrae Area' comprises the Ballantrae Farm (from which I have selected two locations to examine potential wind exposure on either side of the route, namely receptors B1 and B2). In addition, I have selected a number of other ecologically sensitive areas (Schedule F and other identified locations) and four wind turbines (TAP46, 47, 49 and 50). The location of these receptors is shown in **Figure E.1** and **Sheet 4 of Appendix E.4** and uses the same naming convention as previously used. My evaluation of each of the FIDOL factors for the sensitive locations in this area are summarised in **Table E.3**.

Table E.3: Ballantrae Area FIDOL evaluation

Factor	Evaluation
Frequency	**Figure E.8** provides a summary of the frequency of exposure of each receptor to strong winds from the direction of the potential dust sources associated with the Project (within 100 m) in the Ballantrae Area. The frequency of strong winds is calculated based on winds that are 7 m/s or greater that blow from the direction of potential dust sources (including spoil sites) within 100 m towards the receptor. Details of the wind bearings used in the calculation are provided in Appendix E.5. This consideration of strong wind frequency alone is expected to be conservative given that it does not take account of rainfall periods when dust emissions will be reduced. Of note are wind turbines TAP47 and TAP50, ecological receptors F7 and E4, and receptor B1 (Ballantrae Farm). These are all exposed to strong winds from the direction of the Earthworks Footprint for between 4% and 7% of the time reflecting the close proximity to the potential dust sources associated with the Project but more significantly that they are orientated downwind of the Earthworks Footprint during prevailing strong westerly winds. The remaining receptors all have relatively low frequencies of exposure to strong winds (≤ 2%).
Intensity	As discussed earlier, when assessing the intensity of potential dust deposition effects, consideration needs to be given to both the frequency of exposure and setback distance as this will affect the long-term accumulation of any dust. Given this context I consider that: • Wind turbines TAP46 and TAP49, ecological receptor F6 and Ballantrae receptor B2 are likely to experience low levels of accumulated deposition (separation distances ≥ 50 m and frequency of exposure is ≤ 2%). • Wind turbines TAP47 and TAP50, ecological receptor F7 and E4, and receptor B1 may be exposed to moderate to high levels of potential dust deposition from unmitigated sources (≤ 55 m setback and ≥ 4% exposure to strong winds).
Duration	As noted in the section regarding the Ashhurst Area, the duration of wind events is largely linked to the frequency that a given sensitive location is downwind of dust sources.
Offensiveness	As described in the FIDOL evaluation for the Ashhurst Area, I do not consider that the dust will be especially offensive in character when compared with the likes of coal dust or other hazardous dusts.
Location	In terms of location, consideration has been given to the wind turbines and sensitive ecological areas along the project route. There are no residences in this area and I consider the surrounding pastoral farm land to be insensitive to dust impacts. The exception to this is the pastoral land comprising the Ballantrae Farm, which I have evaluated as being of a moderate to high sensitivity in-line with other sensitive ecological locations.

78. Based on the above FIDOL evaluation, I consider the following locations may experience moderate to high levels of dust deposition effects from unmitigated sources associated with the Project:

(a) Ballantrae Farm to the north and east of the Project within 100 m (B1);

(b) Wind turbines TAP46 and TAP49; and

(c) Ecological receptor F7 and E4.

79. Later in this report, I consider mitigation measures later that I expect can be used to control dust deposition nuisance effects on the above receptors to acceptable levels.

80. I expect the dust deposition effects on the remaining receptors will be low due to them being either upwind or sufficiently far away from the Project.

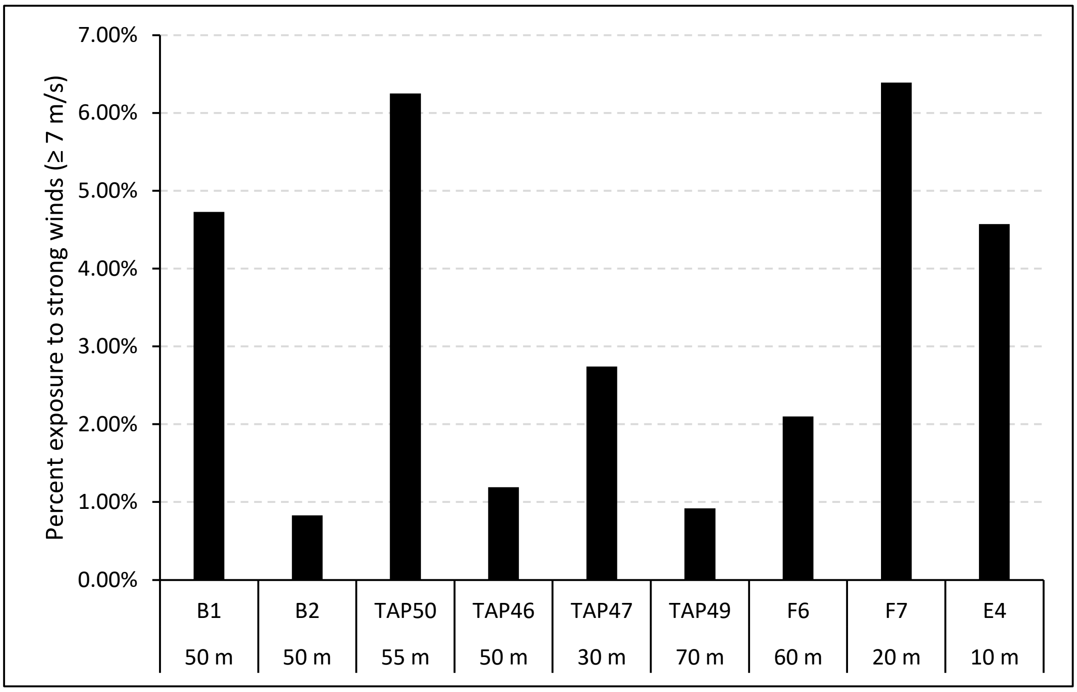

Figure E.8: Ballantrae Area - exposure of sensitive receptors to strong winds from the direction of the Project.

Woodville Area

81. At the eastern end of the Project is what I have described as the 'Woodville Area', where the Alignment comes close to seven residential dwellings. The location of these receptors is shown in **Figure E.1** and **Sheets 5 and 6 of Appendix E.4**. My evaluation of each of the FIDOL factors for sensitive locations in this area are summarised in **Table E.4**.

Table E.4: Woodville Area FIDOL evaluation

Factor	Evaluation
Frequency	**Figure E.9** provides a summary of the frequency of exposure of each receptor to strong winds from the direction of the potential dust sources associated with the Project (within 200 m for residential dwellings and 100 m for sensitive ecological areas) in the Woodville Area. The frequency of strong winds is calculated based on winds that are 7 m/s or greater that blow from the direction of potential dust sources (including spoil sites) within 100 or 200 m towards the receptor (depending on the type of receptor). Details of the wind bearings used in the calculation are provided in Appendix E.5. This consideration of strong wind frequency alone is expected to be conservative given that it does not take account of rainfall periods when dust emissions will be reduced. From this figure, it is evident that: • R2, R3, R6 and R7 will experience a relatively low level of exposure to strong winds from the direction of the potential dust sources (≤ 2%); • R8 will experience a moderate level of exposure (3.5%) • R4 and R5 will be exposed to relatively frequent strong winds from the direction of the potential dust sources (≥ 5%).
Intensity	In terms of potential intensity of dust impacts for residential locations: • Receptor R7 is only 40 m from potential dust sources associated with the Project and therefore has a relatively high risk of exposure to high dust intensity. • Receptor R4 and R5 are approximately 100 m from the potential dust sources associated with the Project, and I consider that they have a moderate risk of exposure to high dust intensities. • The remaining residential receptors are much more than 100 m away from the potential dust sources associated with the Project and therefore have a low risk of exposure to high dust intensities.
Duration	As noted in the section regarding the Ashhurst Area, the duration of wind events is largely linked to the frequency that a given sensitive location is downwind of a dust source.
Offensiveness	As described in the FIDOL evaluation for the Ashhurst Area, I do not consider that the dust will be especially offensive in character when compared with the likes of coal dust or other hazardous dusts.
Location	In terms of location, consideration has been given to sensitive residential dwellings in terms of dust nuisance effects and ecological receptors in terms of dust deposition effects. I consider the surrounding pastoral farmland making up the balance of the area to be insensitive to dust impacts.

82. Based on the above FIDOL evaluation, I consider residential receptors R4 and R5 may experience moderate to high levels of dust nuisance effects from construction activities associated with the Project without the establishment of suitable dust mitigation measures. This is either due to their close proximity to the Project and/or to them being exposed to a high frequency of strong winds from the direction of the Project.

83. Later in my report, I describe mitigation measures that I consider can be used to control dust deposition nuisance effects on the above receptors to acceptable levels.

84. I expect the dust nuisance effects on the remaining receptors will be low due to them being either upwind or sufficiently far away from the Project.

85. As noted earlier, the National Grid Transmission Line traverses along Woodlands Road and over the proposed roundabout at the eastern end of the Project. I consider that dust from roundabout construction works is very unlikely to result in suspended dust concentrations that could cause arcing across conductors, given the following:

(a) the height above ground of the conductions, providing vertical separation;

(b) that high levels of deposition would be required for arcing to occur;

(c) the relatively small scale and nature of dust generating activities associated with the formation of the roundabout;

(d) the requirement to manage dust nuisance impacts at the nearby existing residences, as referred to above.

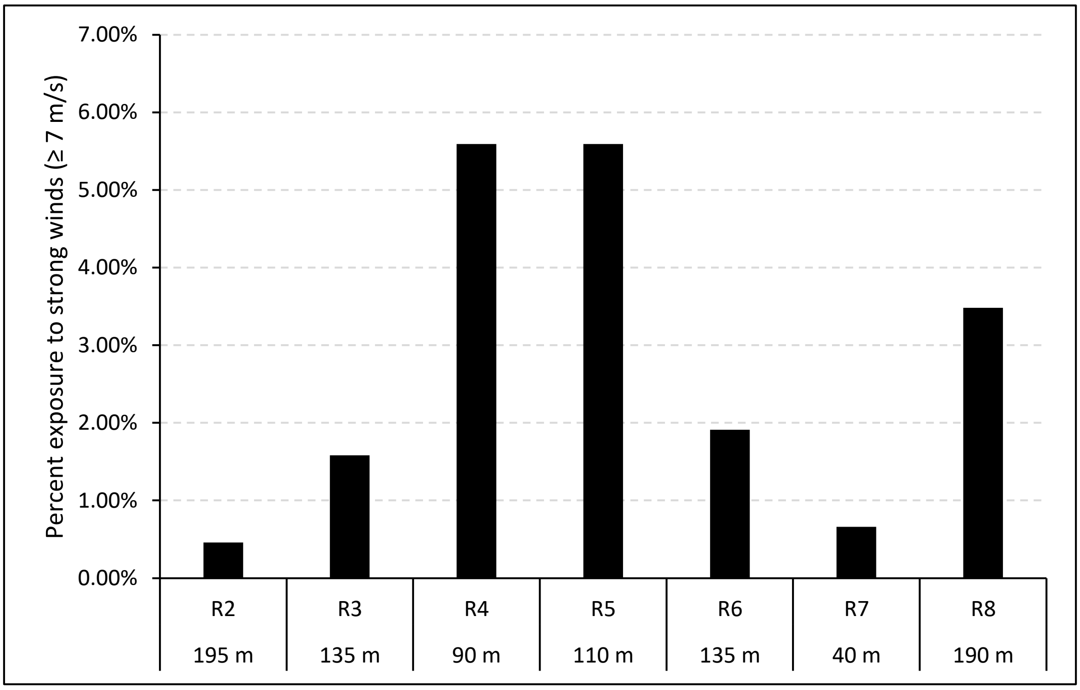

Figure E.9: Woodville Area - exposure of sensitive receptors to strong winds from the direction of the Project.

Summary

86. Based on my above FIDOL evaluation, I consider the following locations will have a moderate to high risk of adverse dust impacts from the Project without proactive management (mitigation):

    (a) Ruahine Range Area:

        (i) Wind turbines TAP09 and TAP10;

        (ii) Ecological receptors F2, F4, E1 and E2.

    (b) Ballantrae Area:

        (i) Areas of the Ballantrae Farm that are north and east of the Project and within 100 m (i.e., Receptor B1);

        (ii) Wind turbines TAP46 and TAP49;

        (iii) Ecological receptors F7 and E4.

    (c) Woodville Area:

        (i) R4 and R5.

87. The following sections discuss the mitigation measures and monitoring that I consider necessary to control dust at the above receptors to acceptable levels. The measures that I set out will generally be appropriate for controlling any additional sensitive locations along the route should they be subsequently identified.

MITIGATION PROVIDED THROUGH THE DESIGNATION CONDITIONS

88. As discussed earlier in my report, the Designation Conditions require a number of management plans to be prepared and implemented in relation to Te Āpiti Wind Farm, the National Grid, and the Ballantrae Farm, and for these management plans to set out the measures that will be taken to manage any effects of dust on these properties/assets.

89. In addition to the above, I recommend below a number of measures which should be included within the proposed Dust Management Procedure prepared as Appendix 3 of the proposed ESCP.

Proposed mitigation measures

90. Based on my FIDOL assessment of potential dust impacts for various sensitive locations, I consider the following dust control measures may need to be implemented to control dust effects to an acceptable level, in combination with

the monitoring that I discuss subsequently in relation to specific receptor locations.

91. Haul routes:

(a) Suppression of dust from haul routes will mainly be achieved by the regular application of water. Water will be applied during dry weather, typically using water carts.

(b) I am advised that a reliable source of water will be available for dust suppression (a water permit is being sought separately from Horizons as an Enabling Works authorisation). However, should water supplies become constrained, or for specific locations requiring additional control, appropriate biodegradable dust suppressants suitable for use on frequently trafficked surfaces could be used. I was involved in a study for the Transport Agency (Bluett *et al* 2016) that investigated the impacts of dust from unsealed roads and specifically the performance of such dust suppression agents. This study demonstrated a high level of prolonged control can be achieved without the need for using water for dust suppression.

(c) In circumstances where dust suppression on unpaved haul roads is not effective at minimising dust emissions in close proximity to sensitive receptors, vehicle speeds could be minimised to further reduce dust emissions. This may occur during prolonged periods of hot dry weather, where the unpaved road surfaces rapidly dries. Reducing vehicle speeds helps to minimise dust emissions on the basis that dust emissions from vehicles moving along uncontrolled and unpaved surfaces is proportional to the speed that the vehicle moves at. For this reason, the MfE[20] and Transport Agency's own guidance[21] suggest a reduced speed limit of 15 km/hr. This is a particularly low speed limit and in my experience the implementation of a slightly higher speed limit of 20 km/hr has proven to be effective in managing dust (I have observed this at quarries and mine operations in particular).

[20] MfE 2016. Good Practice Guide for Assessing and Managing Dust. Ministry for the Environment. Publication Number ME 1277.
[21] NZTA 2019. Guide to assessing air quality impacts from state highway projects. New Zealand Transport Agency. Version 2.2, August 2019.

92. Fill and spoil sites:

(a) The application of water to agglomerate surface material to form a crust on fill and spoil sites will be required periodically during dry weather to minimise dust and reduce the potential for wind erosion of dusty material.

(b) Hay mulch may be used to stabilise finished areas in areas where there are lower winds.

(c) Traffic movements over the fill and spoil sites should be minimised where possible.

(d) Following completion, fill and spoil sites should be stabilised as soon as practicable. This could be achieved using a range of methods, including establishing vegetation (grass), use of dust suppressants, and other methods.

93. Entrance ways will be constructed to minimise the tracking of material from construction areas onto local roads where it could dry and become a localised dust source. This can be achieved using a range of methods, depending on the sensitivity of locations around the entrance ways. This could include washing of wheels where the access way is adjacent to sensitive areas (such as near residences), or using course aggregate (ballast) for a portion of the site access way prior to the entrance in less sensitive areas.

94. I understand that the Transport Agency will adopt its recent practice of rolling and finishing off areas of works progressively as the Project works progress. This will minimise the duration that areas could give rise to dust emissions impacting on sensitive locations.

95. Operation of diggers and loaders:

(a) The drop height of material from the operation of diggers and loaders should be minimised to reduce the potential for wind-blown dust. There is no fixed guidance on this matter that I am aware of, but operators should be trained to ensure that the material being dropped from the digger/loader bucket is done as close as possible to the truck or surface being loaded and not from an unnecessary height.

96. As a contingency measure for sensitive locations within 50 m of potential dust sources and should monitoring (described below) indicate the need, wind break fencing could be erected between the sensitive location and the source to help further minimise dust impacts on the receptor.

MONITORING

97. Dust mitigation measures associated with excavation and fill placement activities should be regularly reviewed and where necessary further measures implemented in areas within 100 m of sensitive ecological locations that are downwind under dry westerly winds when the hourly average wind speed is 10 m/s or more. Under these conditions, significant wind erosion can occur from exposed surfaces. This is a higher wind speed than I would typically recommend, but it reflects two considerations:

    (a) That in my opinion that key concern in the vicinity of excavation and fill sites will largely be dust deposition, rather than wider nuisance effects; and

    (b) The Ruahine Range Area and Ballantrae Area, is generally a high wind environment and a lower windspeed threshold is not likely to be practicable.

98. Given the above, I recommend that a wind monitoring site be established at a representative location in the Ruahine Range Area. The monitoring site should be telemetered with the data available in real-time to site operators and alarmed for when hourly average winds exceed 10 m/s.

99. In addition, I consider that routine monitoring will be required to ensure the effective implementation of the above dust mitigation measures. This should include the following:

    (a) Daily observations of active work areas for any significant visible dust emissions. This should focus on haul routes, frequently trafficked areas, excavation sites and fill/spoil areas. During prolonged dry weather observations may need to be more frequent (a few times per day).

    (b) Checks of weather forecasts at the start of each day (particularly the absence of rain and whether strong winds are expected) should be used to inform activities to be undertaken, including informing staff of the potential risks associated with dust and its potential effects. In practice, given the high wind environment, especially over the Ruahine Range Area, this is likely to be a frequent occurrence.

    (c) For exposed high-sensitivity locations (i.e., residential dwellings), including Receptors R4 and R5 near Woodville, instrumental continuous dust monitors (nephelometers) should be established in general accordance with AS/NZS 3580.12.1:2015[22] or similar. The purpose of these monitors is to provide the contractor with real-time feedback on dust levels near sensitive locations and to provide notice of elevated dust levels and allow a pro-active response. These monitors can be telemetered and used to warn site operators of elevated dust levels that require prompt action. From a review I have made of Spark and Vodafone cellular coverage maps covering the Alignment, there is reasonable coverage for most locations to enable instrument telemetry should the need arise. This monitoring will be most applicable to the most exposed dwellings near constructions works at either end of the Project alignment (i.e., Receptors R4 and R5).

The number of monitors and their general location should be set out in the proposed Dust Management Procedure prepared as part of the ESCP, however, I would initially expect that this might involve monitors being located between the construction works and receptors R4 and R5 when construction works are being carried out within approximately 100 m of any of those receptors.

MfE (2016) sets out guidance for 1-hour average trigger levels. In my experience, the 1-hour average trigger level for PM_{10} is most suitable for managing dust (1-hour concentration of 150 $\mu g/m^3$) when using nephelometer instruments. Although the MfE (2016) sets out trigger values for total suspended particulate (TSP), in practice the nephelometer instruments are not well suited to monitoring TSP.

Should a trigger level be reached then an automated message will be sent to site operations alerting them to the need to cease dust generating activities in that location until such time that emissions can be adequately controlled and concentrations reduced to within the trigger levels.

(d) I recommend that dust deposition monitoring be undertaken in relation to the most exposed wind turbines (TAP9, TP10, TAP47 and TAP50) and sensitive ecological areas (F2, F4, F7, E1, E2, E4 and B1) for the duration of construction works in a given area (i.e., those located close to and downwind during prevailing winds of construction works). Deposition monitors are relatively low-cost passive monitors that are set up and collect deposited material for a month, after which the collected sample is retrieved and sent to a laboratory for analysis to confirm the rate of

[22] AS/NZS 3580.12.1.2015. Methods of sampling and analysis of ambient air – Part 12.1: Determination of light scattering integrating nephelometer method.

measured deposition. The results can then be compared to a trigger value of 4 grams per square metre per 30-days above background levels (4 g/m³/30-days) (MfE 2016). Continuous instrumental monitoring of suspended dust (as I describe above) is often used in preference to dust deposition monitoring to manage potential nuisance effects. However, I consider deposition monitoring to be especially suitable and relevant in this instance where longer term dust deposition is a key consideration for managing potential property damage and ecological effects. However, if monthly monitoring results for a given location did indicate deposition levels above the trigger value, then the use of continuous dust monitors could be employed.

(e) The results of deposition monitoring should be reviewed each month against site activities for the period coinciding with the monitoring. Where results are elevated (i.e., those that approach or exceed the above trigger value) then the potential causes should be investigated, and additional control measures implemented to minimise ongoing emissions. The precise nature of those additional control measures would need to be determined but could include, for example, more extensive dust suppression covering a wider area, more frequent application of water or the wider or the use of a biodegradable dust suppressant.

(f) To determine background levels that can be used to evaluate the above assessment criteria against, I recommend establishing an additional dust deposition monitoring site that is located upwind of the Project Area under prevailing winds and well removed from the Earthworks Footprint (nominally at least 500 m setback from the nearest earthworks).

(g) In terms of the methods that can be used for monitoring deposition, I suggest using directional dust deposition gauges in relation to monitoring downwind of identified wind turbines. The methodology is set out in AS/NZS 3580.10.2:2013[23]. I consider that this method is best suited in relation to impacts on the wind turbines as it provides a gravimetric measure of dust that impinges of vertical surfaces. An example of a directional dust deposition gauge is provided in **Figure E.10**.

[23] AS/NZS 3580.10.2:2013. Methods for sampling and analysis of ambient air. Determination of particulate matter - Impinged matter - Gravimetric method.

(h) In relation to ecological receptors, where deposition on horizontal surfaces is more a concern, I consider that traditional dust deposition gauges would be more appropriate. The methodology is set out in AS/NZS 3580.10.1:2016[24].

Figure E.10: Directional dust gauge (source Thomson Environmental)

SUMMARY RATING OF EFFECTS

100. If the mitigation measures that I have described above are implemented and monitored to ensure their effectiveness, I conclude that the potential dust effects on sensitive locations will be controlled to a level that does not give rise to offensive or objectionable dust effects at sensitive receivers or beyond the designation boundary. This will mean that dust emissions will not be detrimental to amenity values and that ambient PM_{10} levels will be maintained within the NES_{AQ} standards. Consequently, I consider that discharges to air from the Project should be consistent with the objectives and policies of the One Plan.

101. I have reviewed the proposed Dust Management Procedure to be included as part of the ESCP and I consider it generally reflects the mitigation methods and monitoring in line with my recommendations.

[24] AS/NZS 3580.10.1:2016. Methods for sampling and analysis of ambient air. Determination of particulate matter - Deposited matter - Gravimetric method.

CONCLUSION AND RECOMMENDATIONS

102. My conclusions are as follows:

(a) Without implementation of appropriate control measures, there are a small number of sensitive residential locations that would be at risk of being exposed to dust impacts. These are in the vicinity of the Woodville roundabout, where a few are particularly close to the Alignment and are downwind under prevailing strong westerly winds. However, I consider that the mitigation measures I have recommended will enable dust levels to be controlled in order to avoid causing an offensive or objectionable effect. Furthermore, the continuous dust monitoring will enable early warning of elevated dust levels and a proactive response to elevated levels should they occur.

(b) Four of the Te Āpiti Wind Farm turbines (TAP09, TAP10, TAP46 and TAP49) are close to the potential dust sources associated with the Project and likely to be frequently exposed to strong winds from the direction of potential dust generating construction and earthwork activities. It is my understanding that the key consideration regarding dust impacts is the possible effect of deposited dust on the aerodynamic performance of the turbine blades. However, the closest point of these blades to the ground is at least 30 m above ground level. The mitigation measures I have recommended, along with the height of the turbine blades above ground level, will mean that dust impacts on these turbines should be less than minor. Dust deposition monitoring that I have recommended, to be undertaken in the vicinity of the four turbines in question, will enable dust deposition rates to be confirmed. Where deposition rates exceed a pre-determined trigger level, a review of dust management should be implemented with modification to management measures as required.

(c) Without implementation of appropriate control measures, there are six sensitive ecological receptor areas that would be at risk of being exposed to dust impacts. These areas include:

(i) Schedule F areas, which I have labelled F2, F4 and F7; and

(ii) additional ecological receptor areas identified by the Alliance's team of ecological experts, which I have labelled E1, E2 and E4.

I expect that the dust mitigation measures I have recommended will minimise any potential dust deposition effects in the identified areas to levels that are less than minor. Ongoing deposition monitoring to be undertaken in each of these areas will enable the performance of those measures to be evaluated and changes to be made to mitigation should the need arise.

(d) I have reviewed the proposed Dust Management Procedure, to form part of the ESCP and consider that it reflects the mitigation methods and monitoring I have recommended. Provided my recommendations are implemented through the Dust Management Procedure, I expect that adverse dust effects should be appropriately managed and offensive or objectionable dust effects avoided.

Richard Leslie Chilton

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DISCLAIMERS

This report has been prepared for the exclusive use of our client the New Zealand Transport Agency, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report in support of an application for resource consent and that Horizons Regional Council as the consenting authority will use this report for the purpose of assessing that application.

We understand and agree that this report will be used by Horizons Regional Council in undertaking its regulatory functions in connection with resource consent applications associated with air discharges from the Project.

APPENDIX E.1: METEOROLOGICAL MODELLING

A three-dimensional meteorological dataset was developed for the Project Area to provide representative wind data for the Ruahine Ranges in the absence of any publicly available wind data.

The modelling was undertaken using the CALMET meteorological model, with inputs from the numerical weather prediction model MM5, and refined local land use and terrain data.

The CALMET meteorological processor allows for the assimilation of outputs from MM5, and these are used to generate an initial estimate of each hour's meteorological fields in CALMET. This is known as the 'initial guess'.

Modelled hourly, three-dimensional fields of wind, temperature, relative humidity from MM5 were used in the initial-guess stage of the CALMET run for each hour. MM5 solves the equations of atmospheric motion mathematically to give a physically realistic wind field. Numerical outputs from MM5 were purchased from Lakes Environmental[25] for the year 2009, covering an area 50 km by 50 km at 4 km resolution, centred on the Project.

The spatial resolution of CALMET is higher than that of MM5 (150 m versus 4 km), with the MM5 fields interpolated onto the CALMET grid at the initial-guess stage.

CALMET requires terrain and land-use data on a regular grid of points. This information enables the model to produce terrain-driven effects such as blocking and slope and valley flows, and to produce the variations in boundary-layer structure associated with changes in land use (particularly the contrast between land and sea). This is known as the 'Step 1' field.

The meteorological model domain has dimensions 10.2 km x 10.2 km, consisting of 68 x 68 grid cells of size 150 m x 150 m. Maps of the terrain and an example of modelled wind vectors for a given hour are provided in **Figure E.11**.

To check the output from the CALMET model, a comparison of the model output has been made with historic data collected from a 120 m height meteorological mast at Wharite Peak in 1986 (this site was discontinued from 1986). Wind roses for the 1986 observations and those generated using CALMET are provided in **Figure E.12** and show good agreement in terms of the pattern of wind direction.

There is no wind monitoring site near to the Woodville end of the Alignment that would enable a reasonable comparison with the output from CALMET for that

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[25] Lakes Environmental is a North American consultancy that provides air dispersion models and associated input data, including the provision of prognostic meteorological datasets for use with dispersion models.

location. In relation to the Ashhurst end, the nearest monitoring site is the Palmerston North Airport monitoring station run by Metservice.

The Palmerston North EWS monitoring site is located approximately 15 km southwest of Ashhurst on the southern side of Palmerston North closest to the Ruahine Ranges. A comparison of a wind rose derived from measured data for this site in 2017 with the output form the CALMET model for the same location and year is provided in **Figure E.13**. This indicates that the model predicts a greater proportion of west-northwest winds at this location and an overall greater frequency of stronger winds.

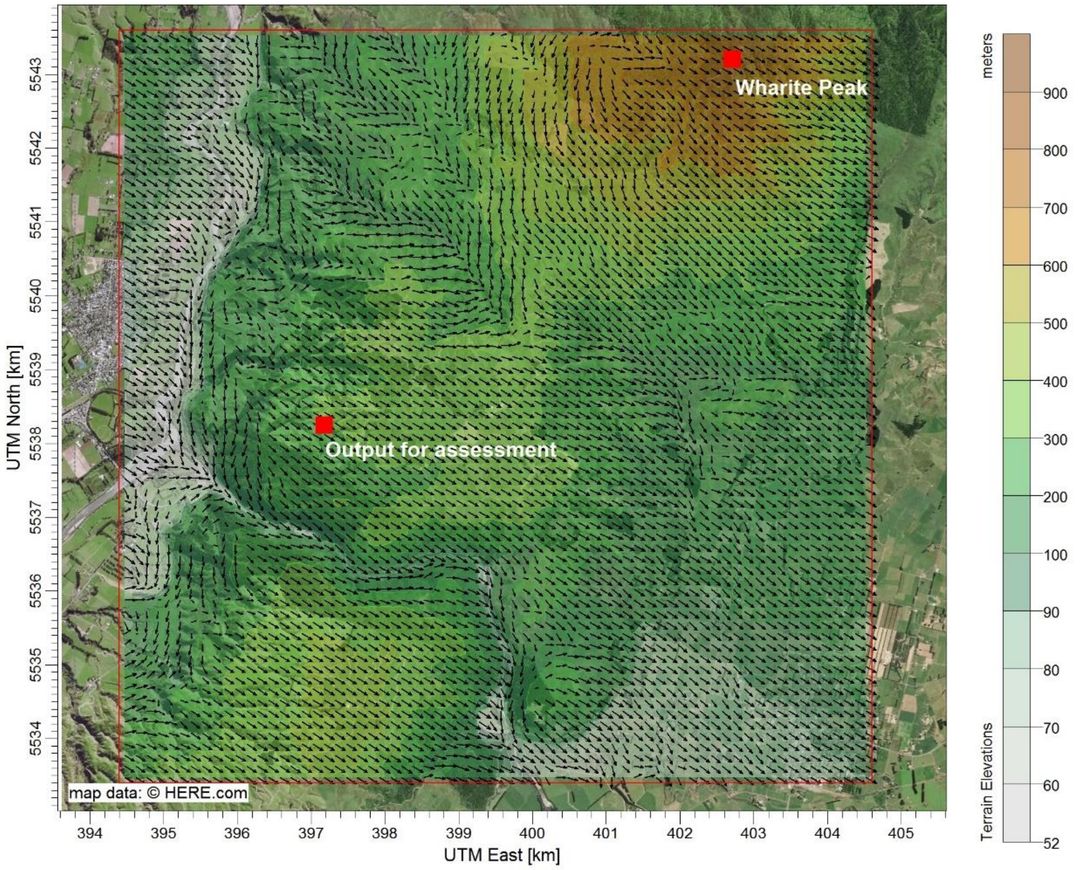
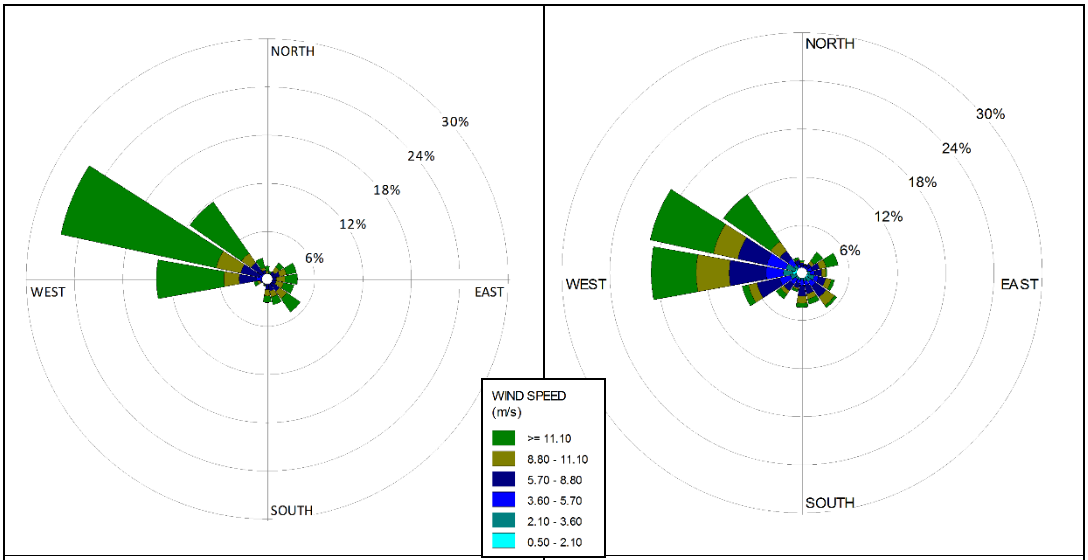
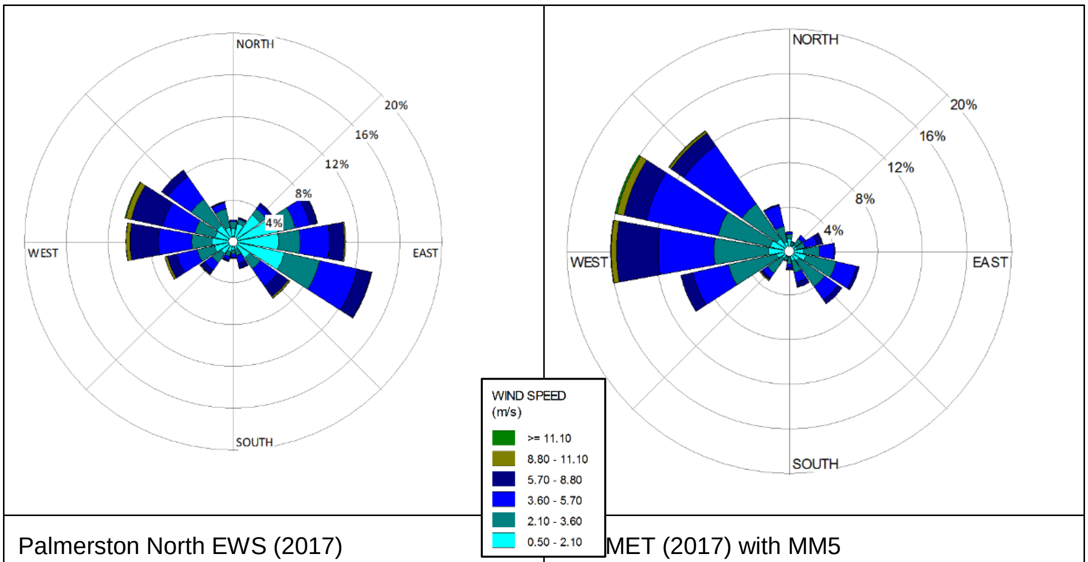


Figure E.11: CALMET model domain showing terrain and an example of resulting wind vectors.



Wharite Peak (1986) Anemometer height at 122 m 3.45% calms	CALMET (2017) with MM5 120 m height 1.44% calms

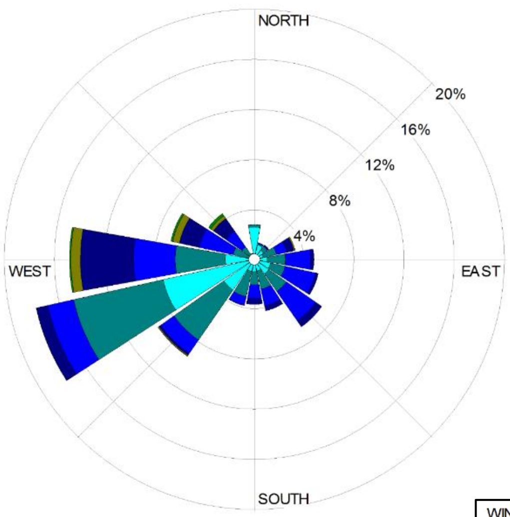
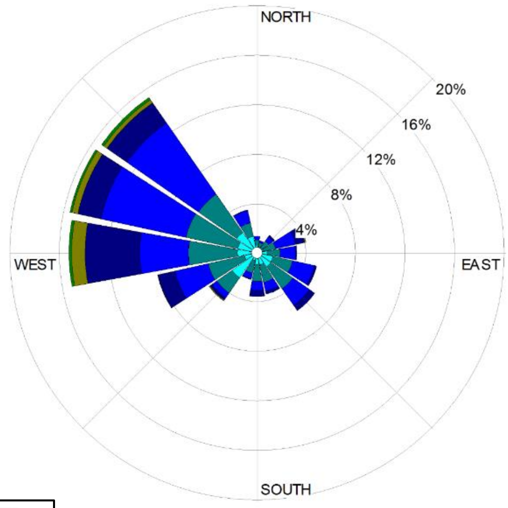
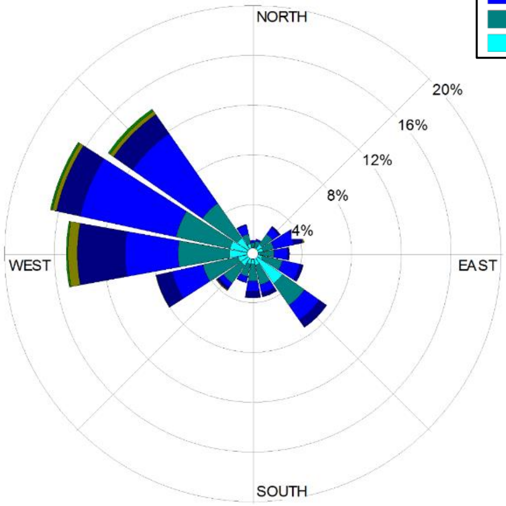
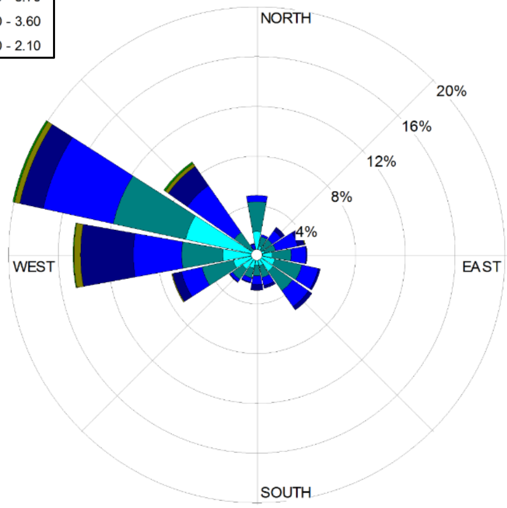
Figure E.12: Comparison of observed winds at Wharite Peak with those generated using MM5/CALMET.

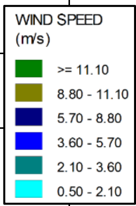


Palmerston North EWS (2017) 10 m height 1.2% calms	MET (2017) with MM5 10 m height 6.8% calms

Figure E.13: Comparison of observed winds at Palmerston North EWS with those generated using MM5/CALMET.

APPENDIX E.2: WIND ROSES

	
Ashhurst (8.6% calms)	ine Range (5.8%)
	
Ballantrae Farm (6.44% calms)	Woodville (8.91% calms)



APPENDIX E.3: DUST RISK INDEX

The NZ Transport Agency (2019) describes its Dust Risk Index as follows:

*DRI = (E+P+T+WS+D+A)*M*WD*

Where:

E = surface exposure (= 10 where greater than 10 ha)

P = exposure period (= 20 where greater than 1 year in duration)

T = time of year (= 50 where works occurring during December to March)

WS = wind speed (= 50 where the project is exposed to prevailing winds)

D = distance to nearest receiver (= 100 for receptors 0 – 50 m, 50 for receptors 51-100 m)

A = construction activity (= 100 where haul operation and fill placement occurs)

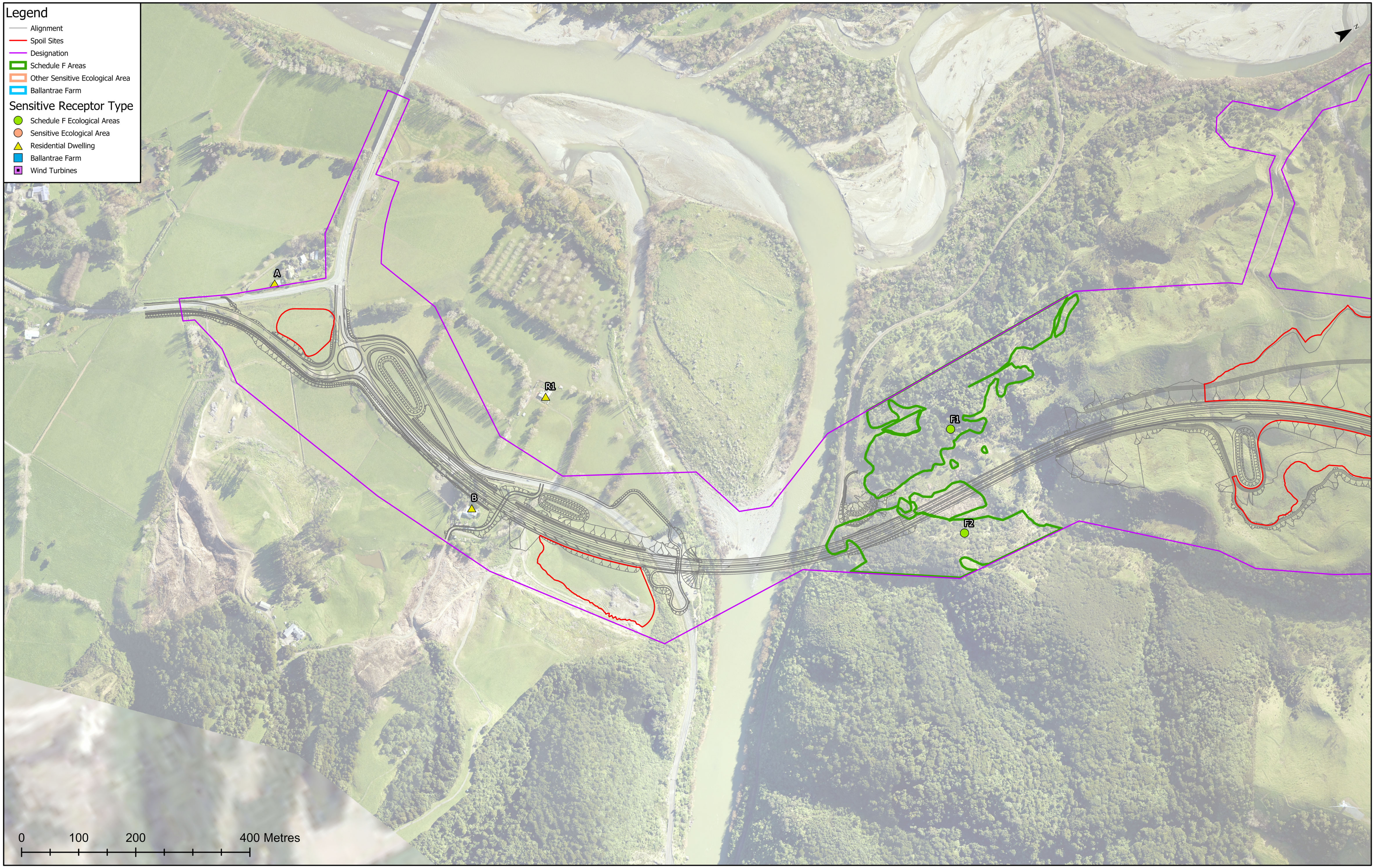
M = mitigation (= 0.8 where 50% control of dust occurs, or 0.5 where 90% of dust controlled)

WD = wind direction (= 1 where downwind under prevailing winds)

Given the above, the Project is calculated as follows to have a score of 264, which corresponds to a high risk. In doing so I have conservatively assumed only 50% control for the “M” parameter, recognising the high wind environment for much of the alignment.

DRI = (10 + 20 + 50 + 50 + 100 + 100) * 0.8 * 1

APPENDIX E.4: AIR QUALITY PLANS – SHEETS 1 - 6



CLIENT	REV	DATE	REVISION DETAILS	APPROVED
WAKA KOTAHI NZ TRANSPORT AGENCY — Te Ahu a Turanga Manawatū Tararua Highway	A	24.02.20	ISSUED FOR REGIONAL CONSENT	D. McGAHAN

SCALE	1:6,000
SIZE	A3
DRAWN	C. SMITH
DESIGNED	R. CHILTON
REVIEWED	D. McGAHAN

CONSENT
NOT FOR CONSTRUCTION

DATE

T. WATTERSON

PROJECT	TE AHU A TURANGA: MANAWATŪ TARARUA HIGHWAY
TITLE	AIR QUALITY PLANS SHEET 1

DRAWING No.	PROJECT No.	PHASE	TYPE	DISC	NUMBER	REV
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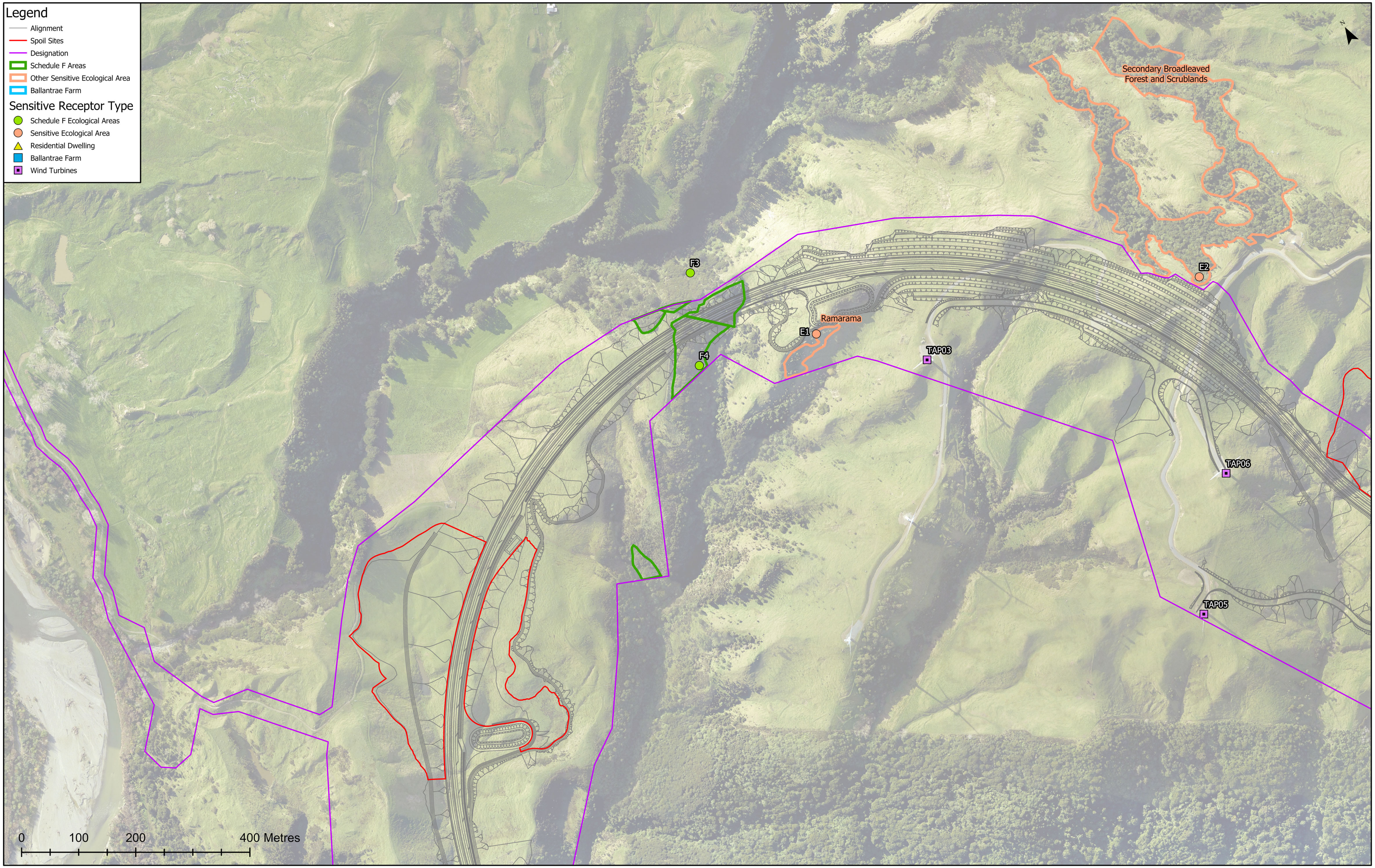

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WAKA KOTAHI NZ TRANSPORT AGENCY — Te Ahu a Turanga Manawatū Tararua Highway	A	24.02.20	ISSUED FOR REGIONAL CONSENT	D. McGAHAN

SCALE	1:6,000
SIZE	A3
DRAWN	C. SMITH
DESIGNED	R. CHILTON
REVIEWED	D. McGAHAN

CONSENT
NOT FOR CONSTRUCTION

DATE

T. WATTERSON

PROJECT	TE AHU A TURANGA: MANAWATŪ TARARUA HIGHWAY
TITLE	AIR QUALITY PLANS SHEET 2

DRAWING No.	PROJECT No.	PHASE	TYPE	DISC	NUMBER	REV
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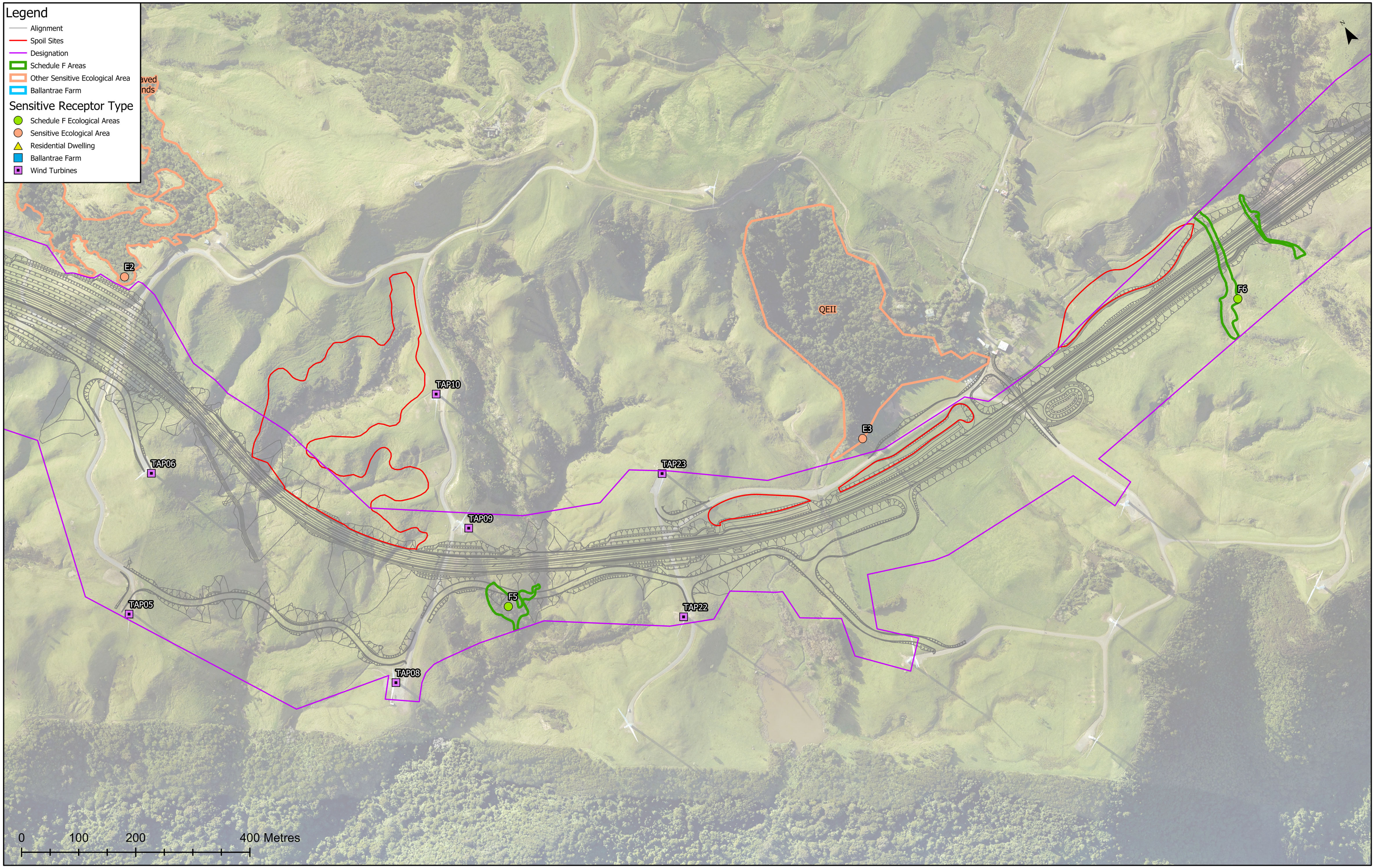

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WAKA KOTAHI NZ TRANSPORT AGENCY — Te Ahu a Turanga Manawatū Tararua Highway	A	24.02.20	ISSUED FOR REGIONAL CONSENT	D. McGAHAN

SCALE	SIZE
1:6,000	A3

DRAWN: C. SMITH
DESIGNED: R. CHILTON
REVIEWED: D. McGAHAN

CONSENT
NOT FOR CONSTRUCTION
DATE
T. WATTERSON

PROJECT: TE AHU A TURANGA: MANAWATŪ TARARUA HIGHWAY

TITLE: AIR QUALITY PLANS
SHEET 3

DRAWING No.	PROJECT No.	PHASE	TYPE	DISC	NUMBER	REV
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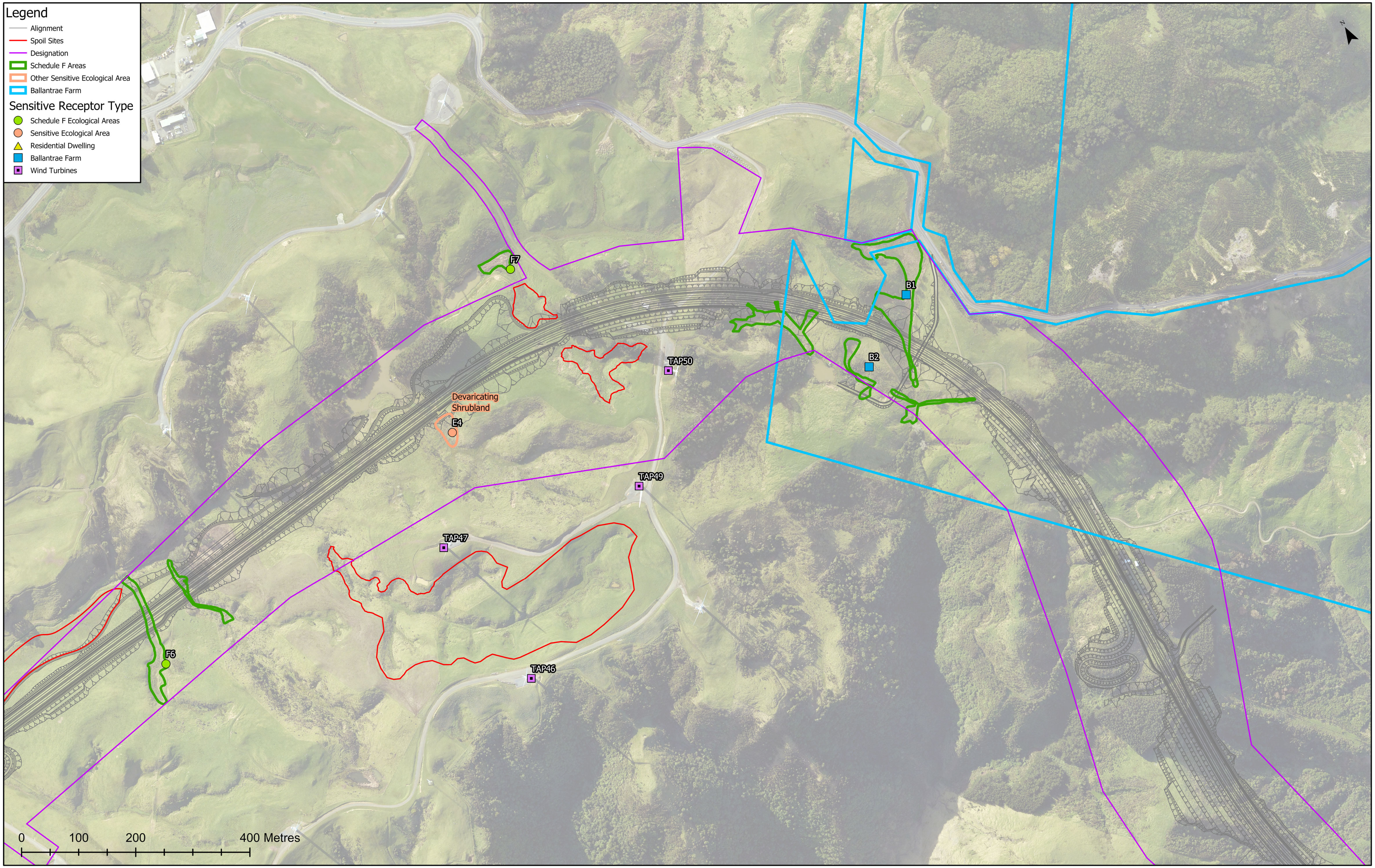

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SCALE 1:6,000 | SIZE A3

DRAWN C. SMITH

DESIGNED R. CHILTON

REVIEWED D. McGAHAN

CONSENT
NOT FOR CONSTRUCTION

DATE

T. WATTERSON

PROJECT: TE AHU A TURANGA: MANAWATŪ TARARUA HIGHWAY

TITLE: AIR QUALITY PLANS SHEET 4

DRAWING No.	PROJECT No.	PHASE	TYPE	DISC	NUMBER	REV
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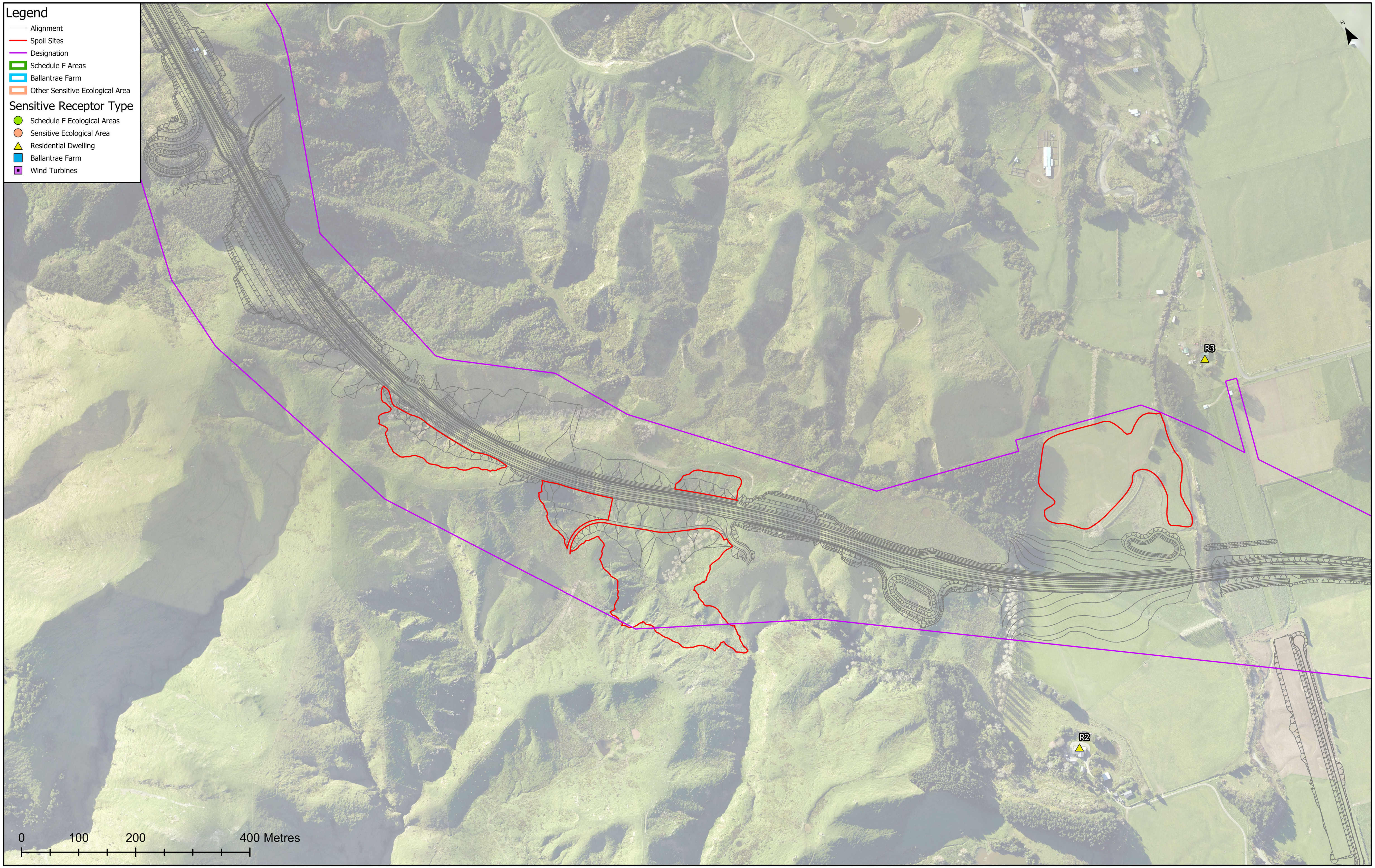

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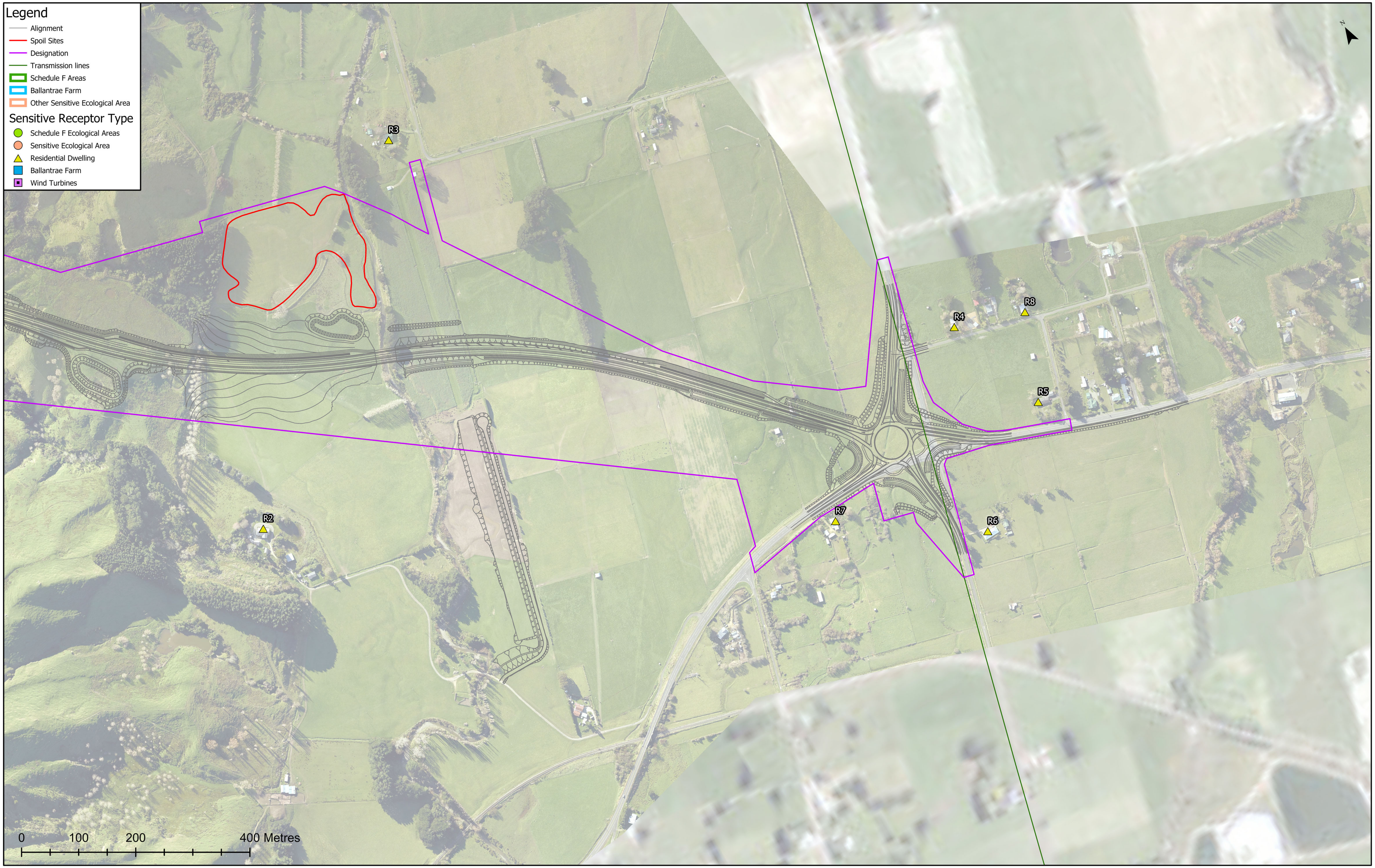
DRAWN: C. SMITH
DESIGNED: R. CHILTON
REVIEWED: D. McGAHAN

CONSENT
NOT FOR CONSTRUCTION

DATE

T. WATTERSON

PROJECT	TE AHU A TURANGA: MANAWATŪ TARARUA HIGHWAY
TITLE	AIR QUALITY PLANS SHEET 5
DRAWING No.	PROJECT No. TAT - PHASE 3 - TYPE DG - DISC E - NUMBER 4175 - REV A



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SCALE: 1:23,000
SIZE: A3
DRAWN: C. SMITH
DESIGNED: R. CHILTON
REVIEWED: D. McGAHAN

CONSENT
NOT FOR CONSTRUCTION
DATE
T. WATTERSON

PROJECT: TE AHU A TURANGA: MANAWATŪ TARARUA HIGHWAY
TITLE: AIR QUALITY PLANS SHEET 6

DRAWING No.	PROJECT No.	PHASE	TYPE	DISC	NUMBER	REV
	TAT	3	DG	E	4176	A

APPENDIX E.5: RECEPTOR DETAILS AND BEARINGS TO POTENTIAL DUST SOURCES

Location	Distance	Receptor ID	Start °N	End °N
Ashhurst Area	185 m	R1	57	237
Ruahine Range Area	75 m	TAP03	29	61
	95 m	TAP06	338	93
	65 m	TAP05	14	124
	20 m	TAP09	118	350
	30 m	TAP08	310	38
	85 m	TAP23	149	240
	80 m	TAP22	300	78
	45 m	TAP10	257	18
	35 m	F1	43	155
	60 m	F2	201	335
	55 m	F3	114	252
	40 m	F4	261	78
	15 m	F5	314	150
	5 m	E1	262	100
	20 m	E2	165	314
	25 m	E3	88	247
Ballantrae Farm Area	50 m	B1	166	302
	50 m	B2	316	137
	55 m	TAP50	220	125
	50 m	TAP46	310	87
	30 m	TAP47	119	272
	70 m	TAP49	207	263
	60 m	F6	290	45
	20 m	F7	208	159
	10 m	E4	269	85
Woodville Area	195 m	R2	335	155
	135 m	R3	215	272
	90 m	R4	153	353
	110 m	R5	143	347
	135 m	R6	300	70
	40 m	R7	315	103
	190 m	R8	181	291