BEFORE THE TARANAKI REGIONAL COUNCIL AND NEW PLYMOUTH DISTRICT COUNCIL

IN THE MATTER OF	The Resource Management Act 1991
AND	
IN THE MATTER OF	Applications for resource consents, and a notice of requirement by the NZ Transport Agency for an alteration to the State Highway 3 designation in the New Plymouth District Plan, to carry out the Mt Messenger Bypass Project [ ]

STATEMENT OF EVIDENCE OF NICHOLAS JAMES DRYSDALE SINGERS (VEGETATION AND OFFSET AREA CALCULATIONS) ON BEHALF OF THE NZ TRANSPORT AGENCY

25 May 2018

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QUALIFICATIONS AND EXPERIENCE

1. My name is Nicholas James Drysdale Singers.

2. I am an ecologist at Nicholas Singers Ecological Solutions Ltd.

3. I hold a Master of Science Degree in Ecology gained at Massey University in 1997. My thesis was on wetland ecology.

4. I have over 20 years' experience as an ecologist, specialising in plant ecology and conservation management. Since July 2012, I have been operating my own ecology consultancy business 'Nicholas Singers Ecological Solutions Ltd'. Prior to that, I was employed by the Department of Conservation as a technical specialist (flora) for 14½ years based in the Central North Island.

5. I am an author of a classification system of New Zealand's ecosystems, including 59 unique forest types (Singers & Rogers 2014). This work involved reviewing New Zealand's plant ecology literature.

6. Using this classification, in 2016 I created a potential ecosystems map for the Taranaki Regional Council which involved researching the vegetation patterns both current and historic for the entire region.

7. I have a good working knowledge of the flora and vegetation and ecosystem patterns of the North Taranaki Ecological District, having undertaken several months' field work of natural value assessments and weed surveys as a field botanist while employed by the Department of Conservation. During this work, I undertook a weed survey of the Parininihi Reserve (then known as the White Cliffs Conservation Area).

8. I am an expert in threatened plants within the central and lower North Island. While employed by the Department of Conservation, I undertook numerous threatened plant surveys and monitoring programmes and developed strategies and recovery plans. In Taranaki, this included an assessment of the population size and threats assessment for Brachyglottis turneri, a small herbaceous critically endangered shrub which occurs only in the North Taranaki and Matemateaonga Ecological Districts.

9. I confirm that I have read the 'Code of Conduct' for expert witnesses contained in the Environment Court Practice Note 2014. My evidence has been prepared in compliance with that Code. In particular, unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to

consider material facts known to me that might alter or detract from the opinions I express.

EXECUTIVE SUMMARY

10. Mt Messenger is situated in the North Taranaki Ecological District, an area of 255,852 ha which is characterised by a warm and humid climate. Indigenous vegetation remains a dominant feature of the area. Primary forest on hill-slopes supports either tawa[1] dominant podocarp, broadleaved forest, or hard beech, kamahi and tawa dominant forest. Areas of secondary vegetation communities that have regenerated from original clearance attempts are also common and are typically dominated by manuka, tree ferns and small broadleaved shrubs and trees. Valley floors have mostly been cleared for farming purposes and would have supported kahikatea, pukatea forest and associated wetlands. Only small and fragmented areas of these communities remain.

11. Potential ecosystems mapped for the Taranaki Region have been used as a hierarchical framework for grouping vegetation communities and assessing loss.

12. Indigenous dominant vegetation loss associated with construction of the Project will result in the loss of 31.676ha of indigenous forest and secondary scrub. This figure does not include areas of pasture or rushland vegetation communities (farmland) dominated by exotic plant species.

13. Of the 31.676ha affected, 2.629ha are communities that broadly conform to the WF8: Kahikatea pukatea ecosystem type, 19.738ha that conform to the WF13: Tawa kohekohe, rewarewa, hinau, podocarp ecosystem type, 8.909ha that conform to the WF14: Kamahi, tawa, podocarp, hard beech forest communities, and 0.399ha of cliff habitat (CL6) (Singers & Rogers 2014).

14. Classified structurally (Atkinson 1985)[2], the area affected includes 23.867ha of forest, 1.363ha of treeland, and 6.445ha secondary scrub.

15. The areas of highest ecological value are areas of forest dominated by kahikatea in the Mimi and Mangapepeke catchments (WF8) and tawa, rewarewa and kamahi forest in the Mimi catchment (WF13).

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[1] Common plant names are used in preference in this evidence. A list of plant names, common and scientific is provided in Appendix Table 11.
[2] Atkinson, I. A. E. (1985). Derivation of vegetation mapping units for an ecological survey of Tongariro National North Island, New Zealand. *New Zealand journal of Botany*, *23*(3), 361-378.

16. In much of the Mangapepeke catchment, vegetation is of comparatively lower ecological value, having been subjected to vegetation clearance from agricultural development on private land and severe browsing by introduced livestock and pests, especially possums, cattle, goats and pigs over the entire catchment. The groundcover weed African clubmoss is widespread and the most abundant groundcover plant in some areas. Consequently, vegetation in this catchment is of much lower quality.

17. The Project has been designed to avoid, remedy, mitigate, offset or compensate potential effects on vegetation by:

(a) Locating the route east of the current state highway to preserve the nationally significant forest sequence in Parininihi from the coast to Mt Messenger.

(b) Locating the route as far as practicable away from the significant Mimi wetland.

(c) The inclusion of a bridge and top-down construction methods to protect the Mimi wetland, described and assessed as being highly significant.[3]

(d) The construction of a tunnel to reduce vegetation loss and maintain east to west ecosystem connectivity.

(e) Constraints on the width of the additional works areas (AWA) where a 5m temporary vegetation loss may occur adjoining high ecological value areas c.f. 20m allowance.

(f) Modifications to the road alignment to avoid areas of valley floor kahikatea forest and several significant trees identified during the vegetation survey programme.[4]

(g) Minor adjustments to the route to avoid the loss of significant trees, reducing loss from 22 to 17.

(h) Specifications in the ELMP to avoid impacts on vegetation such as siting construction related activities and the use of forest resources including harvesting tree ferns and then planting these at a later stage in restoration programmes.

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[3] Mt Messenger Bypass Investigation: Botanical Investigation and Assessment of Effects. Prepared for Opus International Consultants Ltd. © Nicholas Singers Ecological Solutions Ltd. NSES Ltd Report 34:2016/17, April 2017.

[4] Assessment of Ecological Effects - Vegetation included as Technical Report 7a, Volume 3 to the Assessment of Environmental Effects

(i) A comprehensive pest management programme to control animal pests within approximately 1085ha to improve the ecological integrity (health) of like for like ecosystem types and vegetation communities impacted.

(j) Restoration planting of 6ha to recreate kahikatea forest and mitigate the loss of secondary vegetation communities.

(k) Compensation planting of 200 seedlings for every significant tree felled.

(l) Recovery and cultivation of threatened and regionally distinctive plant species to later be returned back to the site.

(m) Enhancement planting of cliff specialists at the top of cut sites to assist succession of road side batters.

(n) Fencing and riparian planting of approximately 8.627km of existing streams.

(o) Recovery of forest resources to enhance terrestrial and aquatic restoration including; precision placement of woody debris and rotten logs that provide habitat for epiphytes, invertebrates and potentially lizards to suitable sites outside of the road footprint, harvesting and reuse of tree ferns and use of manuka slash to enhance natural succession.

18. The design of the Project has avoided many significant trees, however up to 17 may be lost, of which 11 are large rimu.

19. Three of these significant trees are hosts for a small number (<10) of the chronically threatened epiphytic shrub, kohurangi (*Brachyglottis kirkii* var. *kirkii*). Small numbers of two regionally distinctive plants are also affected; swamp maire (*Syzygium maire*) and *Pittosporum cornifolium*. Several other regionally distinctive plants occur within the wider Project area but have not been found within the Project footprint.

20. The overall unmitigated effect of the Project on vegetation is significant because of the scale of vegetation loss, its composition, structure (being older complex forest ecosystems), and because some effects are permanent. However, with the mitigation and offset proposed, described fully in Mr MacGibbon's evidence and summarised below, the Project will provide medium and long-term benefits to vegetation. Overall, the effects of the Project on vegetation are acceptable.

21. Mitigation and offset measures relevant to vegetation include:

(a) The Biodiversity Accounting Model (the Model) developed for the Department of Conservation by Maseyk et al. (2014)[5] has been used as a decision support tool to assist in informing the biodiversity offset required. More specifically, the Model has been applied to calculate what level of offset is required to achieve 'No Net Loss' of biodiversity values within 10 to 15 years.

(b) A 'like for like' mitigation programme will be implemented, including integrated pest management and habitat restoration programmes resulting in habitat which is 'healthy and functional'. Measured in 15 years' time, a net biodiversity gain is anticipated. The proposed Pest Management Area is conservative and much greater than that calculated by the Biodiversity accounting model.

(c) The Model calculated that using integrated pest management in 'like for like' habitat, an area of 230 ha is required to offset the loss of vegetation communities of WF8, WF13 and WF14 ecosystems types, within an identified target area in the Mimi catchment. The Project proposes pest management over 1085ha, significantly above what the model calculates. This extra area addresses habitat loss for fauna such as North Island kiwi and long-tailed bats and provides a sufficient management buffer around the core 230 ha. To offset the loss of kahikatea trees a further 6 ha of restoration planting is proposed.

(d) Net biodiversity gain (measured as Net Present Biodiversity Value) is forecast by Year 15 for all vegetation communities lost. By year 35 I expect significant biodiversity benefits compared to the current situation as a result of the offsetting programme for the Project.

BACKGROUND AND ROLE

22. The New Zealand Transport Agency ("**Transport Agency**") engaged me to advise it on its proposed Mt Messenger Bypass Project ("**Project**") to improve the section of State Highway 3 ("**SH3**") between Ahititi and Uruti, to the north of New Plymouth.

[5] Maseyk, F.; Maron, M.; Seaton, R.; Dutson, G. (2014). A Biodiversity Offset Accounting Model for New Zealand. User Manual. The Catalyst Group Contract Report No. 2014-008 prepared for Department of Conservation.

23. I prepared:

    (a) the Assessment of Ecological Effects – Vegetation included as Technical Report 7a, Volume 3 to the Assessment of Environmental Effects ("**AEE**") for the Project;

    (b) the Ecology Supplementary Report – Vegetation (February 2018) included as Technical Report 7a, Volume 3 to the Assessment of Environmental Effects ("**AEE**") for the Project;

    (c) the Biodiversity Offset Calculation Report, which is Appendix A to the Assessment of Ecological Effects – Ecological Mitigation and Offset included as Technical Report 7h, Volume 3 to the AEE; and

    (d) the Ecology Supplementary Report – Biodiversity Offset Calculation (February 2018).

24. I have had input into the draft Ecology and Landscape Management Plan ("**ELMP**") prepared for the Project,[6] particularly as it relates to vegetation removal, and in respect of my role as author of the Biodiversity Offset Calculation Report.

25. I participated in both alternatives (MCA1 and MCA2) workshops to assist with route selection and discuss design including the need to build a bridge and tunnel.

26. I have visited the site over 30 days from January to October 2017, including in-depth assessments of five potential route options. For this reason I can place information provided for the Project footprint into the context of the surrounding area.

SCOPE OF EVIDENCE

27. The purpose of my evidence is to outline the potential effects construction of the Project would have on vegetation. I then discuss the mitigation, offset and monitoring measures proposed and captured in the ELMP, to address those potential issues, and assess the overall effects of the Project on vegetation with those measures in place.

28. My evidence also discusses the desktop assessment carried out in order to inform the biodiversity offset required, and provided for in the ELMP, to ensure the Project will result in no net loss in biodiversity values.

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[6] An updated version is attached to the evidence of Mr Roan.

29. My evidence addresses:

(a) Part A: Vegetation:

(i) an overview of the existing vegetation values of the Project area;

(ii) the methodology followed in identifying the vegetation values of the Project area and the effects the Project could potentially have on those values; the results of the investigations into the vegetation values and potential effects of the Project; and

(iii) my assessment of the effects of the Project on vegetation, including by reference to the proposed measures to mitigate, offset, and monitor effects.

(b) Part B: Biodiversity Offsetting:

(i) biodiversity offsetting and the Biodiversity Offsets Accounting Model; and

(ii) the application of the Biodiversity Offsets Accounting Model, and the required offsets for the Project.

(c) Part C: responses to submissions and the Section 42A Reports.

PART A: VEGETATION

THE EXISTING VEGETATION VALUES OF THE PROJECT FOOTPRINT AND WIDER AREA

Introduction

30. There are three primary points of reference for the assessment of the ecological values, and in particular the vegetation values, affected by the Project:

(a) the North Taranaki Ecological District;

(b) the wider Project area; and

(c) the Project footprint.

The North Taranaki Ecological District

31. The North Taranaki Ecological District is 255,852ha in size and contains 132,725ha or 51% indigenous forest. The district is characterised by a mosaic

of uplifted marine terraces which are mostly highly eroded forming a steep and dissected landscape. The district includes other landforms, including coastal cliffs, alluvial terraces, uplifted shallow sloping marine terraces and cliff habitats. The major catchments include the Waitara, Mimi, Tongaporutu and Mohakatino Rivers. Bioclimatically, the ecological district encompasses coastal to lowland zones with the highest elevation at 596m (Peneta) south of Ohura.

The wider Project area

32. The 'wider Project area' is an area approximately 4,430ha in size of indigenous dominant vegetation, in the North Taranaki Ecological District (**Appendix Figure 1**).

33. The wider Project area, within which the Project footprint is located, consists of predominantly indigenous forest and farmland habitat. The indigenous forest includes:

    (a) Parininihi, to the immediate west of Mt Messenger known as Parininihi; and

    (b) the Eastern Ngāti Tama forest block, to the east of SH3.

Parininihi

34. Parininihi, previously known as "Whitecliffs Conservation Area", is 1,332ha of mainly primary forest centred on the Waipingao Stream catchment (shown to the west of SH3 in **Figure 1**).

35. Parininhi contains the best remaining example of primary coastal broadleaved to podocarp broadleaved forest on the west coast of the North Island Nicholls 1980, cited in Bayfield et al. (1991)[7]. The area also includes the Waipingao Stream, which has a catchment that is entirely indigenous forest.

36. Ecological management of Parininihi was started in the early 1990s by DOC and involved possum and goat pest control activities. Since the return of this land to Ngāti Tama in 2003, management of these pests has continued, and control of rodents, mustelids and feral cats has also occurred. Consequently, ecosystem health is now improving, with browse-sensitive plants regenerating and various predation-sensitive birds, including the recently released kōkako increasing in abundance. This long management history and the associated

[7] Bayfield et al. 1991. North Taranaki Ecological District. Survey report for the Protected Natural Area Programme. Department of Conservation, Wanganui, New Zealand.

recovery of ecosystem health only further increases the ecological value of this area.

37. Parininihi (and all land to the west of the existing SH3) is being avoided by the Project footprint, following the route selection process carried out in 2017.

Eastern Ngāti Tama forest block

38. The Eastern Ngāti Tama forest block is a contiguous forest, approximately 3,098ha in size, immediately adjacent to Mt Messenger and to the east of the existing SH3. It includes land owned by Ngāti Tama, as well as private land, and public conservation land managed by DOC.

39. The dominant forest would have originally been very similar forest type to the eastern part of Parininihi; however, it has not had consistent pest control. Consequently, the ecological condition of this area is poorer, with fewer palatable canopy trees remaining, such as thin-barked totara (*Podocarpus laetus*) and northern rata (*Metrosideros robusta*).

40. Within the Mangapepeke Stream catchment vegetation communities are more modified and have been affected by farming activities, grazing livestock, and introduced pests and weeds. Kamahi (*Weinmannia racemosa*), was mapped in the catchment as being codominant in the Ecological District's vegetation maps (Bayfield et al. 1991), but today is now uncommon, potentially due to possum induced canopy collapse, which was observed by Professor Bruce Clarkson (*pers.com.*) from the early 1980s onwards.

41. Of greatest botanical significance in this area are the hydrologically intact swamp forest and non-forest wetland areas in the valley floor of the northern Mimi River catchment. The Mimi wetland provides habitat for wetland bird species including fernbird and spotless crake. These vegetation communities are located outside the Project footprint, and will not be directly affected, except potentially by sedimentation if the erosion and sediment control mechanisms fail (and even then, the area of raupō wetland is likely to act as a filter).

The Project footprint

42. The Project footprint includes the road footprint (the road and its associated batters and cuts, spoil disposal sites, haul roads and stormwater ponds). It also includes an "Additional Works Area", to account for additional vegetation loss for construction access, laydown areas, temporary stormwater drains and

temporary clearance required beyond the margins of the road footprint. On the road margins this is typically between 5m (adjacent to high ecological value areas) to 20m wide.

43. The Project footprint straddles a major ecological boundary for hill country forest types. In the south, including the Mimi catchment, forest composition is dominated by tawa, kamahi, rewarewa and occasional podocarp trees. Beech trees are very restricted and occur only on a few very steep ridges outside of the Project footprint.

44. Conversely, in the middle Mangapepeke catchment northwards, hard beech is dominant on ridges and hill slopes, with broadleaved trees including kamahi, tawa, rewarewa and occasional podocarp trees occurring mainly in gullies. Much of the lower hillslope forest is now secondary forest, having recovered from early vegetation clearance activities for farming. These last two communities remain within the Project footprint.

45. Originally kahikatea, pukatea and swamp maire forest and small wetland communities would have occupied the alluvial terrace landforms in the Mangapepeke catchment. These were likely very similar in composition to the remaining habitat in the upper Mimi catchment which the alignment avoids. In the Mangapepeke catchment, very limited representative vegetation remains on the alluvial terrace landforms, having mostly been removed during initial logging for kahikatea and vegetation clearance for farm development. Areas remaining are dominated by pole kahikatea forest and treeland potentially of 50-80 years old. Small areas of highly modified secondary scrub and treeland communities also occur in the upper Mangapepeke Valley, containing small moribund pukatea and treefern and manuka.

46. The majority of the alluvial terrace landforms in the Mangapepeke Valley are farmland dominated by exotic rush, grass and herbaceous species, with a small component of native rushes and sedges. This vegetation is of low botanical value.

INVESTIGATION METHODOLOGY

47. I assessed the vegetation characteristics and values within the wider Project area, and the Project footprint, through:

    (a) a desktop assessment;

(b) field assessments, including vegetation surveys in January 2017, June 2017, and late-October 2017;

(c) classification, description and fine scale mapping of vegetation and putting this into the context of the particular ecological district, regional and national scales; and

(d) assessment of loss, ecological value and effects considering:

(i) District plan;

(ii) EIANZ criteria;[8] and

(iii) Davis et.al 2016 criteria.[9]

48. These assessments have covered multiple alignment options within the wider Project area, with the more recent focus being on the selected alignment, i.e. the Project footprint. In total, I have undertaken over 30 days of field work between January and late-October 2017. This has provided me with an in-depth understanding of the vegetation and flora values in the wider Project area and the Project footprint.

Desktop assessment

49. The desktop assessment included:

(a) Identifying areas within the wider Project area that are listed as having significant ecological values, such as Parininihi and Eastern Ngāti Tama forest block.

(b) A review of key documents, reports and data including:

(i) the New Plymouth District Plan ("**District Plan**"), including Appendix 21: Criteria for Significant Natural Areas; Protected Natural Areas Programme report for North Taranaki ("**PNAPNT Report**") (Bayfield et al.,1991);

(ii) forest and ecosystem classifications, including Nicholls (1976)[10] and Singers & Rogers (2014)[11] and the respective regional maps of these;

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[8] EIANZ, 2015. Ecological Impact Assessment (EcIA): EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems.
[9] Davis, M., Head, N. J., Myers, S. C., & Moore, S. H. (2016). Department of Conservation guidelines for assessing significant ecological *of* values. *Science for Conservation 327*. *Department Conservation, 71p*.

(iii) multiple plant species lists from Parininihi and the Mount Messenger Conservation Area, including a list of regionally threatened and distinctive plants developed by the Taranaki Regional Council to identify possible plants of interest; and

(iv) aerial imagery, high resolution drone imagery and relevant spatial layers including the Taranaki Potential Ecosystems (Singers 2015)[12], the Landcover database 4 ("**Landcare Research**"), and the tree layer from National Vegetation Survey (NVS) vegetation plots.

(c) Discussions with Professor Bruce Clarkson (Deputy Vice Chancellor) from the University of Waikato, and local conservation managers involved with ecological management at Parininihi and elsewhere in Taranaki, including Conrad O'Carroll of Ngāti Tama, Paul Pripp (a biodiversity contractor for Ngāti Tama, and previously DOC, with nearly 30 years of experience working at Parininihi), and staff from DOC.

(d) Spatial GIS analysis using maps of current and potential extent that enabled ecosystem extent (District Plan criteria 3) to be measured. Potential ecosystems within and adjoining the Project footprint are shown in Appendix; Figure 2. Data used for this process included the Landcover database 4 as a measure of current extent, and potential ecosystems layers based on Singers & Rogers 2014 for Northland[13], Auckland[14], Waikato[15], Bay of Plenty[16], Taranaki[17], Hawkes Bay[18] and

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[10] Nicholls, J.L. (1976). A revised classification of the North Island indigenous forests. *New Zealand Journal of Forestry 28*: 105–132.

[11] Singers, N.J.D. & Rogers, G.M. (2014). A classification of New Zealand's terrestrial ecosystems. Science for Conservation. Department of Conservation, Wellington.

[12] Singers, N. J. D. unpublished. Potential Vegetation of the Taranaki Region (2015) based upon N J D Singers & G M Rogers (2014), A classification of New Zealand's terrestrial ecosystems, Science for Conservation 325, Department of Conservation, Wellington.

[13] Singers, N. J. D. unpublished. Potential Vegetation of the Northland Region (2018) based upon N J D Singers & G M Rogers (2014), A classification of New Zealand's terrestrial ecosystems, Science for Conservation 325, Department of Conservation, Wellington.

[14] Singers, N. J. D. unpublished. Potential Vegetation of the Auckland Region (2014) based upon N J D Singers & G M Rogers (2014), A classification of New Zealand's terrestrial ecosystems, Science for Conservation 325, Department of Conservation, Wellington.

[15] Singers, N. J. D. unpublished. Potential Vegetation of the Waikato Region (2015) based upon N J D Singers & G M Rogers (2014), A classification of New Zealand's terrestrial ecosystems, Science for Conservation 325, Department of Conservation, Wellington.

[16] Singers, N. J. D. unpublished. Potential Vegetation of the Bay of Plenty Region (2014) based upon N J D Singers & G M Rogers (2014), A classification of New Zealand's terrestrial ecosystems, Science for Conservation 325, Department of Conservation, Wellington.

[17] Singers, N. J. D. unpublished. Potential Vegetation of the Taranaki Region (2016) based upon N J D Singers & G M Rogers (2014), A classification of New Zealand's terrestrial ecosystems, Science for Conservation 325, Department of Conservation, Wellington.

[18] Singers, N. J. D. unpublished. Potential Vegetation of the Hawkes Bay Region (2017) based upon N J D Singers & G M Rogers (2014), A classification of New Zealand's terrestrial ecosystems, Science for Conservation 325, Department of Conservation, Wellington.

Wellington[19] Regions and the Gisborne[20] and Marlborough[21] Districts as a measure of potential extent[22]. Using these layers, a national assessment of extent remaining has been included in this evidence for WF13 and partial extents (missing only Manawatu-Wanganui and Nelson-Tasman) included for WF8 and WF14.

Threatened and regionally distinctive plants

50. Threatened and regionally distinctive plants were identified by reviewing three plant species lists from the wider Project Area[23], and relevant information within the PNAPNT Report.

51. Two threatened[24] plants were identified as likely to be present within the wider Project area, the:

    (a) 'At risk-declining' king fern (*Ptisana salicina*); and

    (b) 'At risk-declining' kohurangi (*Brachyglottis kirkii* var. *kirkii*).

52. Other threatened plant species that were also identified as potentially being present in the wider Project area included *Brachyglottis turneri*; *Pittosporum kirkii*; and pua-o-te-ringa (*Dactylanthus taylorii*).

53. Four regionally distinctive plants (that are uncommon in Taranaki) were also identified as potentially present in the wider Project area: kauri grass (*Astelia trinervia*), *Pittosporum cornifolium*, Coromandel tree daisy (*Olearia townsonii*) and swamp maire (*Syzygium maire*).

Provisional vegetation map

54. A provisional vegetation map was developed remotely, identifying broad-scale land cover classes, such as farmland, exotic forest, indigenous forest, indigenous scrubland and wetland.

55. Within areas dominated by indigenous vegetation, vegetation compositional variability was further recognised on high resolution aerial images in relation to

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[19] Singers, N. J. D. unpublished. Potential Vegetation of the Wellington Region (2014) based upon N J D Singers & G M Rogers (2014), A classification of New Zealand's terrestrial ecosystems, Science for Conservation 325, Department of Conservation, Wellington.
[20] Singers, N. J. D. unpublished. Potential Vegetation of the Gisborne District (2016) based upon N J D Singers & G M Rogers (2014), A classification of New Zealand's terrestrial ecosystems, Science for Conservation 325, Department of Conservation, Wellington.
[21] Singers, N. J. D. unpublished. Potential Vegetation of the Marlborough District (2017) based upon N J D Singers & G M Rogers (2014), A classification of New Zealand's terrestrial ecosystems, Science for Conservation 325, Department of Conservation, Wellington.
[22] Potential extent is defined as the area an ecosystem type is predicted to occupy if humans arrived in New Zealand today.
[23] Clarkson & Boase 1982; Ogle & Druce 1998; Jane & Donaghy 2005.
[24] Listed by de Lange et al. (2013) as acutely threatened or at risk.

known environmental factors (e.g. slope and aspect) and were similar to patterns and communities described by Blaschke (1988)[25] in East Taranaki. Where distinct communities were recognised, locations for Recce plot sampling were plotted in each community.

Field assessment

56. I have spent a total of nine days surveying on foot the entire Project footprint, excluding areas which were too steep and hazardous to access. Such areas I assessed from vantage points and using high resolution drone imagery.

57. My survey recorded all plant species within the wider Project area, and specifically targeted likely habitat for known or potential threatened plant species including:

    (a) epiphytes in the tops of large trees for kohurangi and *P. cornifolium*;

    (b) cliff habitat potentially suitable for *B. turneri* and Coromandel tree daisy;

    (c) alluvial forest remnants for swamp maire; and

    (d) beneath the forest canopy for king fern, kauri grass and known host trees of dactylanthus.

58. Vegetation communities identified were sampled using the variable area Recce method (Hurst & Allen 2007)[26] recording species present, qualitative abundance and descriptions of vegetation structure and condition.

59. Desk top vegetation maps were modified in the field on hard copy aerial images and then applying the QGIS[27] programme.

60. Significant trees were also specifically identified, being trees with one or more of the following attributes:

    (a) being large and old (typically emergent) trees;

    (b) being relatively uncommon; and

    (c) having significant habitat value for other flora and fauna such as, providing important flowering or fruiting resources, cavities for roost and nests, and supporting large epiphyte communities.

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[25] Blaschke, P. M. (1988). Vegetation and landscape dynamics in eastern Taranaki hill country. PhD. Thesis Victoria University.
[26] Hurst, J. M., & Allen, R. (2007). *The Recce method for describing New Zealand vegetation: field protocols*. Landcare Research New Zealand.
[27] https://www.qgis.org/en/site/

INVESTIGATION RESULTS

61. As a result of the investigations described above, I have been able to classify the entire Project footprint by ecosystem type and vegetation community.

62. That has allowed me to conclude that the Project will result in the loss of 31.676ha of indigenous dominant vegetation (forest and secondary scrub) (**Figures 3, 4 & 5**).

63. This does not include areas of pasture or rushland vegetation communities (farmland) dominated by exotic plant species as described in the Ecology Supplementary Report - Vegetation.

64. I have also been able to specifically identify threatened and regionally distinctive plants, as well as individual significant trees, that are within the Project footprint.

Ecosystem types and vegetation communities within the Project footprint

65. **Table 1** below is a summary of the indigenous dominant and mixed exotic - indigenous vegetation communities within the Project footprint. Of the 31.676ha affected:

    (a) 2.629ha of vegetation communities that are encompassed within the WF8: Kahikatea pukatea ecosystem type, including forest, treeland and scrub. Photos of four of these communities are in **Appendix; Figures 6, 7, 8** and **9**;

    (b) 19.738ha of vegetation communities that are encompassed within the WF13: Tawa kohekohe, rewarewa, hinau, podocarp ecosystem type, including forest and scrub;

    (c) 8.909ha of vegetation communities that are encompassed within the is WF14: Kamahi, tawa, podocarp, hard beech forest type, including forest and scrub; and

    (d) 0.399ha of CL6 cliff habitat.

Table 1 - Summary of indigenous dominant and mixed exotic - indigenous vegetation communities within the Project footprint

Ecosystem Type (Singers & Rogers 2014)	Vegetation community described	Project footprint total (ha)
WF8: Kahikatea pukatea forest	Kahikatea swamp maire forest	0.159
	Kahikatea forest	0.525
	Kahikatea treeland	0.641
	Pukatea treefern treeland	0.722
	Manuka scrub	0.582
	Total	**2.629**
WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest	Tawa rewarewa kamahi forest	6.457
	Tawa nikau treefern forest	8.507
	Miro rewarewa kamahi forest	0.536
	Pukatea nikau forest	1.347
	Secondary mixed broadleaved forest	2.231
	Manuka treefern scrub	0.146
	Manuka succession	0.514
	Total	**19.738**
WF14: Kamahi, tawa, podocarp, hard beech forest	Hard beech forest	0.288
	Tawa rewarewa kamahi forest	0.526
	Manuka treefern rewarewa forest	3.291
	Manuka treefern scrub	3.164
	Treefern scrub	0.080
	Manuka scrub	1.560
	Total	**8.909**
CL6: *Hebe*, wharariki flaxland / rockland	Dry cliff	0.399
Total		**31.676**

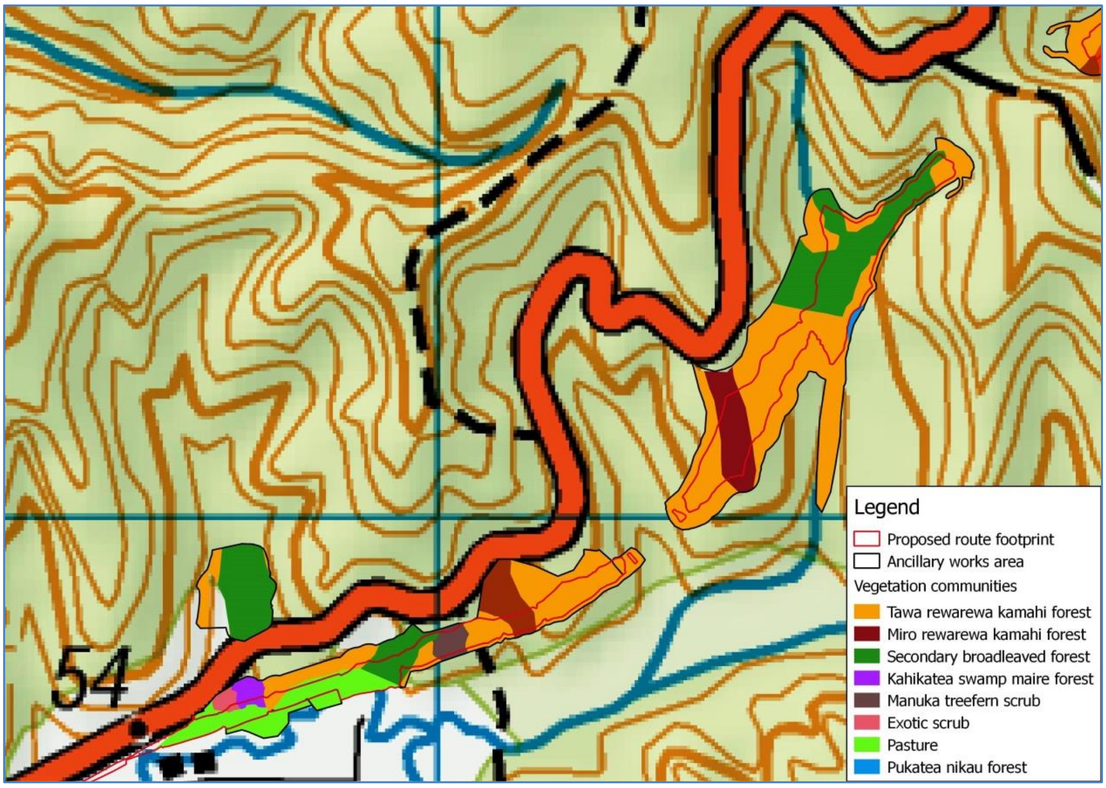

Figure 3 - Vegetation communities within the Mimi Stream within the proposed route footprint and the Additional (Ancillary) Works Area

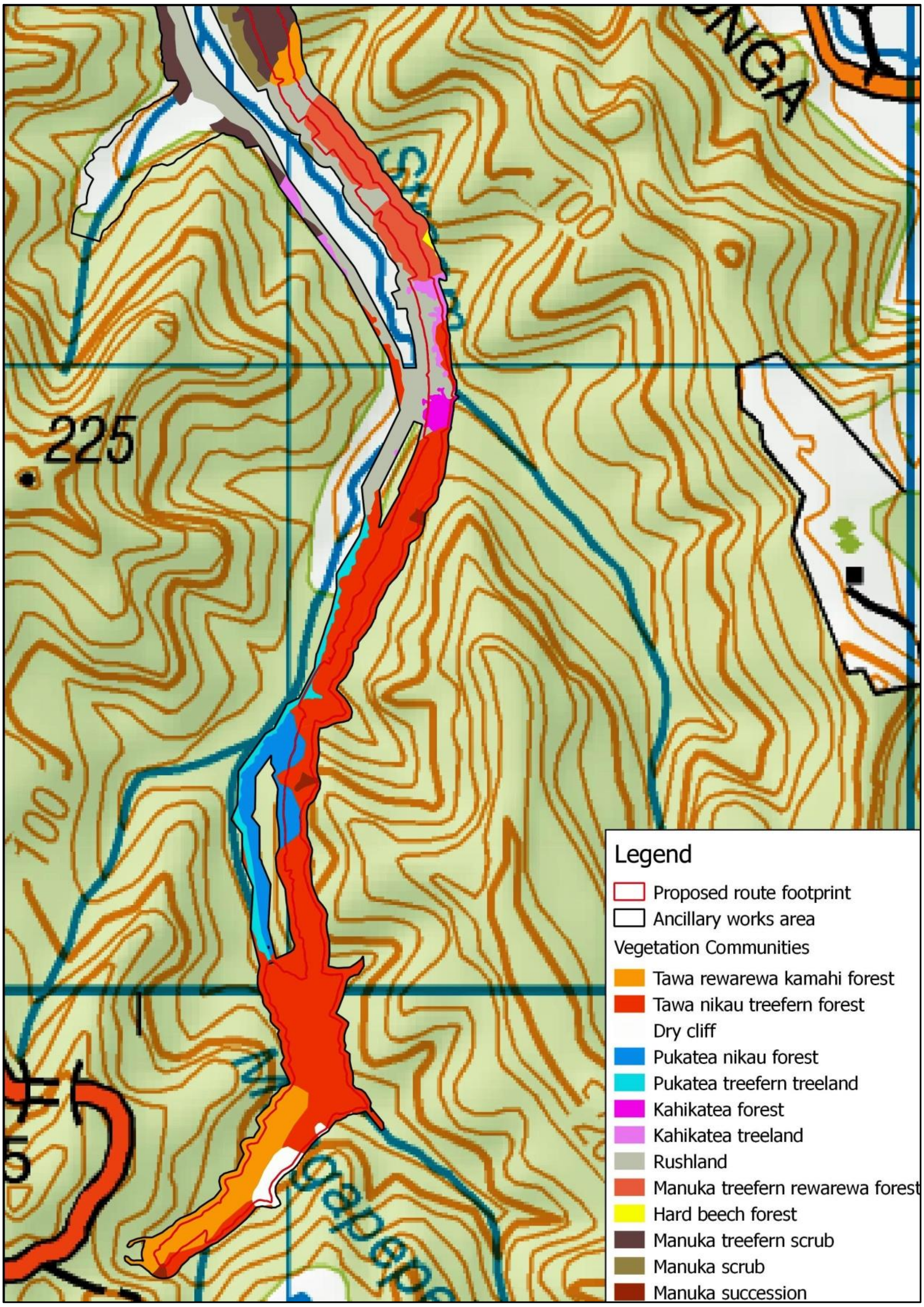

Figure 4 - Vegetation communities within the upper Mangapepeke Stream within the proposed route footprint and the Additional (Ancillary) Works Area

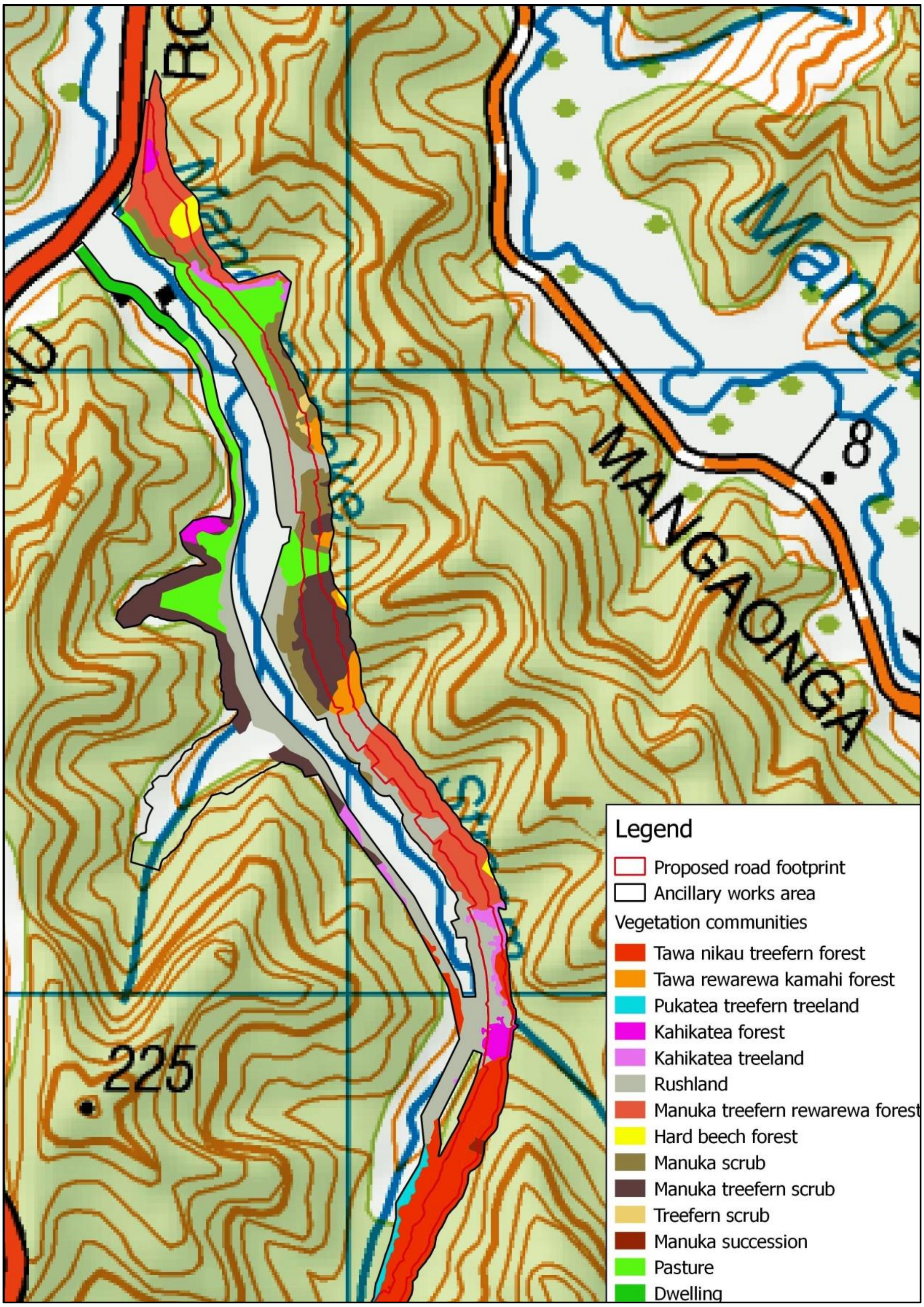

Figure 5 - Vegetation communities within the lower Mangapepeke Stream within the proposed route footprint and the Additional (Ancillary) Works Area

WF8 Kahikatea, pukatea forest

66. WF8: Kahikatea, pukatea forest occurs from Northland to Marlborough and in the Tasman District. A partial national extent has been calculated as 1.3% remaining. For this reason, this ecosystem type is now uncommon and restricted with remnants mostly small in size.

67. Regionally 2.45% of the potential area remains. The North Taranaki Ecological District, is a national stronghold for this ecosystem type and retains 7.6% of the original extent, much of which occurs in three large sites.

68. The Project footprint is expected to result in the loss of 2.629ha, when all five WF8 communities are included. This is 0.59% of this vegetation type in the Ecological District.

69. The most representative and ecologically significant areas are the small stands of kahikatea swamp maire (0.159ha) and kahikatea forest (0.525ha) and locally swamp maire, which are of high ecological value.

70. The small stand of pole kahikatea, swamp maire forest (0.159ha) in the Mimi catchment is most representative and natural vegetation community within this ecosystem type (**Appendix Figure 6**).

71. Three small areas of kahikatea forest are affected in the Mangapepeke catchment which collectively occupies 0.525ha. The design has purposefully attempted to reduce the area affected and approximately 0.2ha has been avoided. All stands impacted are secondary, typically ranging in height from 12m-16m tall and are estimated to be between 50-80 years old (**Appendix Figure 7**).

72. Within the largest stand of kahikatea forest (NZTM 1739238; 5694920) a 200m^2 plot was placed on the proposed road alignment. These trees similar size and diameter to other areas of kahikatea. Within the plot 19 kahikatea trees were recorded, of which:

    (a) 15 were <30cm diameter at breast height;

    (b) 2 were between 30-60cm d.b.h; and

    (c) 2 were >60cm d.b.h (but <70cm).

73. Other trees recorded were all <30cm d.b.h and included: 6 pukatea; 25 wheki; and 2 putaputaweta. Very limited vegetation occurred in the 2-5m tier, though ramarama, houhere and kiekie were present along with climbing rata and

hounds tongue fern. The understorey and ground cover tiers were heavily browsed with vegetation mostly <30cm in height and dominated by the invasive weed African clubmoss (at approximately 50% cover).

74. The other three communities, kahikatea treeland (**Appendix Figure 8**), pukatea, treefern treeland (**Appendix Figure 9**) and manuka scrub, are more modified, with discontinuous canopies, dominated by scattered kahikatea, moribund pukatea, wheki tree fern and manuka.

75. The 0.641ha area of kahikatea treeland encompasses the area where kahikatea trees occur amongst farmland. The size of these trees is more variable compared to 'kahikatea forest' ranging from saplings (5cm diameter at breast height) to 12m trees (up to 60cm d.b.h).

76. The 0.722ha of pukatea, treefern treeland community occurs in the upper part of the Mangapepeke Valley and was likely formerly similar to the closed canopy 'Wheki, ramarama treefernland' community in the Mimi catchment. This community is dominated by scattered moribund pukatea and wheki tree ferns.

77. The 0.582ha of manuka scrub occurs largely on the edge of the valley floor and hillslope. Manuka is the dominant woody plant, though occasional kahikatea saplings occur, typically on raised surfaces.

78. All treeland and scrub communities have a high component of exotic pasture and wetland species in the ground cover tiers and are heavily grazed by stock and feral goats. The kahikatea treeland and pukatea, treefern treeland communities are of moderate ecological value as they retain some canopy species.

WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest

79. WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest ecosystem type occurs from Northland to Taranaki on the west coast and to the Mohaka River mouth on the east coast within the Hawkes Bay Region. With the recent completion of potential ecosystem maps covering the entire extent of this ecosystem type, a national ecosystem extent has been calculated for this evidence. This analysis compared current vegetation using the 'indigenous forest' unit from Landcover database 4 (Landcare Research) with the national potential extent. Nationally within the 'indigenous forest' class 19% of this ecosystem type remains.

80. Vegetation communities within the broader WF13 ecosystem type are nationally and regionally uncommon with estimated extents of 19% and 11.6% of original cover remaining respectively. Regionally this equates to 16,217ha of primary vegetation communities remaining. The North Taranaki Ecological District comparatively has retained more of this ecosystem type, with 37% remaining.

81. Loss of 16.847ha of primary and modified primary forest communities amount to approximately 0.1% of the area and extent of this type of indigenous forest remaining in the Taranaki Region.

82. Within the Project footprint WF13 vegetation communities occupy the largest extent. While this only represents a very small proportion of this habitat at ecological district, regional and national scales, the vegetation communities affected within the Mimi Catchment are highly representative, despite pest modifications. These areas were ranked in the top 10% of biodiversity sites (Leathwick 2016)[28], which is an analogous measure of ecological value and 'representativeness'.

83. This includes approximately 6.993ha of both tawa, kamahi, rewarewa forest and miro, rewarewa, kamahi forest communities located primarily within the Mimi Catchment, which are representative and of high ecological value. These communities retain palatable species, such as kamahi as a canopy dominant and near the Kiwi Road track, highly palatable understorey species including toropapa and pikopiko.

84. Within the Mangapepeke Valley, 8.507ha of tawa, nikau treefern forest and 1.347ha of pukatea, nikau forest communities are less representative due to structural and compositional modifications, caused probably by animal pests, especially possums and ungulates. Where kamahi (and perhaps kohekohe and tawa) were formerly canopy dominants, nikau palm and tree-ferns (both non-palatable to herbivorous pests) are abundant in the canopy and sub-canopy tiers.

85. Similar long-term composition and structural changes have been recorded elsewhere in New Zealand such as in lowland forest near Wellington (Campbell 1990)[29], where a reduction of tawa, kamahi and northern rata occurred and an increase of species not eaten by possums, such as katote,

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[28] Leathwick, J.R. (2016 unpublished). Biodiversity rankings for the Taranaki Region. Taranaki Regional Council Document Number FRODO#1709206.
[29] Campbell, D.R. (1990). Changes in structure and composition of a New Zealand lowland forest inhabited by Brushtailed Possums. Pacific Science, Vol.44., No.3., 277–296.

ponga, pigeonwood and pukatea. All of these species are present at Parininihi–Mt Messenger.

86. There is also widespread recruitment failure of palatable shrubs and trees including tawa, the remaining canopy dominant. Healthy recruiting tawa forest have an abundance (c1200+ seedlings/ ha; Blaschke 1988) which were absent.

87. The pukatea, nikau forest is of high ecological value as the canopy portion of this community is still largely intact while tawa, nikau treefern forest is of moderate ecological value.

88. A further 2.891 ha are secondary communities dominated by broadleaved forest species, manuka and tree ferns of moderate to low ecological value.

WF14: Kamahi, tawa, podocarp, hard beech forest vegetation communities

89. Vegetation communities within the broader WF14 ecosystem type are not threatened or uncommon at national or regional scales, with 38.4% and 76.9% remaining respectively. Within the Taranaki Region and the North Taranaki Ecological District, this equates to 9,790ha remaining.

90. The Project footprint will result in the loss of 8.909ha of WF14 vegetation, of which 0.814ha is modified primary hard beech and tawa, kamahi, rewarewa forest vegetation communities. In total this amounts to approximately 0.008% of the total area of primary forest in the region. Including all secondary forest and scrub communities this amounts to 0.07%.

91. The small area of modified primary hard beech and tawa, kamahi, rewarewa forest communities are representative despite having modified understorey and ground cover tiers and consequently are of moderate ecological value.

92. Much of the lower Mangapepeke Valley is dominated by secondary scrub and forest communities which have developed following initial land clearance activities and in the presence of stock and wild ungulates. This accounts for the remaining approximately 8ha of WF 14 vegetation within the Project footprint. These communities are dominated by a relatively low diversity of unpalatable and browse resilient species such as manuka, kanuka and tree ferns. For this reason, they are less representative and natural compared to primary communities dominated by hard beech, kamahi, tawa and podocarp trees. However, they are of low-moderate ecological value, providing soil and

water protection, and habitat for native fauna. The effect of the loss of these communities is considered low.

CL6: Hebe, wharariki flaxland / rockland vegetation communities

93. A small area (0.399ha) of dry cliff vegetation occurs in the tributary of the upper Mangapepeke Valley. Broadly this ecosystem is likely to be a naturally uncommon ecosystem.[30]

94. Vegetation on this cliff appears to be recently established following landslides, and for this reason lacks diversity compared to similar examples nearby. Similar habitat in Parininihi is considerably more diverse and includes cliff specialist species such as native broom, wharariki, *Olearia townsonii*, *Gaultheria paniculata, G. oppositifolia*, *Pseudopanax laetus* (pers.obs) and closer to the coast *Veronica townsonii* and *Veronica speciosa*[31]. None of these species were found in the Project footprint.

95. Weeds including pampas grass and Spanish heath occur within this vegetation community.

Threatened and regionally distinctive plants

96. Three trees are hosts for a small number (<10) of the chronically threatened epiphytic shrub, kohurangi (*Brachyglottis kirkii* var. *kirkii*). This species is possum palatable and appears to now grow on very tall host trees or trees which are not known dietary components of possums (such as tree ferns). For this reason it is my opinion that fewer than 25 plants of this threatened plant are likely to be within the Project footprint.

97. Small numbers (<25 individuals) of two regionally distinctive plants are also affected: swamp maire (*Syzygium maire*) (as noted above in the discussion on WF8 communities), and *Pittosporum cornifolium* which occurs as an epiphyte often in association with kohurangi. Regionally distinctive plant species are not regarded as being nationally threatened but their presence is regarded as being note-worthy and of conservation importance.

98. Several other regionally distinctive plants occur within the wider Project area but have not been found within the Project footprint.

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[30] This ecosystem type is not accommodated by any cliff ecosystem types described by Williams et al. (2007) or factsheets describing these on Landcare Research's website — but this is possibly due to a lack of data or an oversight.
[31] Clarkson pers.com.

Significant trees

99. Significant trees were defined as those which are:

    (a) large;

    (b) old;

    (c) relatively uncommon; and

    (d) provide significant habitat for associate flora and fauna such as epiphytes or nesting cavities for bats, birds and lizards.

100. The design has specifically avoided many significant trees. Seventeen significant trees have been identified including eleven large rimu, two totara and one each of matai, miro, hinau and pukatea. Post consent design improvements at a fine scale of resolution are planned (involving physically surveying the location) for two trees which may be able to be avoided. These trees have been identified in the ELMP.

Lower value vegetation

101. In the lower Mangapepeke catchment on private land, approximately 4.66ha of vegetation dominated by early successional manuka and tree ferns and of comparatively lower ecological value. This area has been subjected to vegetation clearance from agricultural development and heavy browsing by stock and feral ungulates. The groundcover vegetation has a high diversity and abundance of introduced pasture species, and locally the invasive ground cover weed, African clubmoss, is widespread and locally abundant in some areas. Consequently, vegetation in this part of the catchment is of comparatively lower value and not significant under the District Plan considering botanical values alone.

EFFECTS ASSESSMENT INCLUDING MITIGATION, OFFSETTING AND MONITORING

102. Having a detailed survey of the vegetation within the Project footprint informed my assessment of the potential effects of the Project on indigenous vegetation. My assessment of the unmitigated effects of the Project was carried out with reference to the significance criteria in the New Plymouth District Plan, and in accordance with the EcIA guidelines[32] (adapted based on

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[32] EIANZ 2015. Ecological Impact Assessment (EcIA): EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems.

my expert opinion). Davis et al. (2016) was also used for guidance, especially with determining 'representativeness'.

103. The Project triggers two significance criteria from Appendix 21 within the District Plan:

(a) Criteria 1: Threatened species. For the purpose of assessing this criteria 'threatened species' includes:

(i) any vascular plant listed as 'acutely or chronically threatened' by de Lange et al. (2013)[33]; and

(ii) 'regionally limited abundance' plants listed within the Taranaki regionally distinctive plant list. The presence of non-vascular threatened plants, lichens and fungi were not evaluated.

(b) Criteria 3: Nationally rare ecosystems, habitat or sequences. For the purpose of assessing these criteria, nationally rare ecosystems, habitat or sequences are defined either by Williams et al. (2007)[34] or occupying <20% of their original extent.[35] This has been quantified through using Leathwick (2016)[36] for the North Taranaki Ecological District and Taranaki regional scales. For the national scale, measures of extent remaining have been calculated (as described above) where data exists as not all regions or districts have potential ecosystem maps.

(c) Criteria 2: 'Areas of important habitat: for nationally vulnerable or rare species' was not triggered for vegetation and threatened plants, despite the Project impacting one 'At Risk' species and several regionally distinctive species. In this context 'Important' was defined as including one of the following sub-criteria being:

(i) a population or part of a larger population actively managed for the conservation of the species;

(ii) or being a large population (relative to other populations);

(iii) or being stable with no pressures or agents of decline present;

[33] de Lange, P.J.; Rolfe, J.R.; Champion, P.D.; Courtney, S.P.; Heenan, P.B.; Barkla, J.W.; Cameron, E.K.; Norton, D.A.; Hitchmough, R.A. (2013). Conservation status of New Zealand indigenous vascular plants, 2012. *New Zealand Threat Classification Series 3*. Department of Conservation, Wellington.
[34] Williams, P.A.; Wiser, S.; Clarkson, B.; Stanley, M. (2007). New Zealand's historical rare terrestrial ecosystems set in a physical and physiognomic framework. *New Zealand Journal of Ecology 31 (2)* : 119–128.
[35] This conforms to Priorities 1 and 2 (Ministry for the Environment 2007)
[36] Leathwick, J.R. (2016 unpublished). Biodiversity rankings for the Taranaki Region. Taranaki Regional Council Document Number FRODO#1709206.

(iv) or being on the margin of the species population range; or

(v) containing important genetic diversity.

104. 'Representativeness' is regarded by Department of Conservation as the key criterion for significance assessment[37] under the RMA (1991) and is also included for consideration in the EcIA guidelines. In this context 'representativeness' means the extent to which indigenous biodiversity is typical of the natural diversity of the relevant Ecological District. While not included within the District Plan significance criterion, 'Representativeness' has specifically been discussed in the initial Assessment of Environmental Effects – Vegetation; Technical report 7a and Supplementary report.

EcIA Unmitigated Effects Assessment

105. I applied the EcIA guidelines to assess an overall level of unmitigated effect of the Project on each ecosystem unit. I then completed an overall assessment of the unmitigated effect of the Project on native vegetation values.

106. This assessment is summarised in **Table 2** below. I note that within each ecosystem unit, the assessed value of the individual vegetation communities varies. For example, in respect of the WF8 unit:

(a) kahikatea swamp maire forest has a 'High' ecological value;

(b) kahikatea forest has a 'High' ecological value;

(c) kahikatea treeland has a ‘Moderate’ ecological value;

(d) pukatea treefern treeland has a ‘Moderate’ ecological value; and

(e) manuka scrub has a ‘Low’ ecological value.

Table 2: EcIA unmitigated effects assessment

Ecosystem unit	Value; Magnitude of Effect; Overall Level of Unmitigated Effect	Comments
WF8: Kahikatea pukatea forest	Value: 'High' Magnitude of	Less than 2% of this ecosystem remains in New Zealand. For this reason loss of remaining habitat is

[37] Davis et. al (2016) Department of Conservation guidelines for assessing significant ecological values.

Ecosystem unit	Value; Magnitude of Effect; Overall Level of Unmitigated Effect	Comments
	unmitigated effect: 'High' Overall level of Unmitigated effect: 'Very High'	highly significant. All vegetation communities of this ecosystem type have functional water regimes, a fundamental environmental characteristic. The main influence affecting ecological value is related to representativeness and naturalness. The very small area in the Mimi Catchment is most representative, natural and includes swamp maire a regionally distinctive species. Areas in the Mangapepeke are less representative and natural, largely due to fragmentation and having simpler composition, potentially due to modifications from herbivores.
WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest	Value: 'Moderate-High' Magnitude of unmitigated effect: 'High' Overall level of Unmitigated effect: 'Very High'	While still relatively common within the North Taranaki Ecological District, at a national level this is an uncommon ecosystem with <20% remaining. The difference in ecological value is largely due to the gradient of animal pest impacts and the historical impact on representativeness. In the south, composition and structure is more intact and therefore areas are highly representative and areas contain a high abundance and diversity of palatable species and several significant trees. This community diversity and complexity declines northwards with a dominance and relatively uniformity of unpalatable species especially in the sub-canopy.
WF14: Kamahi, tawa, podocarp, hard beech forest	Value: 'Moderate' Magnitude of unmitigated effect: 'Low' Overall level of Unmitigated effect: 'Low'	These vegetation communities are not rare or threatened and are particularly common in the North Taranaki Ecological District. Areas impacted are predominantly secondary and have developed in the presence of farming practices. As such composition and structure is relatively simple and dominated by species tolerant of or unpalatable to herbivores.

Ecosystem unit	Value; Magnitude of Effect; Overall Level of Unmitigated Effect	Comments
CL6: Hebe, wharariki flaxland / rockland	Value: 'Moderate' Magnitude of unmitigated effect: 'Low' Overall level of Unmitigated effect: 'Low'	While these vegetation communities are naturally uncommon, areas impacted are appear to be recent in origin and lack diversity compared to similar examples nearby. They are also small at less than 0.4ha and include several invasive species which appear to be increasing in dominance.
Overall assessment	Value: High Magnitude of unmitigated effect: 'High' Overall level of Unmitigated effect: 'High'	While the alignment includes ecosystems and vegetation communities which are modified, areas include ecosystems which are nationally rare and uncommon, some of which are highly representative, natural and regionally are some of the best remaining.

107. This level of unmitigated effect requires significant mitigation and offsetting, which is discussed below.

Effect on threatened and regionally distinctive plant species

108. The effect of the Project on threatened and regionally distinctive plant species is minor, as few individuals are known (or expected) within the Project footprint and their threat status is low ('At risk declining' and 'regionally distinctive'). The offsetting discussed below is expected to fully address their loss.

Addressing actual and potential effects on vegetation

109. Extensive efforts have been made to avoid, remedy, mitigate or offset potential effects on vegetation. These efforts are in two broad categories:

(a) avoiding and minimising potential adverse effects through route selection; and

(b) a comprehensive programme to mitigate and offset effects that have not been able to be avoided.

110. The effects assessment set out above takes into account avoidance and minimisation measures but does not take into account the mitigation and offsetting programme.

Avoiding and minimising potential adverse effects through route selection and Project footprint optimisation

111. Potential adverse effects on vegetation have been avoided and minimised by:

(a) Locating the route east of the current state highway to preserve the nationally significant forest sequence at Parininihi from the coast to Mt Messenger.

(b) Locating the route as far as practicable away from the Mimi wetland which contains significant valley floor kahikatea forest and wetland habitat .

(c) The inclusion of a bridge and top-down construction methods to protect the Mimi wetland, described and assessed as being highly significant.[38]

(d) The construction of a tunnel to reduce vegetation loss and maintain east to west ecosystem connectivity.

(e) Constraints on the width of the additional works areas (AWA) where a 5m temporary vegetation loss may occur adjoining high ecological value areas c.f. 20m allowance.

(f) Modifications to the road alignment to avoid areas of valley floor kahikatea forest and several significant trees identified during the vegetation survey programme.[39]

(g) Minor adjustments to the route to avoid the loss of significant trees, reducing loss from 22 to 17.

(h) Specifications in the ELMP to avoid impacts on vegetation such as siting of construction related activities and the use of forest resources including harvesting tree ferns and then planting these at a later stage in restoration programmes.

[38] Mt Messenger Bypass Investigation: Botanical Investigation and Assessment of Effects. Prepared for Opus International Consultants Ltd. © Nicholas Singers Ecological Solutions Ltd. NSES Ltd Report 34:2016/17, April 2017.
[39] Assessment of Ecological Effects - Vegetation included as Technical Report 7a, Volume 3 to the Assessment of Environmental Effects

112. In all examples identified above I have provided recommendations which have influenced the design and Project specifications.

Mitigating and offsetting residual effects

113. Notwithstanding the significant avoidance and minimisation measures discussed above, the Project will still have a high effect on native vegetation.

114. Addressing these effects requires a comprehensive mitigation and offsetting programme. Mr MacGibbon discusses the elements of the mitigation and offsetting programme in detail in his evidence. Along with Mr MacGibbon, I have been heavily involved in developing this programme - including through the application of the biodiversity accounting offset model, discussed in Part B of my evidence below.

115. The key measures for mitigating and offsetting effects on vegetation include:

(a) A comprehensive pest management programme to control animal pests within approximately 1085ha to improve the ecological integrity (health) of like for like ecosystem types and vegetation communities impacted.

(b) Restoration planting to recreate 6ha of kahikatea forest and mitigate the loss of secondary vegetation communities.

(c) Restoration planting (1:1 ratio) for early successional vegetation types, such as manuka and tree-ferns of approximately 5ha which are not significant under the District Plan.

(d) Compensation planting of 200 seedlings for every significant tree felled.

(e) Recovery and cultivation of threatened and regionally distinctive plant species to later be returned back to the site.

(f) Enhancement planting of cliff specialists at the top of cut sites to assist succession of road side batters.

(g) Fencing and riparian planting of approximately 8.627km of existing streams.

(h) Recovery of forest resources to enhance terrestrial and aquatic restoration including; precision placement of woody debris and rotten logs that provide habitat for epiphytes, invertebrates and potentially lizards to suitable sites outside of the road footprint, harvesting and reuse of tree ferns and use of manuka slash to enhance natural succession.

Overall effects assessment taking into account mitigation and offsetting

116. In this section I discuss the overall effects on vegetation of the Project, considering the proposed mitigation and offsetting measures. I first discuss each of the vegetation ecosystem types discussed above, then threatened and regionally distinctive plants, and significant trees.

117. The Restoration Package including the biodiversity offsetting component, has been developed considering the principals described in the Guidance on Good Practice Biodiversity Offsetting in New Zealand[40]. The selection of the offset actions (integrated pest management and restoration planting) was purposeful to ensure that as much of the impacts on vegetation as possible would be improved within the offset sites. Where biodiversity could not be offset, such as with the loss of significant trees, compensation has been offered.

118. The integrated pest management site was chosen to include all ecosystem types impacted, in order to be 'like for like' habitat. The major component of the Restoration Package is a deliberate trade-off between loosing habitat (area) and gaining ecological integrity (condition) by undertaking integrated pest management over 1085ha area in perpetuity. Additional restoration planting of 6ha has specifically been added, to offset ecological values which will not be offset with integrated pest management alone.

119. With intensive integrated pest management occurring in perpetuity, the offset site will support a wide range of pest sensitive species which will progressively increase in abundance over time, enabling recovery of populations and the communities they occupy. Implemented as planned, I am comfortable that, excluding the loss of significant long-lived trees, impacts on vegetation and loss of habitat for fauna will be addressed over time.

WF8 communities

120. All vegetation communities impacted, including highly modified treeland and scrub, were included within offset calculations.

[40] Guidance on Good Practice Biodiversity Offsetting in New Zealand. August 2014. http://www.doc.govt.nz/documents/our-work/biodiversity-offsets/the-guidance.pdf

121. Ecological offsetting for the loss of these communities has been proposed involving two methods; integrated pest management and restoration planting for the loss of kahikatea trees.

122. The area (22ha) of available valley floor kahikatea, pukatea (WF8) habitat proposed to receive integrated pest management is located within two branches of the Mimi Catchment, most of which is in the Mt Messenger Conservation Area (**Appendix, Figure 10**). This habitat is surrounded by indigenous forest communities which will also be managed. This area includes high quality, advanced secondary forest of kahikatea and swamp maire. Smaller areas of associated wetlands and riparian shrubland and treefern communities, typically with small sized kahikatea and pukatea trees, are also present. This community variety was likely formerly present in the Mangapepeke Valley before land development for agriculture. For these reasons the vegetation communities present are considered to be an appropriate 'like for like' habitat.

123. The targeted 22ha pest management site includes a number of palatable tree and shrub species, such as swamp maire, kaikomako, mahoe and kamahi. Possum and goat browsing is currently having a detrimental effect on canopy health and regeneration processes. Within the understorey and ground tiers, browsing by stock and feral ungulates has greatly compromised composition. Palatable shrubs and ferns are uncommon, and there appears to be recruitment failure of important canopy tree species including pukatea and swamp maire. It is expected that integrated pest management of especially goats and possums and locally exclusion of stock will result in significant changes to these and other vulnerable components.

124. Restoration planting of 6ha is also proposed to offset the loss of kahikatea trees, which are not expected to benefit as greatly from integrated pest management. Potential sites include within the Mangapepeke and Mimi Catchments, which will in-fill habitat and reduce fragmentation of forest habitat. These restoration sites will also benefit from integrated pest management so should also develop healthy understorey and ground tier vegetation dominated by palatable species as well as providing habitat for a range of fauna present.

125. Offset actions for freshwater and terrestrial ecosystems have been separated spatially. The offset for freshwater ecosystems includes 17.2ha of terrestrial riparian margin planting, in which kahikatea, pukatea and other associate

species will be planted. With time this area will also develop into kahikatea, pukatea forest. In the Mangapepeke Valley it is expect that 6.23ha of riparian margin will be restored for freshwater offsetting, which will be contiguous with up to 6ha of kahikatea forest for terrestrial offsetting. Potentially this could result in a combined area of continuous valley floor kahikatea, pukatea forest of 12+ha, doubling the offsetting area calculated for terrestrial kahikatea forest. At over 12ha, this habitat will become one of the larger kahikatea, pukatea forests in the North Taranaki Ecological District and nearly 4ha greater in size than the Mimi wetland.

126. Even without counting the contribution from the riparian margin, the Restoration Package for WF8 communities is still substantial. It will provide significant improvements to existing habitat enabling palatable canopy, sub-canopy trees and ground cover vegetation, including to species such as pukatea currently suffering from recruitment failure. Restoration planting of 6ha currently in pasture and introduced exotic rushland will be restored into kahikatea, pukatea forest. This will add 1.5% over and above what is being lost to the remaining extent of this ecosystem type within the ecological district. Significantly, these areas will have natural hydrological regimes, enabling ecologically functional communities to develop. For these reasons, it is my opinion that combined pest control within existing areas in perpetuity and restoration planting of 6ha, will result in a net biodiversity gain and more than adequately offset the loss of WF8 habitat impacted within the Project footprint.

WF13 and WF14 communities

127. The proposed offsetting site is similar forest to the eastern side of Parininihi with the majority of the forest dominated by tawa (WF13). Locally pukatea, rimu and miro are locally abundant on shallow sloping hillslopes and within gullies. Remnant trees of northern rata and thin-barked totara also occur. On several ridges kamahi and rewarewa are common though several ridges has hard beech 24.8ha (**Appendix, Figure 10**), which is a larger than the 18ha required to offset the loss of WF14 forest communities. For these reasons these vegetation communities are considered to contain both WF13 and WF14 ecosystems and be 'like for like' habitat for offsetting loss (**Appendix: Figure 5** AEE Vegetation Report 7a).

128. WF13 vegetation communities contain numerous species which have dramatically declined in abundance or are continuing to decline as a result of

animal pests, including possums and ungulates. Significant declines of canopy trees include kohekohe, kamahi, northern rata, thin barked totara and many species within sub-canopy and groundcover tiers. Recruitment failure of several canopy trees is apparent where ungulates are abundant including a near absence of saplings of tawa, kamahi, pukatea and hinau. Tawa recruitment failure is especially obvious, as healthy forests have a reversed J-shaped demographic aged structure with >1200 saplings/ ha (Blaschke 1988). Without management within the proposed offset site, continued decline in composition and structural components are expected.

129. Ecological management at Parininihi provides an exemplar of the potential recovery of this ecosystem type. Highly palatable species such as pikopiko, hangehange, large leafed coprosma shrubs and toropapa are common in the understorey[41]. Canopy trees such as kamahi, northern rata and thin-barked totara also have dense and healthy canopies. Low predator numbers have further lead to recovery of native birds and have allowed for the recent return of kōkako, a highly pest sensitive species.

130. By targeting the same range of pests with integrated pest management to similarly low pest densities, it is expected that analogous ecological outcomes will result, within the proposed offset site as observed within Parininihi. While not calculated within offset calculations, ecological benefits will also likely occur for Parininihi, as the offset site will effectively become a pest buffer for the eastern side of Parininihi. Long-term benefits from this could include local eradication of goats and a much lower reinvasion rate of possums and possibly mustelids, leading to improved conservation outcomes.

131. Overall, the offset and mitigation for WF13 and WF14 communities will provide significant improvements to the condition and regeneration of palatable canopy, sub-canopy trees, understorey shrubs and groundcover vegetation. A primary objective of possum and ungulate control is to re-establish regeneration of the canopy dominant tawa, which is currently suffering from recruitment failure in most of the pest management area. It is expected that within 10 years a seedling bank of tawa will be present within the browse tier. In optimum regeneration sites a portion of these will have grown above the goat browse tier by Year 15. Other indicators of success include widespread regeneration of large leafed shrubs and palatable ferns such kiokio.

[41] Singers, N and Bayler, C. (2017). Mt Messenger Bypass Investigation. Botanical Investigation and Assessment of Effects. Unpublished Contract report for Opus International Consultants Ltd by Nicholas Singers Environmental Solutions.

Improvement in canopy condition and productivity with possum control is expected to result in enhanced flowering and fruiting of palatable species. These benefits are expected to occur throughout most of the 1085ha pest management area, given the frequency and intensity of pest control planned. For these reasons, it is my opinion that integrated pest control over 1085ha in perpetuity will provide a net conservation benefit and will more than adequately offset the loss of WF13 and WF14 habitat impacted within the Project footprint.

Threatened and regionally distinctive plants

132. I consider that the offset measures proposed for the Project will fully account for the loss of threatened and regionally distinctive plants as a result of the Project.

133. Population increases are expected for all three threatened plant species discussed above as a result of integrated pest management. A large population of swamp maire is known in the Mimi wetland, and kohurangi and *Pittosporum cornifolium* also occur within the same catchment. Kohurangi and swamp maire are very palatable to herbivore pests and canopy condition, flowering, seed production, dispersal and recruitment are all expected to improve with threat management. *Pittosporum cornifolium* is also dispersed by birds and with forest bird population increases from predator control, this species should increase as well.

134. Population increases of other threatened plant species (not affected by the Project) are also expected from integrated pest management. The most likely species to benefit are king fern and kauri grass which are eaten by goats and pigs. Though not known in the integrated pest management site, both are likely to be still present at low abundances and also occur in close proximity at Parininihi. With the control of goats and pigs these species should increase in abundance within the integrated pest management site.

Significant trees

135. The Project will potentially result in the loss of up to 17 significant trees. Offsetting the loss of these large and long-lived trees is not possible and for this reason every significant tree lost, will be compensated for by planting 200 eco-sourced seedlings of the same species. This compensation has been undertaken to ensure that these trees remain in the landscape for the

foreseeable future, and with time contribute resources (flowers and fruit) and habitat for the wider ecosystem.

136. While currently not quantified it is expected that integrated pest control will benefit existing possum browse sensitive significant trees within the Pest Management Area, potentially including remaining kohekohe, northern rata and thin-barked totara.

Confirming actual vegetation loss and impacts

137. The Supplementary Report Vegetation includes 17.891ha of indigenous vegetation within the AWA which for the purpose of the consent application is assumed will be cleared to enable the construction to occur. This scenario is, however, not expected to occur due to a combination of more refined mapping of the area required for ancillary works, such as access roads, as well as constraints included in the vegetation removal section of the ELMP, specifically around vegetation removal protocols. This means that actual vegetation loss within the AWA should be much lower. Upon completion of each vegetation removal stage, actual vegetation loss will be re-measured as set out in section 4.8; Table 4.1 of the ELMP. Upon completion of the Project this will allow the Biodiversity Offsets Accounting Model to be populated with figures of actual vegetation loss.

138. There is also intent to further reduce effects on vegetation identified in the Supplementary Ecology Report – Vegetation including:

(a) potentially avoiding two small areas of kahikatea of 0.2ha on private land in the lower Mangapepeke Valley; and

(b) one very tall rimu tree south of the tunnel in the Mimi Catchment. These have been identified in section 4.4.2 of the ELMP and will be addressed during detailed design.

PART B: BIODIVERSITY OFFSETTING

BIODIVERSITY OFFSETTING AND THE BIODIVERSITY OFFSETS ACCOUNTING MODEL

Introduction

139. Mr MacGibbon explains in his evidence that it is not possible to avoid, remedy or mitigate (in the traditional sense) all the effects the Project will have on ecological values. There will be significant residual effects of the Project that need to be addressed through biodiversity offsetting. As part of my work on the Project, I:

   (a) worked with Mr MacGibbon to devise an overall approach to offsetting the residual effects of the Project; and

   (b) in doing so, applied the Biodiversity Accounting Model developed for DOC by Maseyk et al. (2014) ("**the Model**").

140. My work in applying the Model to the Project is set out in the Biodiversity Offset Calculation Report, and the Supplementary Biodiversity Offset Calculation Report, both of which I prepared and were reviewed by the lead author of the calculator, Dr Fleur Maseyk.

141. The required offsets generated through the application by the Model have been provided for through the ELMP, along with a significant additional buffer area. This is described by Mr MacGibbon in his evidence.

142. In this Part B of my evidence, I provide an overview of biodiversity offsetting, and the Model. I then explain how the model was applied to the Project in order to generate measures that will achieve a net biodiversity benefit in ecological values within 15 years of the construction of the Project, and significant biodiversity benefits (compared to the existing situation) within 35 years.[42]

Biodiversity offsetting

143. The process of offsetting seeks to counter-balance the unavoidable impacts of development on biodiversity by enhancing the state of biodiversity elsewhere. The goal of biodiversity offsetting, adopted for this Project by the Transport

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[42] More details including calculations used to apply the Model are set out in the Biodiversity Offset Calculation Report and the Supplementary Biodiversity Offset Calculation Report.

Agency and Alliance, is to achieve No Net Loss or a Net Gain of biodiversity, in comparison to the baseline.

144. Biodiversity offsets can include securing or setting aside areas for conservation, enhanced management of habitats or species, and other defined activities. They can be used to:

(a) create, expand or buffer existing protected areas;

(b) enhance, link or restore habitats; and

(c) protect or manage species of conservation interest (either within a designated conservation area or more broadly across the habitat where the species occurs).

145. Irrespective of the specific focus of the offset activities, measurable conservation outcomes should be achieved (Ledec & Johnson 2016)[43].

146. Biodiversity offsets should provide for:

(a) additionality: conservation gains beyond what would be achieved by ongoing or planned activities that are not part of the offset;

(b) equivalence: focussing on the same values as those lost (the 'like-for-like' principle); and

(c) permanence: benefits that persist for at least as long as the effects of the project (in practice this often means in perpetuity).

147. Offsets should be developed using a precautionary approach. Outcome monitoring (that is feasible, able to obtain relevant information, and not unduly complex) should be provided for.

The Model

148. The Model was developed as part of a New Zealand Government-funded project to develop the Guidance on Good Practice Biodiversity Offsetting in New Zealand (August 2014)[44] ("**Offsetting Guidance**").

149. The Offsetting Guidance was a collaborative document developed by a number of Government organisations. The Model, driven by the principles in the Offsetting Guidance, is consistent with the World Bank Offsets Guide. The

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[43] Ledec, G.C. and Johnson, S.D.R. (2016). *Biodiversity offsets: a user guide*. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/344901481176051661/Biodiversity-offsets-a-user-guide
[44] Guidance on Good Practice Biodiversity Offsetting in New Zealand. https://www.doc.govt.nz/documents/our-work/biodiversity-offsets/the-guidance.pdf

Model also broadly aligns with the approach in the Stream Ecological Valuation method, a freshwater offsetting model which has been used in New Zealand since 2006 (and is being used in respect of stream values for this Project, described in Mr Hamill's evidence).

150. I consider the Model to be appropriate for use in calculating biodiversity offsets for the Project, noting that it is consistent with the New Zealand Government's best practice guidance document.

151. The Model broadly operates by taking the areas and condition of vegetation communities and habitat to be removed or affected by the Project and calculating how much biodiversity offsetting is required to account for those effects. The Model operates on a 'like for like' basis so the offsets calculated are aimed at achieving No Net Loss (or Net Gain) by exchanging similar areas of habitat.

152. Biodiversity components are turned into a unit of measure, akin to a currency, and the model determines the offsets required to achieve a No Net Loss or Net Gain outcome in the medium term following the completion of the Project.

The two steps in the Model

153. The Model uses two steps to calculate offsets:

(a) The 'impact model', which determines the impact of the development on biodiversity by:

(i) determining the amount of biodiversity loss and its condition;

(ii) allocating a benchmark ecosystem area (in this case, in the North Taranaki Ecological District); and

(iii) ultimately calculating the biodiversity value (BV) of the lost biodiverstiy; and

(b) The 'offset model' which determines the required offset by:

(i) starting with the value of the loss;

(ii) applying a 'discount rate' for the loss;

(iii) applying the relevant type of offsetting (in this case, pest management and restoration planting); and

(iv) determining the required areas of offsetting to generate a No Net Loss or Net Gain, and ultimately calculating the net present biodiversity value (NPBV).

The impact model

154. To calculate loss, the impact model requires the classification and quantification of biodiversity impacted by the Project footprint. There is a three-tiered classification system for biodiversity:

(a) Biodiversity types: the high-level classification of the ecosystem type in an area within the Project footprint;

(b) Biodiversity components: the specific vegetation communities in the various areas of the Project footprint; and

(c) Biodiversity attributes: the specific measures used to turn the biodiversity components into currency.

155. Once these are classified, the Model requires:

(a) the calculation of areas of each biodiversity attribute that will be lost due to the Project; and

(b) an assessment of the ecological integrity of each biodiversity component (factoring in current state, and habitat condition, both of which are heavily influenced by the degree of pest and human modification).

156. The condition of biodiversity attributes are then measured against high-quality 'benchmark sites'. The benchmark provides a mechanism to weight the loss of attributes of different biodiversity value at the impact site (i.e. within the Project footprint).[45]

157. A 'discount rate' is applied to the calculation, to account for inherent uncertainties in offsetting and the time lag between the loss (from the Project) and the subsequent gains. The discount rate is comparable to adding 'interest' to the calculation to account for this time lag. Discount rates are typically between 0 and 4%.

[45] It is important to understand that reaching the same quality as the benchmark sites is not the same as reaching No Net Loss.

The offset model

158. The offset model takes the biodiversity of both the impact site (Project footprint) and the target site(s) (offset sites) to determine the area of biodiversity offsets required.

159. A crucial input in this process is the selection of appropriate offset actions. Based on the ecosystem types being affected by the Project, the ecologists working on the Project collectively contributed, based on professional judgement, the appropriate offset actions required.

160. An assumption of the Model is that the same level of benefits result from each type of offset action.

161. Based on the appropriate offset actions to be implemented (and therefore used in the Model), appropriate potential or target sites for offsets need to be selected.

162. Given the Model operates on a 'like for like' basis, it is important that offset sites are the same types of ecosystems that will be impacted and ideally should be located in relatively close proximity to the area of lost.

163. The ecological integrity of the offset sites is assessed, using the same method as for the sites presumed to be lost as a result of the project. This provides a baseline for gains from the offset actions.

164. This process provides the starting point for forecasting the ecological outcomes from the offset actions over time; allowing for a determined point in time in which No Net Loss will be reached (that determination also depends on the amount of offset land being targeted).

165. The model requires confidence levels to be set for the various offset actions. A lower confidence level may increase the modelled offset area required or lengthen the amount of time it takes for No Net Loss to be achieved. There are three options for assigning confidence levels:

    (a) Low confidence: the proposed offset action would use methods that have either been successfully implemented in New Zealand or in the situation and context relevant to the offset site but infrequently, or the outcomes of the proposed offset action are not well proven or documented, or success rates elsewhere have been shown to be variable. The likelihood of success is > 50% but < 75%.

(b) Confident: the proposed offset action would use well known and often implemented methods which have been proven to succeed greater than 75% of the time, although enough complicating factors and/or expert opinion exists to not have greater confidence in this offset action. The likelihood of success is greater than 75% but less than 90%.

(c) Very confident: the proposed offset action would use methods that are well tested and repeatedly proven to be very reliable for the situation and context relevant to the offset site; evidence-based expert opinion is that success is very likely. The likelihood of success is > 90% (Maseyk et al. 2014).

166. Once the above attributes are entered into the Model, the Model can be used to calculate the gains achieved over time through the operation of the offset programme. The Model allows the user to choose how to define the time horizon of an offset calculation by use of a finite endpoint or calculation of accrued Net Present Biodiversity Value (NPBV) at five yearly intervals across 35 years (Maseyk et al. 2014).

167. At the point where the Model gives a '0' number, a No Net Loss of biodiversity values (in terms of the loss that has been considered through the Model) is achieved. From that point, positive numbers will be returned, indicating a Net Gain in biodiversity values.

168. The time at which No Net Loss will be achieved will depend on a range of factors, including in particular the area (ha) of land subject to the offset programme.

APPLYING THE MODEL TO THE PROJECT, AND THE REQUIRED OFFSETS FOR THE PROJECT

Overall approach including conservatism

169. In applying the Model to the Project, the aim has been to reach a No Net Loss point within 10 to 15 years for each of the ecosystem units put through the Model. It would not be realistic to achieve No Net Loss within a shorter timeframe.

170. In applying the Model to the Project, the focus has been on vegetation (habitat) loss. It does not specifically attempt to calculate and offset for the loss of animal species.

171. I consider the focus on vegetation is appropriate given the difficulties in assessing the full range and abundance of all animal species in the Project footprint, and because focussing on vegetation will improve habitat values across the offset sites, thereby benefiting animal species. The focus on vegetation means I was well placed to have the primary responsibility for applying the Model.

172. The Model has been used as a decision support tool and applied in a precautionary or conservative manner. The consequence of this approach is that a larger area of offset is calculated. Conservatism has been applied in a number of cumulative ways including:

(a) Determining the Project footprint (i.e. for the purposes of the Model all vegetation within the AWA is assumed to be lost, though this may not actually occur);

(b) Upscaling the measure of ecological integrity for kahikatea forest in the Project footprint to consider potential value in the future, as well as the national rarity of this ecosystem type;

(c) Allocating high ecological integrity for benchmark sites;

(d) Setting the 'discount rate' at 3%, was recommended by Dr. Fleur Maseyk (an author of the model used) as a conservative rate;

(e) Setting conservative levels of confidence for the offset actions to recognise uncertainty; such as establishing seedling kahikatea in restoration planting and achieving significant positive biodiversity outcomes from integrated pest management for swamp forest vegetation communities.

(f) Setting conservative changes in the difference made from management of pests on ecological outcomes for the canopy and understorey measures, within the ecological integrity score at Year 10 and 15 at offset sites (**Tables 6 & 7**).

Applying the impact model to the Project

173. The application of the impact model relied on vegetation categorisations outlined in Part A of my evidence and set out in the AEE Vegetation Report 7a and Supplementary Report - Vegetation (February 2018).

174. The Model has been applied to 25.811ha of the 31.676ha of indigenous dominant vegetation within the Project footprint. The residue 5.466ha is young, grazed secondary vegetation dominated by manuka and tree fern scrub. These excluded vegetation communities are not regarded as being significant under Appendix 21 of the District Plan. As explained by Mr MacGibbon in his evidence, these communities are being mitigated for through 1:1 restoration planting. Input data used in the Model are summarised in Tables 2.2 and A1 in Ecology Supplementary Report - Biodiversity Offset Calculation.

175. For each of the vegetation communities within the Project footprint that are being addressed through offsetting, I calculated:

(a) The area that will be lost due to the Project (a simple application of the surveyed areas, as per **Table 1** in Part A of my evidence); and

(b) The ecological integrity of that area.

Ecological integrity scores

176. Indicators for monitoring ecological integrity have been developed by Lee et al. (2005). While this framework is the 'ideal' approach for a quantitative assessment of ecological integrity for New Zealand ecosystems, this approach was considered to be unachievable and has not been applied because:

(a) Indicators required to 'gauge' ecological integrity include some that have not been applied in equivalent or similar ecosystems.

(b) While impacts of herbivores on New Zealand vegetation is widely known and long term recovery with herbivore control is broadly accepted[46], essential information required such as multi-decadal response of tree seedling regeneration of tawa and kamahi from goat control are not available.

(c) Many indicators would require well designed case studies over multiple years and at multiple sites of different pest control histories to provide baseline and comparative data of improvements in order to forecast changes.

177. Instead a qualitative or 'expert judgement' assessment of ecological integrity was applied recognising the output of the model would provide information as

[46] Nugent, G., Fraser, W., & Sweetapple, P. (2001). Top down or bottom up? Comparing the impacts of introduced arboreal possums and 'terrestrial'ruminants on native forests in New Zealand. *Biological Conservation*, *99*(1), 65-79.

a 'decision support tool' to assist in determining the appropriate level of offset required, not the decision *per se*. Expert judgement is increasingly being used in data poor situations in the New Zealand conservation sector to guide decision making (Monks et al. 2013).[47]

178. The method used was developed by Dr John Leathwick to score 'ecological value' for spatial biodiversity planning purposes.[48] The approach is vegetation based and qualitatively assesses current state and condition of ecosystems. The methodology is described in full in Appendix A – Biodiversity Offset Calculations (December 2017) and Appendix A Ecology Supplementary Report – Biodiversity Offset Calculations (February 2018).

179. The two elements of ecological integrity, current state and habitat condition, are essentially analogous to a value of 'representativeness'. The formula used to assess ecological integrity is:

Ecological integrity = Current state * Condition.

180. The inputs into the impact model as applied for the Project are set out in **Table 3** below. A breakdown of the ecological integrity input (into current state; and the three habitat condition components) can be found in Appendix A to the Supplementary Biodiversity Offset Report.

Table 3: Inputs into impact model

Ecosystem unit	Biodiversity Component (Vegetation community)	Level of forest intactness	Biodiversity Component #	Biodiversity attribute (Ecological Integrity or Canopy cover %)[1]	Total Habitat Loss (ha)
WF8	Kahikatea swamp maire forest and kahikatea forest[2]	Advanced secondary forest	1.1	69	0.684
	Pukatea treefern treeland	Modified secondary forest	1.2	11	0.722
	Manuka scrub	Modified secondary forest	1.3	7.5	0.582
	Kahikatea treeland	Modified secondary forest	1.4	17	0.641
	Kahikatea trees	Advanced secondary forest and Modified secondary forest	1.5	55 (Canopy cover)	1.325

[47] Monks, J. M., O'Donnell, C. F., & Wright, E. F. (2013). *Selection of potential indicator species for measuring and reporting on trends in widespread native taxa in New Zealand*. Publishing Team, Department of Conservation.
[48] Leathwick, J.R. (2016 unpublished) Biodiversity rankings for the Taranaki Region. Taranaki Regional Council Document Number FRODO#1709206.

Ecosystem unit	Biodiversity Component (Vegetation community)	Level of forest intactness	Biodiversity Component #	Biodiversity attribute (Ecological Integrity or Canopy cover %)[1]	Total Habitat Loss (ha)
WF13	Tawa rewarewa kamahi forest	Intact primary forest	2.1	70	6.457
	Tawa nikau tree-fern forest	Modified primary forest	2.2	34	8.507
	Miro rewarewa kamahi forest	Intact primary forest	2.3	61	0.536
	Pukatea nikau forest	Intact primary forest	2.4	39	1.347
	Secondary broadleaved forest	Modified secondary forest	2.5	32	2.231
WF14	Hard beech forest and Tawa kamahi rewarewa forest[3]	Intact primary forest	3.1	41	0.813
	Manuka tree-fern rewarewa forest	Modified secondary forest	3.2	15	3.291

1= excluding 'Kahikatea trees' all scores are ecological integrity
2 = Kahikatea swamp maire forest and kahikatea forest have been aggregated to raise the overall ecological integrity score of Kahikatea forest which was assessed as 22% (see previous Offset Calculation report for full justification).
3 = Hard beech forest and Tawa, kamahi, rewarewa forest are the two predominant vegetation communities within WF14. These have been mapped separately but aggregated in the offset calculation as they are physically adjacent and have identical ecological integrity scores.

Benchmark sites and discount rate

181. I selected a benchmark site for each of the three ecosystem types within the Project footprint, based on my knowledge of the area. These sites, and their biodiversity attributes, are shown in **Table 4** below.

Table 4: Benchmark sites selected for input into the Model

Ecosystem type	Benchmark site	Biodiversity attribute (%)	Reason for selection
WF13 (Tawa, kohekohe, rewarewa, hinau, podocarp forest) and WF14 (Kamahi, tawa, podocarp, hard beech forest)	Parininihi	85	While it primarily includes WF13 forest it occupies the transition zone between these two broad forest types and within the management area, small areas of hard beech forest are present. Parininihi is regarded as the best remaining example of this type within the Taranaki Region.
WF8 (Kahikatea, pukatea forest)	Hutiwai Stream	80	Hutiwai Stream is a northern tributary of the Tongaporutu River. Adjacent to the stream is approximately 189ha of terraces containing kahikatea, pukatea forest and associated non-forest wetlands, surrounded entirely by

Ecosystem type	Benchmark site	Biodiversity attribute (%)	Reason for selection
			native forest. The area receives conservation management by DOC, primarily involving regular aerial 1080 operations to control possums and predators. It is regarded as one of the best remaining examples of this type in New Zealand.
Kahikatea trees	Mimi Stream	65	The benchmark site chosen was the kahikatea stand in the northern tributary of the Mimi Stream, for which drone imagery was also available and assessed as 65% canopy cover.

182. As mentioned above, following discussions with Dr Maseyk, I applied a conservative discount rate of 3% for the Project.

Applying the offset model

Offset actions for the Project

183. Two types of offset action are proposed for the Project:

(a) ecosystem and habitat preservation. More specifically, integrated pest management to enhance managed areas of forest to a healthy and functional state - high ecological integrity. This is the offset action for the majority of the affected area, including all of the WF13 and WF14 ecosystem type being offset, and some of the WF8 ecosystem type that is being offset;[49] and

(b) restoration planting in respect of kahikatea forest specifically, which is part of the WF8 ecosystem type being lost through the Project. This second action is being applied because integrated pest management is not expected to result in improvements for this type of habitat, including because there is insufficient suitable kahikatea swamp maire forest habitat to offset what is being lost through pest management.

[49] The definition of ecological integrity is expressed by Lee et al 2005. A review of national and international systems and a proposed framework for future biodiversity monitoring by the Department of Conservation. Landcare Research Contract Report: LC0405/122 as "*A condition that is determined to be characteristic of its natural region, and likely to persist, including abiotic components, and the composition and abundance of native species and biological communities, rates of change, and supporting processes*".

184. As noted above, offsetting is not proposed for all of the vegetation communities within the Project footprint. The approach taken to all the vegetation communities is discussed by Mr MacGibbon in his evidence.

185. A conservative approach was undertaken when forecasting improvements from integrated pest management. Expected improvements over ten years include:

(a) canopy improvement to very near 'normal distributed data' with respect to canopy or foliage cover, resulting from a significant reduction of possum browse of preferred species. Improvements in productivity are also expected resulting in enhanced flowering and fruiting of preferred species, such as kamahi, hinau, rata, miro and tawa.

(b) improvements in regeneration within the ungulate browse tier are expected to be the most significant change from management, with stock exclusion and goat and pig control to very low levels. This is expected to result in rapid recovery of seedlings, saplings and epicormic shoots of preferred species including pikopiko, hangehange, mahoe, kamahi, tawa and pukatea (amongst others). Of significance is that several species including the canopy dominant, tawa, were observed as suffering recruitment failure and it is expected that control will enable seedling regeneration through the browse tier of this species.

186. The expected conservation outcome of the offset for 'ecological integrity' is that integrated pest management will result in habitat and communities that are 'healthy and functioning'. This assumes that all (low) pest control targets are achieved as detailed in the ELMP. Applicable indicators of 'healthy and functioning habitat were informed by Monks et al. (2013) and include:

(a) a measureable increase in common native forest birds, especially functionally important pollinators and seed dispersers such as tui, bellbird and kereru;

(b) an increase of palatable ground ferns, shrubs and seedling trees including pikopiko, hangehange, mahoe, tawa and pukatea in the ungulate browse tier; and

(c) canopy recovery of possum palatable tree species, and increased flower and fruit production of species suppressed by browse.

Offset sites and their measures of condition

187. The core offset site for integrated pest management is located within the Mimi Catchment and occurs predominantly in the Mt Messenger Conservation Area (**Appendix Figure 10**). The site was principally chosen because it is a like for like mosaic of all ecosystems impacted by the Project. Restoration planting of kahikatea forest is planned to occur within the Mangapepeke Valley and if required in the Mimi Catchment. Full details of these sites are included in sections 4.6 & 9 of the ELMP.

188. Ecological integrity scores were determined for integrated pest management, through application of data collected during Recce Plot sampling and walk through surveys including surveying the presence, abundance, condition and demography of indicator species. Forecasting involved similar judgement and application of knowledge of predicted improvements for management sites. Scores are provided in **Appendix; Tables 6 & 7.**

189. For WF8 the Year 0 score of ecological integrity was assessed as 39%. This was based on:

(a) Current state: Largely advanced logged and potentially fire affected (mostly secondary) forest with a few large, typically hollow kahikatea and pukatea. Majority of forest is now largely pole trees estimated to be between 60-80 years old.

(b) Canopy condition: Widespread possum browse on palatable species including swamp maire, some individuals scoring 4 for possum browse of Foliar browse scores (FBI), and scores of 2 and 3 for mahoe and kaikomako.

(c) Understorey condition: Recruitment failure of key canopy species including swamp maire and pukatea, owing to cattle and goat browse. Near absence of palatable ferns and large leaved shrubs in the understorey, except near to Kiwi Road track.

(d) Native dominance: Minimal invasive weed presence in core areas. Occasional African clubmoss and pasture on edges.

190. At Year 10 a 5% improvement of ecological Integrity was applied due to changes in canopy and understorey condition resulting from integrated pest management. Specifically, this included recovery of browsed canopies, enhanced productivity (flowering & fruiting) of species affected by possum

browse, e.g. swamp maire, kamahi & mahoe. Understorey improvements with recovery of palatable ferns and seedlings in browse tier with removal of ungulates.

191. For WF13/14 the Year 0 score of ecological integrity was assessed as 44%. This was based on:

(a) Current state: Largely intact unlogged forest, though some marginal vegetation damage may have occurred with early land clearance fires.

(b) Canopy condition: Widespread possum browse on palatable species including kamahi, thin-barked totara, northern rata, kaikomako and mahoe. Signs of past dieback including dead spars and logs especially on ridgelines indicative of past mortality. Kohekohe is almost extinct, but was common in NZ Forest Survey Plots in 1940's. Palatable trees are in better condition close to Parininihi (SH3) and worse eastwards away from Parininihi treatment boundary.

(c) Understorey condition: Recruitment failure of key canopy species including tawa, kamahi, as well as others like hinau. Widespread ungulate induced understorey modification with ground cover vegetation replacement by unpalatable tree ferns, bush rice grass and hookgrass, with crown fern on ridges. Near absence of palatable ferns and small shrubs in the understorey, except next to Kiwi Road track or steep locations and refugia.

(d) Native dominance: Minor invasive weed abundance of scattered incursions, e.g. pampas in canopy gaps.

192. At Year 10 a 5.25% improvement of ecological Integrity was applied due to 80%+ recovery compared the desired state in terms of canopy condition (e.g. foliar density, canopy spread and net primary production) of existing palatable canopy trees such a tawa, kamahi, thin-barked totara, northern rata and understorey species including mahoe, kaikomako. Major increases productivity of flowers and fruit especially of species heavily browsed by possums (e.g. tawa, kamahi, nikau palm, hinau, northern rata) leading to enhanced recruitment. Understorey Improvements: Obvious recovery of palatable seedlings, saplings and ferns including canopy trees e.g. development of seedling bank of tawa, hinau, kamahi (on raised mounds), miro and sub-canopy shrubs e.g. hangehange, large leaved coprosma shrubs, pate, wineberry and pikopiko in goat browse tier (<2m). Fast growing

palatable species dominating regeneration of recent gaps and in manuka successions on slips. However large areas of unpalatable species remain including swards of bush rice grass, hook-grass and crown fern and groves of tree ferns.

193. An additional area of restoration planting of kahikatea forest has been identified, as integrated pest management is not sufficient to offset the loss of kahikatea trees (Supplementary Biodiversity Offset Calculation Report).

194. For the restoration planting of kahikatea seedlings the change in canopy cover is presented in **Appendix; Table 8**. This forecast is based on planting of all species at 1.3m spacing's with at least 40% (2600/ha) large sized kahikatea (e.g. PB5). Releasing and weed management will occur annually for at least 6 years, though mortality of 10% is expected, reducing the final stocking rate of kahikatea to 30%. At Year 5, mean spread of individual trees was measured at 105cm^2 (Marden & Phillips)[50]. At a 30% stocking density this equates to potentially 17% cover — 6% was used in the calculator to recognise slower growth on impeded and seasonally flooded soils as described by Burns et al. (1999)[51]. Percentage cover at year 35 expected to be 65% based on a minimum of 1600 trees/ha with a canopy spread of at least 2.5m radius or canopy cover of 4.1m^2.

Confidence levels

195. The confidence levels assigned for the integrated pest management in WF13 and WF14 ecosystems are 'very confident' (>90%). This is because integrated pest management in tawa and beech dominant forest has been proven to be highly successful in achieving desired conservation outcomes throughout the North Island. In particular, the adjacent Parininihi Reserve is an exemplar of this approach, where pest management over 25+ years has produced significant positive ecological outcomes.

196. Integrated pest management in the WF8 ecosystem has been assigned a confidence level of 'confident' (>75<90%). The integrated pest management required is a well-known and proven method in achieving conservation outcomes generally and it is expected that pest management will achieve the desired conservation outcomes for WF8. However, a level of conservatism has been applied on the basis that there is limited documented evidence

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[50] Marden & Phillips. Kahikatea (*Dacrycarpus dacrydioides*). http://icm.landcareresearch.co.nz/research/land/documents/Kahikatea.pdf

[51] Burns, B.R., Smale, M.C., & Merrett, M.F. (1999). Dynamics of kahikatea forest remnants in middle North Island: implications for threatened and local plants. Department of Conservation.

available specifically in respect of this ecosystem type, and it is thought that integrated pest management will not significantly enhance the regeneration of kahikatea particularly. The latter issue is addressed through the provision for restoration planting as the offsetting method for kahikatea forest.

197. For restoration planting of WF8 kahikatea forest (including swamp forest), I have also assigned a 'confident' level (>75<90%). Riparian restoration planting is a proven method of restoration and has been carried out successfully throughout New Zealand, including in the Taranaki Region. The climate is warm and humid supporting plant growth throughout much of the year and there is little risk of seedlings dying from drought. However, a level of conservatism has been applied because there is risk in attempting to recreate the variety of vegetation communities suitable for the subtle changes in alluvial landforms, corresponding soil patterns and water tables present. In addition, when seedlings are small, impacts from floods or herbivores such as feral goats could result in plant losses, though these will be replaced and managed for a period of six years.

Modelled outcomes and the required offset

198. The results from the application of the Model show that:[52]

    (a) Applying integrated pest management over an area of 190ha for the targeted WF13 and WF14 communities achieves 'not net loss' within 10 years;

    (b) For the targeted WF8 communities, applying integrated pest management over a 22ha area, together with 6ha of restoration planting specifically targeting kahikatea treeland, achieves no net loss within 10 years.

199. From the point that no net loss is achieved, net gains begin to accrue for all ecosystem types between years 10 – 15. By year 35, significant biodiversity benefits are expected as a result of the Project.

200. Overall, therefore, across the three ecosystem units (WF8, WF13 and WF14), the total offset required for the Project is:

    (a) 230ha of integrated pest management intended to achieve a high level of ecological integrity; and

[52] See Table 2.2 of the Supplementary Biodiversity Offset Report for more detail, and Appendix A of that report for the full workings.

(b) a further 6ha of restoration planting targeting kahikatea, designed to achieve a 65% canopy cover of kahikatea by year 35.

201. The range of discount rates used in the model is from 1 – 4%. As a comparison, the model calculated 198ha, 213.5ha and 247ha for integrated pest management for 1%, 2% and 4% discount rates. Similarly for kahikatea forest restoration, 5.25ha, 5.6ha and 6.5ha area would be required for these same discount rates. The 3% discount is at the conservative end of this spectrum.

202. This core offset area is provided for through the ELMP and described by Mr MacGibbon in his evidence. When vegetation communities were mapped within the proposed offset area, the actual size required to neatly accommodate all ecosystem types within came to 251.4ha. (**Figure 10: Table 5**). To ensure the core area is adequately buffered and accommodate species such as kiwi which require larger managed habitat, integrated pest management has been proposed for the Project of 1085ha.

PART C: RESPONSE TO SUBMISSIONS AND SECTION 42A REPORT ON VEGETATION AND OFFSET CALCULATIONS

203. I respond below to issues with the vegetation and offset calculations raised in submissions on the Project and in the Section 42A Report on the Project.

Submissions - Director General of Conservation ("DOC")

204. DOC's submission includes a section headlined "Terrestrial Vegetation Effects". My discussion with DOC experts has led to some of the submission points being resolved. Others remain unresolved at the time of filing this evidence.

205. DOC acknowledges the extensive field work undertaken to describe and document terrestrial vegetation effects.

206. DOC submitted that that the assessment of vegetation values in the application was lacking the detail on private land in the lower Mangapepeke. Since making the submission, DOC has had the opportunity to view the Ecology Supplementary Report – Vegetation (Singers 2018). I understand that DOC now considers the detail to be adequate for the purposes of assessing values and effects.

207. DOC agrees with respect to the ecological values of vegetation and the effects of the project works on those will be high.

208. Several of DOC's submission points have been discussed and included within the ELMP including:

    (a) African clubmoss will be managed within soil dumps and restoration planting areas.

    (b) Appropriate measures have been included for managing myrtle rust, though these are likely to change with the uncontainable spread of this fungal disease in the future.

    (c) Revegetation is planned to occur as soon as possible and some planting in unaffected sites will occur as soon as plants can be made available.

209. DOC considers that the offset approach for terrestrial vegetation does not recognise that:

    (a) there will be a permanent loss of vegetation associated with the Project footprint. This point has been discussed with DOC and there is now recognition that the offset proposed specifically trades loss of habitat (area) for condition.

(b) some values are not offsettable. This has been recognised with the compensation provided for the 17 significant trees at a ratio of 200 trees for every tree lost. While many of the canopy trees, such as kamahi and tawa have lifespans of 250–400 years, these trees are impacted by animal pests including widespread recruitment failure. For this reason, while it is acknowledged that large trees cannot be replaced, regeneration of seedlings will enable a new cohort of these trees to regenerate throughout much of the 1085ha pest management area.

(c) That no net loss will not be achieved within the stated 10 years. Ten years was the point to determine no-net loss within the biodiversity calculator, using vegetation components only. I consider the model to be a decision support tool, not making the decision per se and it has been useful for this purpose. Recognising the uncertainty around this result, additional mitigation, offsetting and compensation has been provided which is summarised within Mr MacGibbon's evidence.

Public submissions

210. Ian Arms, Dawn Bendall and Sydney Baker submitted that *Dactylanthus taylorii* a nationally vulnerable threatened plant occurs within the area. *Dactylanthus* is a threatened plant which is a root parasite and for this reason is difficult to detect. I am very familiar with *Dactylanthus* and its ecology having coordinated recovery and monitoring projects and previously been a recovery group member and I am one of the authors of the Dactylanthus Recovery Plan (2004–2014). *Dactylanthus* was identified within the broad candidate list of potential threatened plants within the wider Project Area, because it is known approximately 26km north east on the Waitaanga Plateau, though occurs in the Whanganui River catchment. As far as I'm aware it has never been recorded within the Tongaporutu or Mimi Catchments. In my career I have found numerous populations of *Dactylanthus* and during field work at Mt Messenger I was consciously surveying for *Dactylanthus*, especially under suitable host trees. I did not find *Dactylanthus* and do not consider the forest to be very suitable habitat. Further, agents of decline including feral pigs and possums have been present in high population abundances for many decades, so even if *Dactylanthus* had been present, these pests would have resulted large scale population decline and potentially local extinction.

211. Mr Ross Soffee submitted that the Mangapepeke Valley contains significant wetlands. I have surveyed all areas within the Project footprint and wider within the valley. Small freshwater wetlands occur in the valley which are dominated by exotic pasture and wetland plants and in my opinion are not significant wetlands.

Section 42A Reports

212. The New Plymouth District Council Section 42A report raises several points of discussion.

Paragraph 104 – Eastern Alignment, ecological value and condition

213. Parininihi was assessed as having higher ecological value than Option E (the Project) because it has;

(a) A national significant forest sequence from the coast to lowland forest at Mt Messenger.

(b) The Waipingao Stream catchment is entirely indigenous forest and is the only remaining fully indigenous forested catchment in the Taranaki Region and one of the few remaining in the North Island.

(c) Vegetation communities are healthy and functioning with limited (current) impacts by animal pests. Indicator species such as kohekohe, northern rata, thin-barked totara and kamahi widespread, locally numerous and healthy.

(d) This habitat supports a diverse range of fauna, including kokako.

(e) This was described by Singers (April 2017).

214. There is a wide range of evidence for the poor ecological condition (and therefore lower comparative ecological value compared to Parininihi) for vegetation communities east of SH3.

215. My evaluation and conclusion was supported by a variety of information including; the abundance of indicator trees within the wider project area, such as kohekohe and kamahi within National Forest Survey plot data, vegetation maps from the PNA survey (Bayfield et al. 1991), observations of forest collapse made by Professor Bruce Clarkson, data collected during the assessment of ecological effects including comparisons of the abundance of

palatable species and personal observations of animal pests between Parininihi and the eastern forest.

(a) The National Forest Survey measured plots in North Taranaki between 1949 and 1953 within 5 chain (100 yards) x 2 chain (40 yards) plots, recording the emergent, canopy and sub-canopy trees. Two plots within the Mimi Catchment, both within the proposed Pest Management Area, strongly illustrate the local decline of kohekohe, kamahi and northern rata — all vulnerable to possum browse induced mortality (Montague 2000[53]).

(b) In plot 1124290 (NZTM E1740097; 5692247) 25 kohekohe (62.5 trees per ha) and 6 northern rata (15 trees per ha) were recorded. In plot 1124283 (NZTM E1738349; 5692198) 13 kamahi (32.5 trees /ha) were recorded along with 1 northern rata. Tree abundance supports the classification of plot 1124290 as forest type D12, which was formerly common in North Taranaki below 300m a.sl. (Nicholls 1976)[54].

(c) The 1986 North Taranaki vegetation map (**Figure 11**) classified the forest composition around the location of plot 1124290 as Tawa, pukatea, kamahi, rata and did not record kohekohe, despite its previous dominance.

(d) During 9 days of field work in 2017 I only observed two small browsed kohekohe trees near SH3, and 1 sapling within a Recce Plot in the upper Mimi Stream east of SH3. This indicates that there has been a significant decline in abundance of kohekohe from previous a canopy dominant to one of the rarest occurring plants present. Most of this decline likely occurred between 1953 and 1986.

(e) In Mangapepeke and Mimi catchments this map also classified much of the forest was as Tawa/kamahi (T/K) (**Figure 11**). As described in the Assessment of Ecological Effects – Technical Report 7a, much of this forest in the Mangapepeke Catchment was classified as Tawa, nikau, treefern forest and kamahi was specifically noted as being uncommon throughout most of this catchment. Professor Bruce Clarkson recalled that canopy collapse of kamahi occurred in this forest from the mid 1980's onwards.

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[53] Montague, T.L. (2000). The Brushtail Possum: Biology, Impact and Management of an Introduced Marsupial. Maanaki Whenua Press, Lincoln, New Zealand.
[54] Nicholls, J.L (1976). A revised classification of the North Island indigenous forests. *New Zealand Journal of Forestry 28*: 105–132.

(f) Data was collected using the Recce Method to describe vegetation communities and summarise vegetation condition within the Assessment of Ecological Effects – Vegetation 7a and the Supplementary Ecology Report. Recce is a valid method for assessing composition and structure and is especially useful to describe understorey vegetation composition because it samples species presence and assesses abundance within multiple tiers, enabling information to determine if recruitment failure is occurring.

(g) Recce Plot species presence and abundance data from two representative plots is provided, one each from the Mangapepeke and Mimi catchments (**Appendix: Table's 9** & **10**). This data shows that canopy species such as tawa, hinau and pukatea are suffering recruitment failure and are at very low abundance levels below 2m height. In comparison healthy tawa forest has seedling abundances of >1200 seedlings per ha (Blaschke 1988), which equates to one tawa seedling for every 8.3m^2. Sensitive browse indicator species (Monks et al 2013) are even more uncommon in the ground tier, such as large leaved coprosma shrubs, pate and pikopiko (<1%) while unpalatable species such as bush rice grass are abundant. This data is consistent with my general observations for much of the land east of SH3, especially in valley floor areas where goats, cattle and pigs co-occur and their impacts are additive across different species and ecosystem components.

(h) Possum and rat abundance monitoring in the Mangapepeke Stream recorded moderate to high possum abundance – the most recent index was 31.6 +/- 11% (WSP Opus 2018)[55].

(i) Possum damage on indicator species was prevalent east of SH3 and some particular individual trees of sensitive species such as swamp maire and kaikomako were observed as being severely impacted (**Figures 10** & **11**).

216. It is expected that integrated pest control will enable some components of this forest to recover, however this will not result in the return of kamahi and kohekohe, which were former canopy dominants, and recover to similar

[55] WSP Opus (2018). Mt Messenger Baseline Monitoring of Vertebrate Pests: Survey design and Baseline Monitoring (2017/2018).

abundances at Parininihi within 10 years. For these reasons I consider the ecological value of the eastern alignment to be of lower value to Parininihi.

Paragraph 298 – Ecological value of land protected by conservation covenant and on private land

217. The Assessment of Effects Technical Report 7a – Vegetation is transparent and explicit that the Project Area impacts vegetation and habitat of high ecological value some of which is protected by conservation covenant.

218. Mr Pascoe's land comparatively has the lowest ecological values within the Project footprint. Unlike land 'protected' by conservation covenant, Mr Pascoe's land does not meet any of the significance criteria for vegetation within the operative District Plan.

219. Modification from land development, grazing by stock and impacts by animal pest species such as feral goats and pigs has significantly modified the condition of this vegetation. Its current state is a result of this history of use and management.

Paragraph 299 – Lack of quantitative data to assess differences in ecological condition between Parininihi and east of SH3

220. The Assessment of Effects Technical Report 7a – Vegetation and Supplementary Report – Vegetation used a wide variety of data sources to describe vegetation and make an assessment of ecological condition. Much of this is presented in relation to Paragraph 104 (above). In my opinion I would have come to the same conclusions if quantitative monitoring had been specifically undertaken, such as monitoring canopy condition of palatable indicator species such as swamp maire (e.g. using foliar browse index) or quantitative plot based methods to assess recruitment failure of tawa, hinau or pukatea.

Paragraph 300 – Consolidation of ecological effects across disciplines

221. In my opinion the Assessment of Effects reports adequately address effects for all components. The magnitude of affects assessment within the Technical Report 7a Vegetation also recognises effects at a relevant scale of ecosystems affected. In relation to the examples given manuka scrub and manuka treefern areas were searched for lizards (as described by Ecology Technical Report 7d) and none were found. For these reasons these vegetation communities do not trigger significance criteria for within the District

plan for vegetation and evidence gathered suggests similar assessment for fauna.

Paragraph 302 – Significant Trees

222. Identification of significant trees and compensation planting at a 1:200 ratio was proposed as a voluntary measure for the loss of large and notable trees (as described within the Technical Report 7 Assessment of Effects – Vegetation; section 4.3.2 Loss of large emergent or notable trees). This measure was proposed because ecologically large trees play a wide range of critical ecological roles in a forest ecosystem. The definition was further broadened to include; relatively uncommon trees including sub-canopy species such as *Mida salicifolia* and trees having significant habitat value.

223. Compensation was proposed because some of the roles that large trees play such as their structural and functional importance cannot be adequately mitigated for with integrated pest management. The pest management is expected to improve the condition of some (palatable) significant tree species.

224. Planting of 200 trees for every significant tree lost is proposed to ensure these species, especially rimu which accounts for 11 of the 17 trees, remain and over time increase in abundance within the area affected and provide resources (e.g. fruit) for native birds and fauna.

225. To be systematic three criteria were devised for tree selection, which identified 11 qualifying species. The scale that these criteria were considered at was the wider Project Area (**Appendix: Figure 1**).

226. The third criterion for significant trees '*Having significant habitat value for other flora and fauna such as, providing important flowering or fruiting resources, cavities for roost and nests, and supporting large epiphyte communities*' was included to recognise wider ecosystem value. The emphasis of this definition is on <u>significant</u> habitat value.

227. The methodology specified that canopy dominant trees such as tawa, rewarewa and kamahi were not considered as being significant, irrespective of size or other attributes. This decision was made because these species are locally common within the wider Project Area and their loss (and associate resources such as flowers and fruit) at this scale is not considered to be significant.

228. Conditions 25.f.)iii, 25.i)iii and 27.b)iii proposes identification of significant trees be reviewed and include an additional seven species of which six species (tawa, kamahi, rewarewa, nikau, kaikomako, hard beech and kamahi) are locally common in the wider Project Area. For the same reason stated above I consider that nikau, hard beech and kaikomako do not meet the definition of significant trees.

229. The seventh species, kohekohe, does qualify as it is (now) relatively uncommon especially east of SH3, though less so in Parininihi, and should have been included within the original list. It is important to note that while this tree was once locally common in NFS plot data (see above) within the general area, only three individuals were seen east of SH3, none within the Project footprint. This species has been added to the ELMP and if any kohekohe trees are discovered, compensation of 200 trees for every tree lost will occur.

230. Wildlands' review also questions why kahikatea and swamp maire were not compensated for. While kahikatea trees are being lost within the Project footprint, these are relatively small in size and within the wider Project area are locally common especially within the Mimi wetland. Loss of these trees is specifically being off-set for through a combination of integrated pest management and restoration planting of 6ha (as described above, in Mr MacGibbon's evidence and section 4 of the ELMP).

231. The Wildlands review also questions the loss of only one miro tree given a forest type of miro, rewarewa kamahi forest is present. This vegetation community name was used during the vegetation mapping phase during route section, covering much of the wider Project area, including the eastern side of Parininihi where miro is more common on ridges. The community name is less meaningful for the two small areas affected in the Mimi catchment, as miro is less abundant on these specific ridges. The alignment however was shifted to avoid one miro adjoining near the Kiwi Road track (Figure 3.20; within the Technical Report 7 Assessment of Effects – Vegetation).

Paragraph 303 m – High value areas (outside of the Project footprint) in the ELMP

232. High value areas outside of the Project footprint were specifically mapped in the ELMP (Section 4.4.1; Figure 4.1). It is acknowledged that in the assessment of effects, most vegetation in the Mimi Catchment was described as being of high ecological value. The purpose of Figure 4.1 was to specifically highlight areas of high(er) risk of damage to vegetation during

clearance and construction phases, such as downslope of areas to be cleared, and not all high value areas *per.se*.

Paragraph 303 n Threatened or regional distinctive plants including epiphytes

233. Translocation and relocation of any threatened or regionally distinctive plants will occur as described in section 4 of the ELMP, and recommended in condition 27.c). Translocation of kohurangi and *Pittosporum cornifolium* (to my knowledge) have never been attempted into the wild, though both are cultivated in horticultural facilities. While there is every intention to relocate these plants to suitable high-light locations to maximise survival and reproduction, e.g. on ponga or at the top of cut batters, there is uncertainty whether translocation will be successful. For this reason, this action will primarily provide an opportunity to trial translocation and improve knowledge of methodology. Survival of these will be monitored 1 year after planting (Section 4.ELMP), recommended in condition 28.h.

234. Integrated pest management is also expected to benefit these species. Kohurangi is vulnerable to possum browse and *P. cornifolium* is dispersed by birds. During discussion DOC‘s representatives were asked whether monitoring of these species has occurred in association with pest control. The response confirmed that while there is anecdotal evidence that recovery does occur for kohurangi with possum control, no quantitative monitoring has been undertaken. For these reasons, in combination with integrated pest control and translocation of up to 30 individuals of each species, I am confident that these actions will mitigate for the loss of a small number of individuals of these species.

Paragraph 303 o – Mitigation planting in areas of indigenous vegetation

235. The intent of offsetting and mitigation planting is to create contiguous and dense vegetation within the Mangapepeke Valley including within areas mapped as manuka scrub, Pukatea, wheki treefernland and Kahikatea treeland within the valley floor. These vegetation communities have a scattered cover of woody vegetation (as described in the Ecology Technical Report 7a and the Supplementary report – Vegetation). For example, Pukatea, wheki, treefern land, only has a 5-10% cover of woody vegetation. Beneath the sparse tree and scrub cover in all of these communities, the ground cover vegetation is dominated by exotic species such as soft rush and pasture grasses. With exclusion of ungulates and without planting these areas would rapidly become dense rushland inhibiting natural regeneration. Open, non-

forest vegetation is also much more prone to invasion by weeds. Given the abundance of pampas in the wider Project area this potentially would readily invade, while with planting these communities to achieve canopy closure will dramatically reduce this risk and dramatically increase the rate of vegetation recovery.

Paragraph 315 – Consent conditions

236. Methods of offset were explicitly determined to have the largest potential benefit for the widest range of species present, and improve the ecological integrity (health) of the vegetation communities they inhabit. The intensity of management (targeting ungulates, possums, rats, predators (stoats, weasels and cats) and invasive weeds) was deliberate to offset impacts of the development including to species at risk of decline or (local) extinction.

237. Integrated pest management to improve the condition of an area and survival of a number of threatened species, while accepting loss of habitat in an impact area, was a deliberate decision and is considered by the World Bank to be a valid approach to offsetting (Ledec & Johnson 2016).

238. I recognised that integrated pest management would not benefit kahikatea trees within the 22ha WF8, Kahikatea, pukatea offset site. For this explicit reason additional restoration planting of 6ha to offset this loss is proposed, over-and-over integrated pest management within 22ha of WF8, Kahikatea, pukatea swamp forest habitat.

239. While I recognise that the offset calculator is a 'decision support tool', I have applied the model very conservatively. The model calculated that no net loss would be achieved at Year 10 and net gain by Year 15 within 230ha. The ELMP has greatly extended the size of the habitat protected to 1085ha. For this reason I consider that replacement of indigenous vegetation on an area basis (31.676ha or greater) and planting 'like for like' (as proposed in 25.f.)i, 25.f.)ii, 25.i)ii) is not required to achieve no net loss.

ELMP Conditions

240. Council proposed condition 25.b): A quantitative assessment of forest condition and tree health has not been undertaken within either the core offset area or Pest Management Area. It is my opinion (described above) that there is sufficient evidence that, excluding some vegetation immediately adjoining SH3, most of the area east of SH3 is pest modified and in a poorer condition than Parininihi.

241. Council proposed conditions 28.a) and 28.b): The ELMP will undertake monitoring to measure the change in the condition of vegetation both prior to and post construction (Section 9.5). This monitoring will occur before pest control, such as of ungulates to ensure any changes, measure the difference made by management. The ELMP lists appropriate indicator species for both the understorey and canopy components, provides performance measures for these. This monitoring is fundamental to measuring the success of integrated pest management and the offset calculated.

Nicholas J. D. Singers

25 May 2018

Appendix

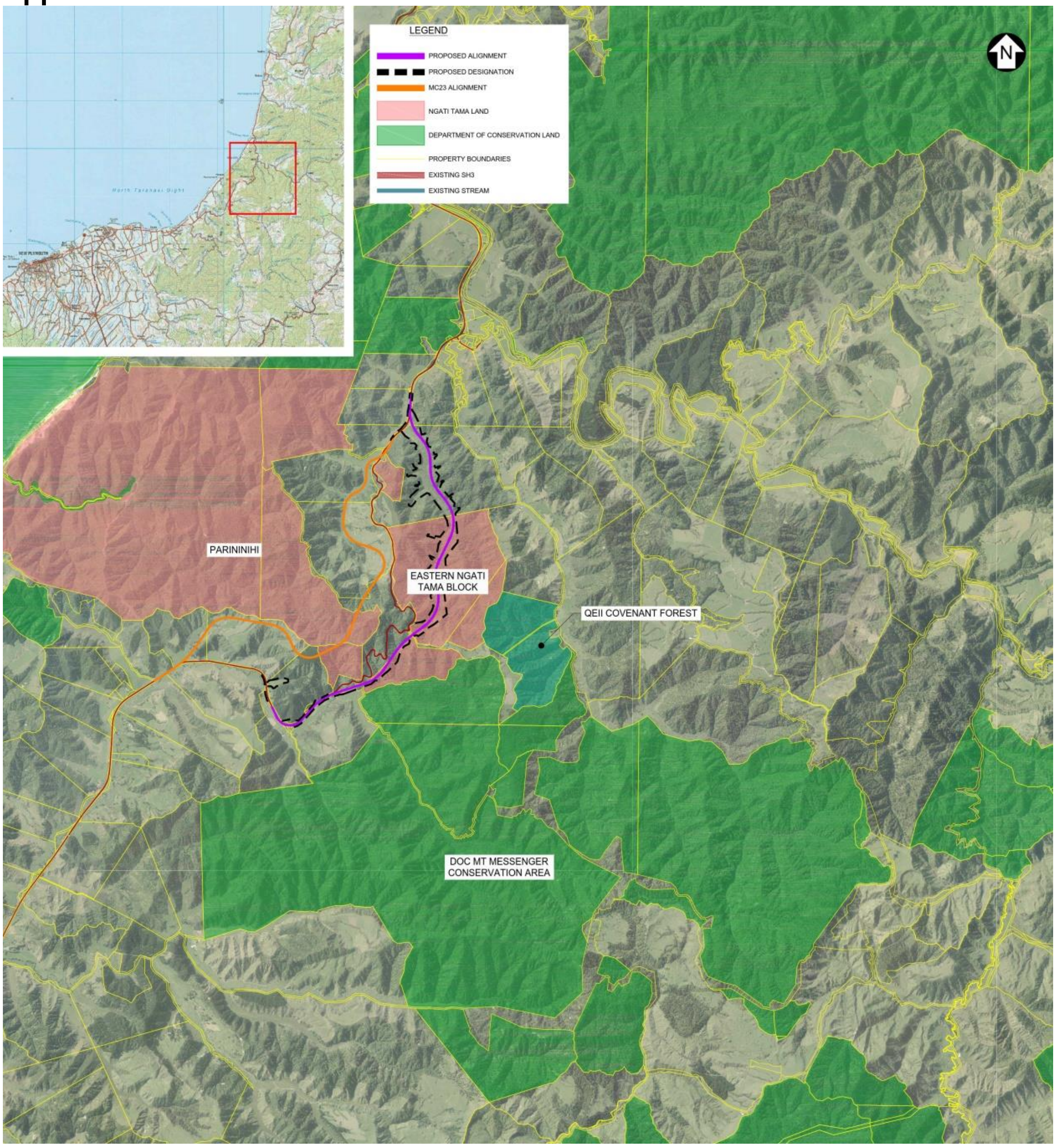

Figure 1: The wider Project area, showing Parininihi, Eastern Ngāti Tama forest block to the east, including areas of DOC and private land to the southeast and the Project footprint and and the initially proposed MC23 alignment to the west of the existing SH3

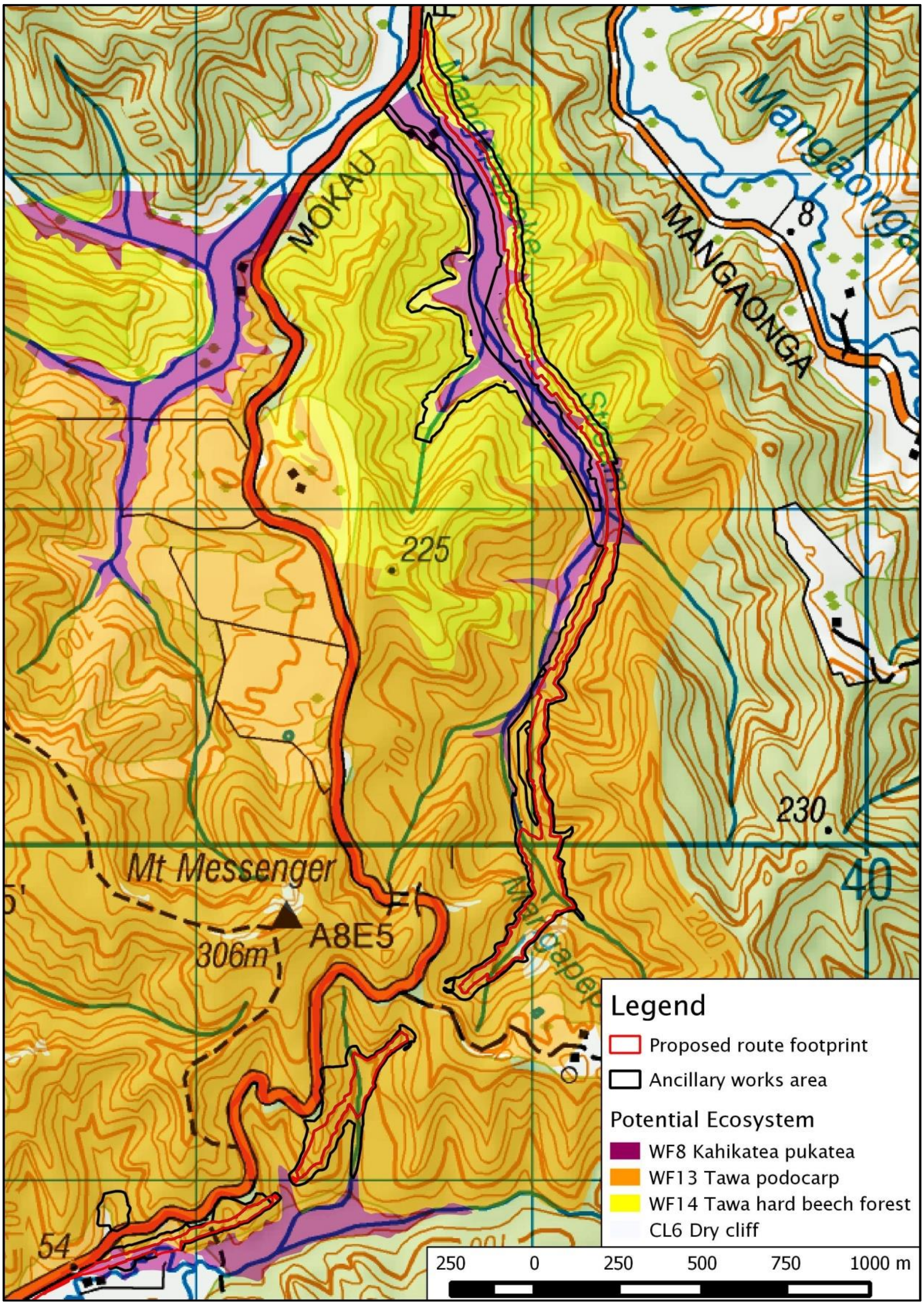

Figure 2: Project footprint, Additional (Ancillary) Works Area and potential ecosystems

Figure 6: Mimi catchment kahikatea (erect conifer shaped trees) and swamp maire (rounded, khaki trees) forest, taken from the edge of SH3 (NZTM 1737747; 5692806)

Figure 7: Mangapepeke pole kahikatea forest situated on the Project footprint (NZTM 1739228; 5694961)

Figure 8: Kahikatea treeland in the Mangapepeke Valley consists of kahikatea (erect conifer shaped trees) and scattered manuka (rounded shrubs) and exotic rushland (foreground), taken on the property margin of Ngāti Tama and private land (approximately NZTM 1739219; 5615107)

Figure 9: Pukatea tree fernland in the Mangapepeke Valley (NZTM 1739049; 5694595)

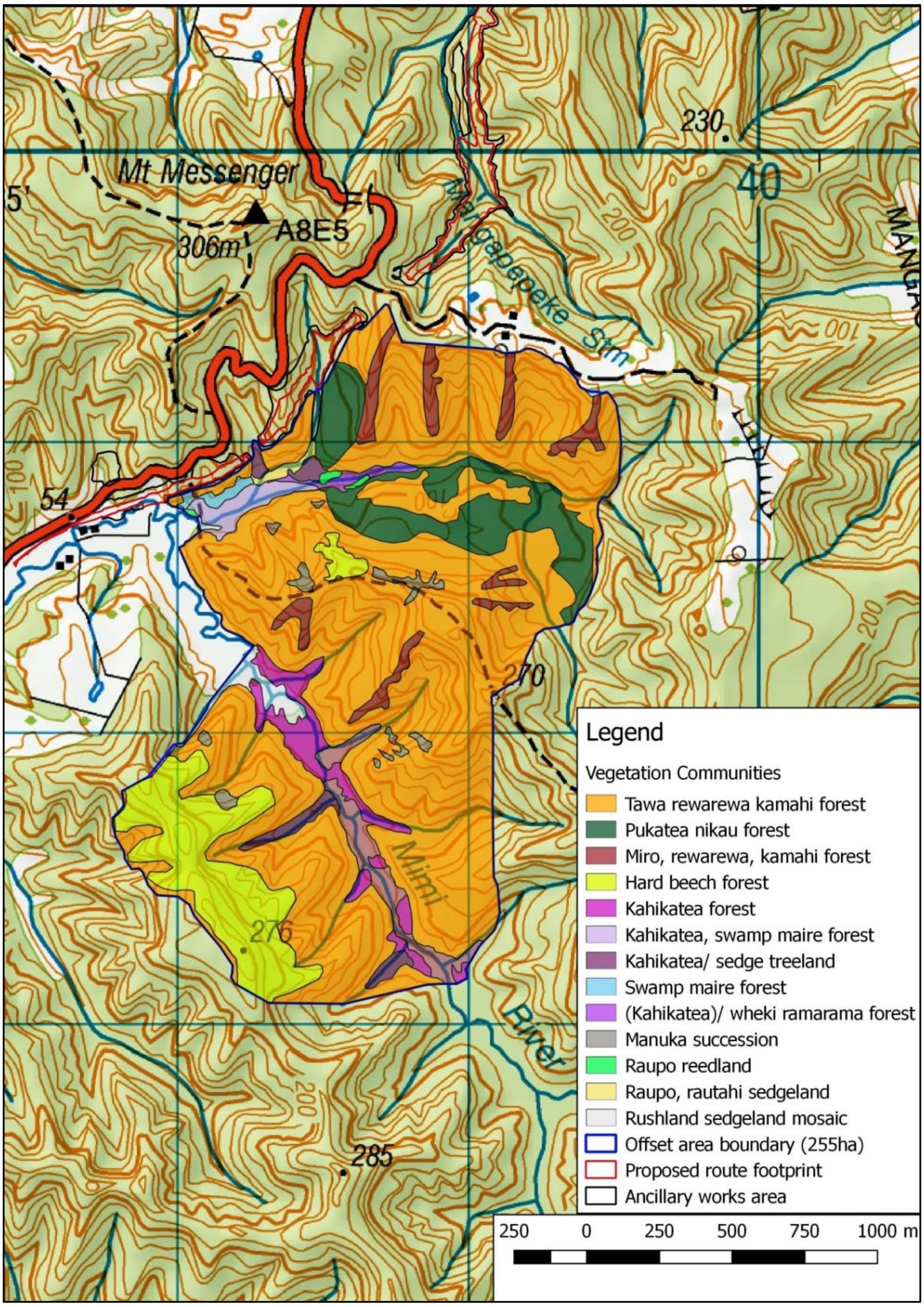

Figure 10: Vegetation communities present within the proposed physical offset site.

Table 5: Comparison of offset amount (ha) calculated by the model and amount present in the physical offset site (251.422ha). Components have been grouped within best fit for 'like for like'. Modified primary and secondary communities are shown in italics.

Offset amount calculated by the Model			**Amount present in offset area (255ha)**		
Biodiversity type	Biodiversity component	Required area of offset (ha)	Actual area of offset	Biodiversity component	Biodiversity type
WF8: Kahikatea, pukatea forest	Kahikatea, swamp maire forest & Kahikatea forest	15	15.490 (+0.490)	Kahikatea, swamp maire forest, Kahikatea forest, Swamp maire forest & Kahikatea/ sedge treeland	WF8: Kahikatea, pukatea forest
	Kahikatea/ exotic rushland treeland, *Pukatea treefern treeland & manuka scrub*	7	7.085 (+0.085)	*Kahikatea/ wheki ramarama forest & Wheki ramarama treefernland*	
	Nil	0	1.177 (+1.177)	Raupo, rautahi sedgeland (contains hukihuki) & Raupo reedland	
	Sub-total	**22**	**23.751 (+1.751)**	**Sub-total**	
WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest	Tawa rewarewa kamahi forest, Miro, rewarewa kamahi forest, Pukatea nikau forest, *Tawa, nikau, treefern forest & Secondary broadleaved forest*	190	200.241 **(+10.241)**	Tawa rewarewa kamahi forest, Miro, rewarewa kamahi forest, Pukatea nikau forest	WF13: Tawa kohekohe, rewarewa, hinau, podocarp forest
	Manuka succession	0	2.590	*Manuka succession*	
WF14: Kamahi, tawa, podocarp, hard beech	Hard beech forest, Tawa rewarewa kamahi forest & *Manuka, treefern, rewarewa forest*	18	24.840 **(+6.840)**	Hard beech forest	WF14: Kamahi, tawa, podocarp, hard beech forest

forest					
	Total	**230**	**251.422**	**Total**	

Table 6: Ecological integrity scores for WF8: Kahikatea, pukatea forest at the Mimi offset site

Year	Current condition	Canopy condition	Understorey condition	Native dominance	Raw EI	% EI used in model	% improvement since year 0
0	0.85	0.8	0.6	0.95	0.3876	39	
1	0.85	0.81	0.605	0.95	0.3957	39.5	0.5
5	0.85	0.82	0.62	0.95	0.4105	41	2
10	**0.85**	**0.84**	**0.65**	**0.95**	**0.4408**	**44**	**5**
15	0.85	0.85	0.68	0.95	0.4667	47	8
20	0.85	0.87	0.71	0.95	0.4987	50	11
25	0.85	0.87	0.75	0.95	0.5268	53	14
30	0.85	0.88	0.79	0.95	0.5613	56	17
35	0.86	0.88	0.8	0.96	0.5812	58	19
Bench mark site							
Hutiwai Stream	0.95	0.95	0.9	0.98	0.796005	80	

Table7: Ecological integrity scores for WF13: Tawa kohekohe hinau podocarp forest and WF14: Kamahi tawa podocarp hard beech forest at the Mimi offset site.

Year	Current condition	Canopy condition	Understorey condition	Native dominance	Raw EI	% EI used in calculator	% improvement since year 0
0	0.95	0.8	0.6	0.96	0.4377	44	
1	0.95	0.81	0.605	0.96	0.4469	44.5	0.5
5	0.95	0.825	0.62	0.96	0.4664	46.5	2.5
10	**0.95**	**0.84**	**0.655**	**0.96**	**0.5056**	**50.25**	**5.25**
15	0.95	0.86	0.7	0.96	0.5490	55	9
20	0.95	0.87	0.8	0.96	0.6347	63	19
25	0.955	0.88	0.87	0.96	0.7019	70	26
30	0.96	0.9	0.915	0.96	0.7505	75	31
35	0.96	0.9	0.92	0.97	0.7710	77	33

Bench mark site							
Parininihi	0.95	0.95	0.95	0.99	0.848801	85	

Table 8: Kahikatea trees, predicted change in percentage cover over 35 years

Year	Kahikatea % cover
0	0
1	2
5	6
10	16
15	26
20	37.5
25	50
30	60
35	65

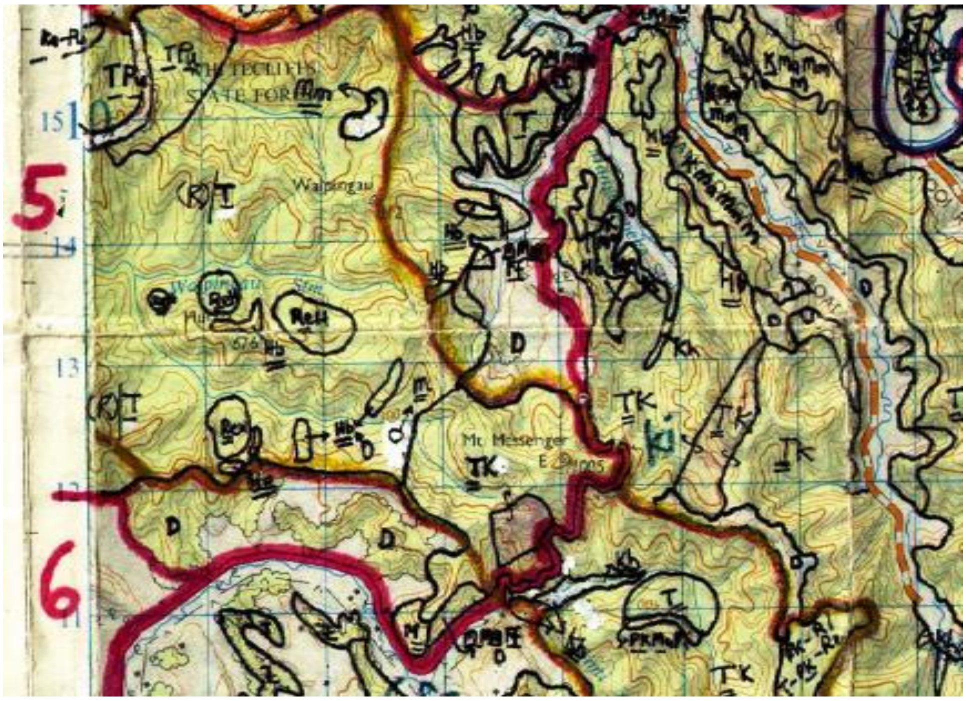

Figure 11: Scanned copy of the original vegetation map produced during the North Taranaki PNA Survey (Bayfield 1991) covering much of the wider Project. T= tawa, K= kamahi

Table 9: Representative species abundance in Recce Plot East of SH3
Cover classes 1=<1%, 2=1-5%,3=6-25%, 4=26-50%, 5=51-75%, 6=76-100%

Mangapepeke Catchment: Tawa – Pukatea Forest (NZTM E1738930; 5694230)					
Species	Tier 2 (12–25m)	Tier 3 (5–12m)	Tier 4 (2–5m)	Tier 5 (0.3–2m)	Tier 6 (<0.3m)
Canopy & sub-canopy tiers					
Pukatea	4	3	3	-	-
Tawa	4	-	-	-	-
Hinau	3	-	-	-	-
Rewarewa	3	-	-	-	-
Mahoe		4	-	-	-
Nikau palm		5	5	2	2
Katote		3	1	1	1
Pigeonwood		3	-	-	1
Wheki		2	1	-	-
Putaputaweta		2	-	-	-
Kaikomako		2	-	-	-
Quintinia		1	-	-	-
Understorey and ground cover tiers					
*Inkweed				1	-
Diplazium australe				2	
Pteris macilenta				2	
Bush rice grass					2
Kiwakiwa (*Blechnum fluviatile*)					2
Thread fern (*B. filiforme*)					2
Hook grass (Uncinia spp.)					2
Ground cover species <%					STEgra, MICsti, BLEcol, LEPhym, ASPbul, SCHdig, BLEcha, ELArug, MICsca, STEmed
Pertinent comments: Browse is severe including cattle, goat and pigs. Understorey is very open and closely cropped with numerous animal tracks present. Canopy gaps failing to recruit into trees, being replaced by unpalatables inc. hook grass, bush rice grass, inweed and katote (treefern)					

Table 10: Representative species abundance in Recce Plot East of SH3 in Offset site
Cover classes 1=<1%, 2=1-5%,3=6-25%, 4=26-50%, 5=51-75%, 6=76-100%

Mimi Catchment: Pukatea (kahikatea) riparian forest (NZTM E1738930; 5694230)					
Species	Tier 2 (12–25m)	Tier 3 (5–12m)	Tier 4 (2–5m)	Tier 5 (0.3–2m)	Tier 6 (<0.3m)
Canopy & sub-canopy tiers					
Pukatea	2	2	-	-	<2
Kahikatea		3	1	-	-
Rimu			1	-	-
Kaikomako		4	2	-	-
Mahoe		2	2	-	1
Ramarama		4	2	1	1
Putaputaweta			2	-	-
Wheki		4	3	1	-
Kiekie			2	-	-
Hukihuki			2	1	1
Katote		2	3	1	-
Cyathea cunninghamii			1	-	-
Hoheria populnea			1	-	-
Lancewood			1	-	-
Koromiko (stream edges)				2	-
Understorey and ground cover tiers					
Bush rice grass					6
Kiwakiwa (*Blechnum fluviatile*)					1
Thread fern (*B. filiforme*)					1
Hook grass (Uncinia spp.)					2
Ground cover species <1%					HYPamb, ASPbul
Pertinent comments: Severe browse. Almost no understorey shrubs and very limited fern cover. Trespassing cattle present and numerous feral goats. Pig rooting also present. Ground cover almost dominated by bush rice grass up to 80%. Abundant small pukatea seedlings (< 15cm) but none present above this height. Possum browse common on most mahoe and some kaikomako (FBI browse scores typically moderate to heavy (25-75% of canopy). Some individuals severe of possum browse of 4 (75-100% of canopy).					

Figure 12: Severely browsed swamp maire tree in the Mimi wetland near Kiwi Road track. Note the lack of foliage and chewed stems. Swamp maire is highly palatable to possum browse.

Figure 13: Severe browse on kaikomako

Table 11: Common and scientific names of plants mentioned in the evidence

Common Name	Scientific Name
*African clubmoss	*Selaginella kraussiana*
Coromandel tree daisy	*Olearia townsonii*
hangehange	*Geniostoma ligustrifolium* var. *ligustrifolium*
hard beech	*Fuscospora truncata*
hebe	*Veronica townsonii*
hinau	*Elaeocarpus dentatus* var. *dentatus*
Houhere	*Hoheria sexstylosa*
kahikatea	*Dacrycarpus dacrydioides*
kaikomako	*Pennantia corymbosa*
kamahi	*Weinmannia racemosa*
kanono	*Coprosma grandifolia*
kanuka	*Kunzea robusta*
karamu	*Coprosma robusta*
kauri grass	*Astelia trinervia*
king fern	*Ptisana salicina*
Kirk's kohuhu	*Pittosporum kirkii*
kohekohe	*Dysoxylum spectabile*
kohurangi	*Brachyglottis kirkii* var. *kirkii*
katote	*Cyathea smithii*
mahoe	*Melicytus ramiflorus*
manuka	*Leptospermum scoparium* var. *scoparium*
matai	*Prumnopitys taxifolia*
miro	*Prumnopitys ferruginea*
napuka	*Veronica speciosa*
native broom	*Carmichaelia australis*
nikau	*Rhopalostylis sapida*
northern rata	*Metrosideros robusta*
*pampas grass	*Cortaderia selloana*, *C. jubata*
pigeonwood	*Hedycarya arborea*
pikopiko	*Asplenium bulbiferum*
pua-o-te-ringa	*Dactylanthus taylorii*
pukatea	*Laurelia novae-zelandiae*
rewarewa	*Knightia excelsa*
rimu	*Dacrydium cupressinum*
shining karamu	*Coprosma lucida*
snowberry	*Gaultheria oppositifolia*
snowberry	*Gaultheria paniculata*
*Spanish heath	*Erica lusitanica*
swamp maire	*Syzygium maire*
tawa	*Beilschmiedia tawa*
tawhirikaro	*Pittosporum cornifolium*
thin-barked totara	*Podocarpus laetus*
toropapa	*Alseuosmia macrophylla*
totara	*Podocarpus totara* var. *totara*
wharariki	*Phormium cookianum* subsp.

	hookeri
wheki	*Dicksonia squarrosa*
	Brachyglottis turneri
	Pseudopanax laetus
Large-leaved coprosma's	*Includes C. grandifolia, C. lucida & C.robusta*