BEFORE THE TARANAKI REGIONAL COUNCIL AND NEW PLYMOUTH DISTRICT COUNCIL

MT MESSENGER BYPASS PROJECT

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

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STATEMENT OF EVIDENCE OF KEITH DAVID HAMILL (FRESHWATER ECOLOGY) ON BEHALF OF THE NZ TRANSPORT AGENCY

25 May 2018

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QUALIFICATIONS AND EXPERIENCE

1. My full name is Keith David Hamill. I am an Environmental Scientist and Director at River Lake Limited. River Lake Limited is a consultancy that provides research and environmental science advice for understanding and managing rivers, lakes and estuaries. My technical speciality is in water quality and aquatic ecology.

2. I hold a Bachelor of Science degree (Geography) from the University of Auckland (1992) and a Master of Science (1st Class Hons) in Ecology and Resource & Environmental Planning from the University of Waikato (1995).

3. I have 23 years' experience in the area of resource management and environmental science. I have previously worked as a Principal Environmental Scientist at Opus International Consultants Limited, in the United Kingdom as a Senior Environmental Scientist for a consultancy called WRc, and as an Environmental Scientist at Southland Regional Council for six years.

4. My role in the SH3 Mt Messenger Bypass Project (referred to as the Project) has been assessing the potential effects of the Project on freshwater ecology and recommending measures to address those effects.

5. 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

6. The Mt Messenger area has high quality habitat for indigenous terrestrial and aquatic flora and fauna. The geology is dominated by papa mudstone; this has a considerable influence on stream substrate and sediment levels.

7. The Project footprint extends up the Mangapepeke Stream (east branch) and into the Mimi River catchment. The headwaters of the catchments are predominantly covered in indigenous forest but the valleys through which the streams meander is mainly pasture and grazed wetland.

8. Both catchments have a high diversity of fish, with Fish IBI scores indicating ‘excellent’ diversity in lowland sections and ‘good’ diversity in steeper sections. Fish caught included: inanga, longfin eel, giant kōkopu, banded kōkopu, redfin bully, common bully, kōura and kākahi.

9. The potential effects of the Project on streams include:

   (a) sedimentation from earthworks;

   (b) direct removal of fish from streams;

(c) restricting fish passage through culverts,

(d) loss of stream habitat and functions; and

(e) potential effects of road stormwater on stream hydrology and water quality.

10. The potential effects on streams during the construction period can be minimised and mitigated by implementing good practice with respect to erosion and sediment control, fish recovery, vegetation clearance, water takes and undertaking monitoring during the construction period. Similarly, many of the long-term effects from the road footprint can be minimised and mitigated by good culvert design to ensure fish passage, stormwater management, and design of stream diversions.

11. Nevertheless, the piping and diversion of streams required by the Project will affect 3,822m (3,361m^2) of stream and cause, after mitigation, considerable loss of stream values; this residual effect will be addressed by implementing offset compensation.

12. The Stream Ecological Valuation (SEV) method was used calculate the amount of offset required for the loss of stream habitat. To achieve 'no net loss' restoration work will be required along 8,627m or 8,157m^2 of stream habitat.

13. Overall, the effects of the Project on freshwater ecology can be appropriately managed and mitigated. The residual loss of stream habitat will be offset by the mitigation package to ensure 'no net loss' of stream values and probably provide a net gain in the medium to long term.

BACKGROUND AND ROLE

14. The New Zealand Transport Agency ("**Transport Agency**") has 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 (referred to as the Project).

15. I undertook initial investigations of alternative route options in February 2017 (reported in Hamill 2017a). I contributed to ranking the potential effects of different route options, undertook fieldwork to inform the assessment of effects of the chosen route. I led field investigations during June and August 2017 and prepared the Assessment of Ecological Effects – Freshwater Ecology included as Technical Report 7b, Volume 3 to the Assessment of Environmental Effects ("**AEE**") for the Project (Hamill 2017b). I led supplementary field surveys during October/ November 2017 and prepared the Mt Messenger Bypass Project Ecology Supplementary Report (Hamill 2018) to report the results and update the tables from the AEE.

16. I have had input into the draft Ecology and Landscape Management Plan ("**ELMP**") prepared for the Project, particularly as it relates to freshwater ecology. As part of this I prepared the Fish Rescue and Recovery Protocols (Appendix D of the ELMP) and the Ecological Design Principles (section 7 of Landscape and Environmental Design Framework (LEDF)) to inform the detailed design of stream diversions.

17. In addition, I have also participated in several meetings with experts from Wildlands and Department of Conservation ("**DoC**") to discuss the Project.

SCOPE OF EVIDENCE

18. The purpose of my evidence is to outline the potential effects construction and operation of the Project would have on freshwater ecology values. 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 on freshwater ecology with those measures in place.

19. My evidence addresses:

    (a) an overview of the existing freshwater ecology values of the Project area;

    (b) the methodology I followed in identifying the freshwater ecology values of the Project area and the effects the Project could potentially have on those values;

    (c) the results of my investigations into the freshwater ecology values and potential effects of the Project;

    (d) my assessment of the effects of the Project on freshwater ecology values, including by reference to the proposed measures to mitigate, offset, and monitor effects; and

    (e) responses to submissions and the section 42A report.

THE EXISTING FRESHWATER ECOLOGY VALUES OF THE PROJECT AREA

20. The Mt Messenger area contains high quality habitat for indigenous terrestrial and aquatic flora and fauna. The geology is dominated by papa mudstone; this has a considerable influence on stream substrate, the gravels are soft enough to be crushed by hand and fine sediment is prevalent in most streams.

21. The proposed route spans two hydrological catchments (see Figure 1 below):

    (a) the Tongaporutu River to the north (of which the Mangapepeke Stream is a tributary); and

    (b) the Mimi River to the south.

22. A brief description of each catchment is below.

Mangapepeke Stream

23. The Mangapepeke Stream drains north-west to the Mangaongaonga Stream and the Tongaporutu River, which enters the coast at Tongaporutu, about 9km north of the Project footprint. The lower section of the Mangapepeke Stream (near the current SH3) is a small low gradient stream about 1.4m wide and 0.4m deep in runs with occasional deep pools.

24. The catchment is predominantly covered in indigenous forest, but the valley through which the stream meanders is mainly pasture and grazed wetland. More wetland vegetation remains where the ground is poorly drained.

25. In places near the current SH3 the stream has been straightened, but the stream meanders through most of the Mangapepeke Valley. The substrate is silt with occasional wood becoming more common further up the catchment. Aquatic macrophytes common in the stream included watercress (*Nasturtium officinale*), starwort (*Callitriche stagnalis*) and native charophyte (stonewort) (*Chara* sp). The streams in the valley have high potential to be enhanced by removing stock and riparian planting.

26. A remnant of degraded kahikatea (*Dacrycarpus dacrydioides*) swamp forest is present on the true right of the Mangapepeke Valley near site Ea10.[1] The swamp forest condition has been degraded by stock grazing, nevertheless the stream through this small section has maintained much of its original complex morphology, being relatively narrow and deep with tree roots stabilising the stream banks and forming pools, undercuts and small cascades.

27. The upper reaches of the Mangapepeke Stream and most tributaries entering from the valley sides typically have a steep gradient, cascade-pool morphology and indigenous forest cover. The sections with dense forest cover are wider and shallower (about 2.5m wide and 0.25m deep at site E5 as shown on Figure 1) and have deep pools downstream of cascades and log jams. Waterfalls are common (eg sites Ea14, Ea15, and E5). Further up, the main valley becomes very narrow (about 1.5 to 2.5m wide at the base) and is confined with steep sides (ie sites Ea16 and Ea17).

Mimi River

28. The Mimi River flows south-west to enter the coast between Waiiti and Urenui, about 21km south-west of the Project footprint. The lower section near the current SH3 is a low gradient stream about 2.1m wide and 0.45m deep in runs with occasional deep pools.

29. The catchment is predominantly covered in indigenous forest but the valley through which the main stream meanders is mainly exotic pasture and grazed wetland (sites E7, Ea27 and Ea28 on **Figure 1**). The aquatic macrophytes *Potamogeton* sp. and the aquatic weed *Elodea canadensis* are present in the

[1] See below for a discussion of the survey sites. These sites are shown on the maps at Figures 1 – 3.

lower reaches. The streams in the valley have high potential to be enhanced by excluding stock and riparian planting.

30. Downstream of the southern tunnel portal, there is a raupo (*Typha orientalis*) reedland and rautahi (*Carex geminata*) swamp (referred to as raupo swamp). Adjacent to this is a kahikatea swamp-maire swamp-forest (referred to here as the kahikatea swamp forest). This kahikatea swamp forest has high ecological value because it is hydrologically intact and only a very small percentage of the original area of this forest type remains in the region. It offers high quality habitat.[2] The stream through this section is narrow (about 1.1m) and deep (1m) with a complex morphology.

[2] See the evidence of **Mr Singers** for a more detailed description of the kahikatea swamp forest.

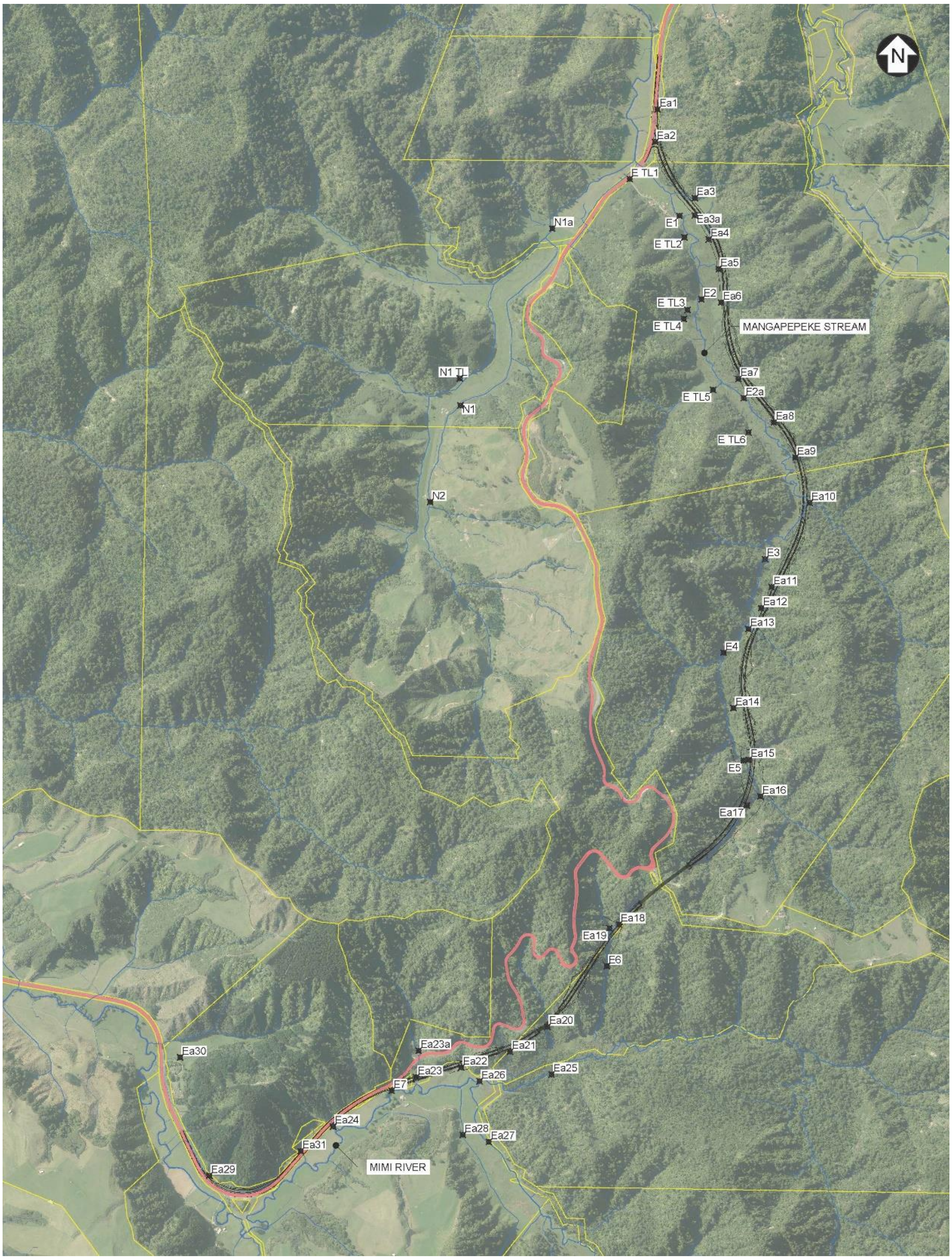

Figure 1: Overview of waterways and freshwater ecology survey sites in the vicinity of the Project

INVESTIGATION METHODOLOGY

31. Stream surveys were undertaken across the Project footprint to assess habitat quality, fish and aquatic macroinvertebrates. The Stream Ecological Valuation ("**SEV**") method was used for the surveys and to calculate the extent of offset restoration work to achieve-no-net loss of aquatic ecosystem values when combined with other mitigation.

Stream surveys

32. Surveys of streams within the Project area were undertaken during:

(a) 6 - 9 June 2017;

(b) 31 July – 1 August 2017; and

(c) 30 October 2017 to 1 November 2017.

33. All waterways affected by the Project were visited at least once and basic morphology and habitat measurements collected.

34. In addition, more comprehensive ecological surveys were undertaken at selected sites addressing the following:

(a) stream habitat;

(b) fish surveys;

(c) aquatic macroinvertebrate survey; and

(d) an SEV method assessment.

35. Sites were selected for more intensive survey based on their representativeness and length effected by the Project. Stream surveys and SEV assessments were also undertaken at a number of sites not directly affected by the Project but with potential to be restored as part of an offset package (discussed at paragraph 37 below). The survey sites are described in **Table 1** and shown in **Figures 1 - 3**.

36. The detailed assessment methodology is described in the freshwater ecology assessment report and supplementary report (Hamill 2017b, Hamill 2018). By way of brief summary:

(a) 48 stream sites were surveyed, including three unaffected by the Project but with potential for restoration. Measurements were made of stream width, water depth (mid-channel), macrophyte cover and riparian vegetation type;

(b) habitat assessments were carried out at 21 sites using the national rapid habitat assessment protocol for streams and rivers (Clapcott 2015);

(c) SEV assessments were undertaken at 14 sites using methods described in Storey et al. (2011);

(d) aquatic macroinvertebrate samples were collected at 14 sites;[3]

[3] Using a kick net and following Protocol C1 (Hard bottom stream) or Protocol C2 (soft bottom stream) in Stark et al. (2001), as appropriate to the stream

(e) fish surveys were undertaken at 16 sites. A range of methods was used to suit the stream conditions, including electro-fishing, fine-mesh fyke nets, gee-minnow traps and spot lighting.[4]

37. Additional SEV assessments, fish surveys and macroinvertebrate surveys were done during February 2017 in the west branch of the Mangapepeke Stream and western tributaries to the Mimi River (Hamill 2017).[5] These sites are not affected by the Project but provide contextual information about the ecology of the streams and some of the sites may have potential to be restored as part of offset mitigation.

Assessment of effects scoring

38. The assessment of ecological effects follows the Ecological Impact Assessment guidelines ("**EcIA**") (EIANZ 2015). This approach provides a consistent and transparent assessment of effects. It provides structure but does not replace the need for sound ecological judgement. In simple terms, the EcIA uses a matrix to assess the overall level of effects of an activity based on the Ecological Values of the site affected and the Magnitude of Effect.

39. The assessment was applied to Project activities both without mitigation and with mitigation. The 'with mitigation' assessment did not include any biodiversity offsets. See Hamill (2017b) for a more detailed description of how this approach was applied.

Stream Ecological Valuation (SEV) assessments

40. The SEV is a comprehensive method for assessing stream values and quantifying loss and any requirements for offset compensation. It has been widely used in New Zealand. The assessment incorporates a broad range of stream functions including hydraulic, biogeochemical, habitat and native biodiversity; the scores for these functions are integrated into the final SEV score. Scores can range from 0 to 1, with higher scores indicating better values.

Calculating an Ecological Compensation Ratio (ECR)

41. An Environmental Compensation Ratio ("**ECR**") was calculated for each section of stream affected by stream diversions or culverts. The ECR determines the amount of another stream reach that would need to be restored relative to the amount of stream degraded or lost, in order to achieve no-net-loss of stream ecological function.

[4] The survey methods followed protocols in Joy et al. (2013). Some sites were surveyed twice, i.e. sites E4, E5, and E6.

[5] Not included in the site numbers referred to above, or shown on Figures 1 - 3.

42. The ECR was calculated using SEV scores and the formula in Storey et al. (2011).[6] ECR is a ratio of the loss of potential habitat values (measured using SEV scores) at an impact site, divided by the estimated gain in habitat values from restoration at an offset site, and is multiplied by 1.5. The formula uses the potential SEV score of a site rather than actual SEV score in order to account for potential improvements that are forgone by culverting a stream. The multiplier of 1.5 accounts for risks and time lags in achieving restoration outcomes at offset sites.

43. A potential SEV score was estimated for all affected sites where it was needed to calculate an ECR, including sites where an SEV survey was not undertaken. The potential SEV score was based on SEV scores at nearby reference sites and tested against a hypothetical restoration scenario.

ECR for stream diversions and short-term works

44. The ECR equation was not designed for stream diversions where the final stream values will be similar or better than the current stream values. Some assumptions embedded in the ECR equation do not apply to stream diversions; for example, unlike a piped stream, a stream diversion does not lose the potential for future restoration work to occur.

45. For stream diversions and short-term works, where the final stream condition will be similar to before the works, a standard ECR value of 0.5 was used, instead of applying the ECR equation. This means that what is required to address effects on these sections of stream is restoration of the stream diversion section plus offset compensation amounting to an additional 50% of the stream diversion length/area. This is conservative for streams being diverted with low current SEV scores because the new channel will rapidly achieve its current condition or better.

Site Ea10 (kahikatea wetland)

46. The SEV is a tool and expert judgement is also needed in any final decision about appropriate mitigation and offsets. With that in mind, I applied my judgement to double the ECR values for site Ea10. That is because the stream morphology through this section has maintained the complex character of a kahikatea wetland and is challenging to recreate in a stream restoration until the floodplain forest has matured.

[6] ECR = [(SEVi-P – SEVi-I)/(SEVm-P – SEVm-C)] x 1.5.
Where: SEVi-P are the current and potential SEV values respectively for the site to be impacted. SEVi-I is the predicted SEV value of the stream to be impacted, after impact. SEVm-C & SEVm-P are the current and potential SEV values respectively for the site where offset restoration is occurring.

Calculating Offset requirements

47. The goal of biodiversity offsets is to achieve no-net-loss and preferably a net gain of biodiversity on the ground. This is aligned with the Project aim for freshwater ecology values.

48. The length of stream requiring restoration in order to achieve this aim was calculated by multiplying the length of stream section being piped or diverted during the Project by its ECR. This was then multiplied by the average stream width and expressed as stream area to ensure 'no net loss' of overall habitat.[7] The average width of stream lengths being affected by the Project was approximately 0.88m so in practice there was little difference between offset calculations expressed as length as compared to area.

49. When calculating requirements for stream offsets I assumed that the area that will be used for the purpose of restoration would be in the upper Mangapepeke Stream and Mimi River catchments, contiguous with existing native forest. Evidence presented by Mr MacGibbon confirms that this will be the case, and that informal landowner agreements are already in place for the Mangapepeke Stream valley (east branch) and the upper Mimi River.

[7] Consistent with the method in Storey et al. (2011).

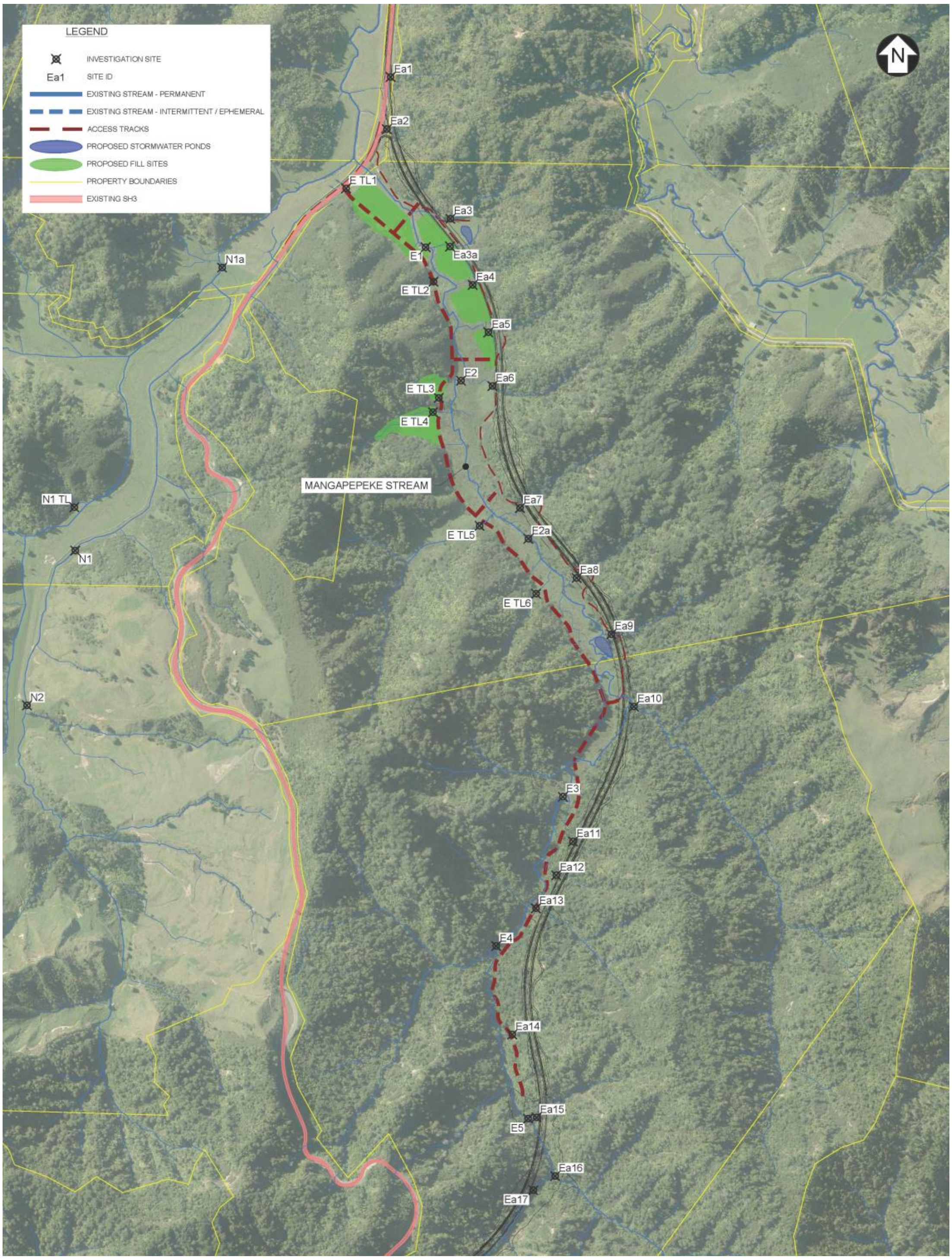

Figure 2: - Location of waterways in Mangapepeke Stream catchment.

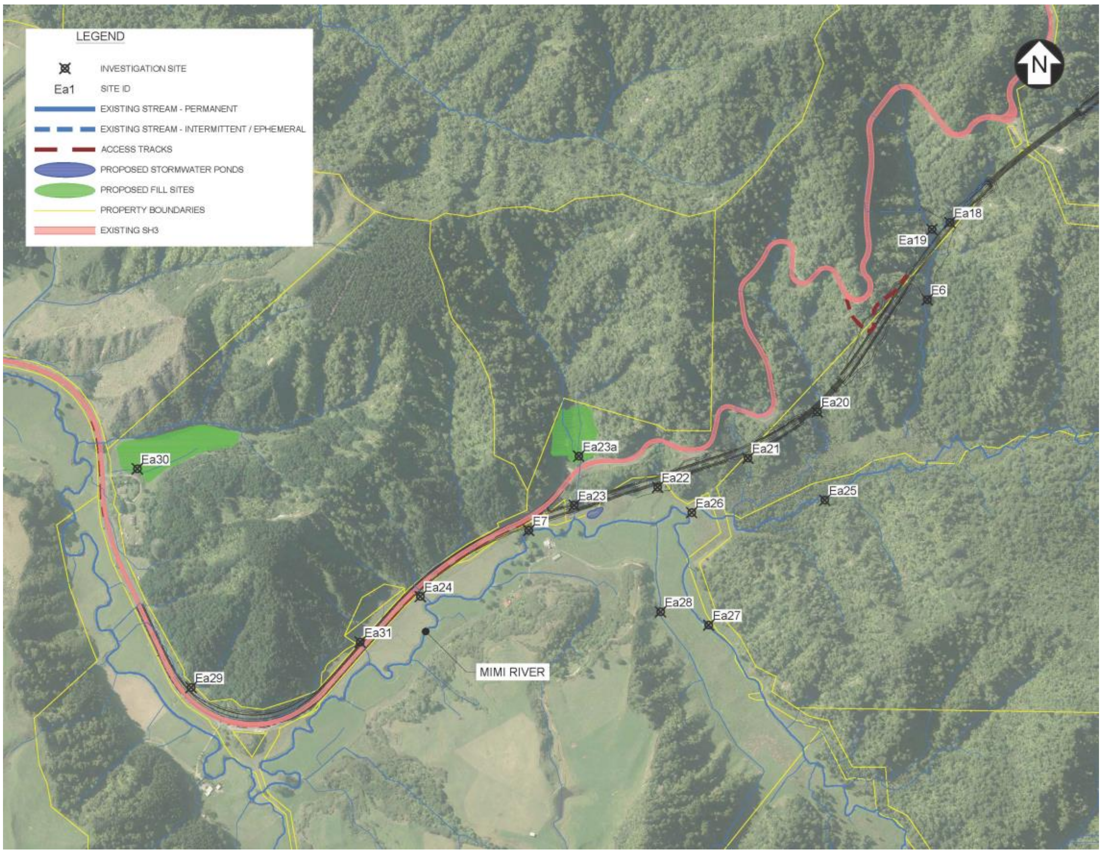

Figure 3: Location of waterways in Mimi River catchment.

Table 1: Location of waterways potentially affected by the Project (culverts, swales, stream diversion) and stream surveys. Highlighted cells indicate sites surveyed or resurveyed as part of the supplementary survey in October/November 2017.

Site	Catchment	latitude	longitude	catchment area (ha)	ID culvert / diverson	Chainage	Length of culvert / diversion	survey method
Ea1	Mangapepeke trib	-38.869671	174.598523	3.82	1	250	24	v
Ea2	Mangapepeke trib	-38.870796	174.598444	1.80	2	300	26	v
E1	Mangapepeke	-38.873345	174.599765	328				H, F
Ea3	Mangapepeke trib	-38.872707	174.600242	6.3	3	570	67	v
Ea3a	Mangapepeke trib	-38.873304	174.600246	6.3	3	570	67	v
Ea4	Mangapepeke trib	-38.874061	174.600811	1.8	4	750	81	v
Ea5	Mangapepeke trib	-38.875142	174.601345	4.2	5	870	87	v
E2	Mangapepeke	-38.876197	174.600613	306				SEV, H
Ea6	Mangapepeke trib	-38.876297	174.601484	4.4	SD2 swale	1050	90	H
Ea7	Mangapepeke trib	-38.878920	174.602306	6.8	6	1300	27	SEV, H, F
E2a	Mangapepeke	-38.879580	174.602552	248				H
Ea8	Mangapepeke trib	-38.880407	174.603903	5.8	7	1500	36	v
Ea9	Mangapepeke trib	-38.881602	174.604886	7.9	8	1700	35	v
Ea10a	Mangapepeke trib	-38.883153	174.605548	67	9	1850	56	F
Ea10b	Mangapepeke	-38.883153	174.605548	149	SD5	1850-1950		SEV, H, F
E3	Mangapepeke	-38.885127	174.603628	133				SEV, H
Ea11	Mangapepeke trib	-38.886086	174.603931	2	10	2220	37	v
Ea12	Mangapepeke trib	-38.886820	174.603485	1.6	11	2300	25	F
Ea13	Mangapepeke trib	-38.887543	174.602936	9.8	12	2400	74	SEV, H, F
E4	Mangapepeke	-38.888551	174.601769	116				SEV, H, F
Ea14	Mangapepeke trib	-38.890273	174.602344	1.7	13	2700	15	F
E5	Mangapepeke	-38.892081	174.602827	64	SD6	2800-2900		SEV, H, F
Ea15	Mangapepeke trib	-38.892053	174.603057	5	14	2900	117	H, F
Ea16	Mangapepeke trib	-38.893312	174.603602	36	15	2960	210	v
Ea17	Mangapepeke trib	-38.893624	174.603009	17	SD7	3000-3350	300	v

Table 1 continued

Site	Catchment	latitude	longitude	catchment area (ha)	ID culvert / diverson	Chainage	Length of culvert / diversion	survey method
Ea18	Mimi trib	-38.897816	174.597454	6	SD8	3650-3930	250	v
Ea19	Mimi trib	-38.897950	174.597026	10	16	3800	115	v
E6	Mimi trib	-38.899262	174.596944	21				SEV, H, F
Ea20	Mimi trib	-38.901392	174.594367	15	Bridge			v
Ea21	Mimi trib	-38.902276	174.592733	3	17	4440	22	H, F
Ea22	Mimi trib	-38.902848	174.590586	1.5	swale			H
Ea23	Mimi trib	-38.903208	174.588603	25	18/19	4750	29/43	H
Ea23a	Mimi trib	-38.902294	174.588693	25				SEV, H, F
E7	Mimi	-38.903693	174.587532	919				SEV, H, F
Ea24	Mimi trib	-38.904961	174.584971	13	20	5150	40	v
Ea29	Mimi trib	-38.906730	174.579537	12	21	5650	34	v
Ea30	Mimi trib	-38.902671	174.578163	2.9				v
Ea31	Mimi trib	-38.905831	174.583556	4.1	SD	5225-5300		v
Ea25	Mimi trib	-38.903034	174.594584	208				F
Ea26	Mimi trib	-38.903309	174.591411	221	restoration			SEV, H
Ea27	Mimi	-38.905400	174.591865	630	restoration			SEV, H
Ea28	Mimi trib	-38.905169	174.590710	25	restoration			SEV, H
E TL1	Mangapepeke trib	-38.872089	174.597347	1.3				v
E TL2	Mangapepeke trib	-38.874071	174.599807	1.9				v
E TL3	Mangapepeke trib	-38.876573	174.600008	2.1	SD3	1050	900	v
E TL4	Mangapepeke trib	-38.876884	174.599855	6.6	SD4	1100	200	H
E TL5	Mangapepeke trib	-38.879318	174.601197	32				SEV, H, F
E TL6	Mangapepeke trib	-38.880764	174.602792	3.1				v

Stream survey: SEV = SEV + macroinvertebrate samples, H = habitat assessment, F = fish survey, v = site visit only.

INVESTIGATION RESULTS

50. A detailed description of survey results is provided in Hamill (2017b) and Hamill 2018. The following section is a summary of the survey results. A general description of each site is provided in **Table 2** and summary results are provided in **Table 3**. I discuss below:

(a) the stream habitat and biological communities; and

(b) the offset calculations I carried out to determine what area of stream needs to be restored to offset the effects of the Project on freshwater ecological values.

Table 2: Characteristics of waterways potentially affected by the Project. TL=true left.

Site	Catchment	catchment area (ha)	Riparian cover	Morphology	width (m)	depth run	depth pool (m)	Stream description
Ea1	Mangapepeke trib	3.82	indigenous forest	Ephemeral, steep	0.2	0.03	0.05	No fish passage through existing culvert. Wet mud but no flow.
Ea2	Mangapepeke trib	1.80	road side, scrub	Ephemeral cut-off drain	0.2			Ephemeral road cutoff drain. No water on alignment
E1	Mangapepeke	328	pasture	meander	1.4	0.4	0.8	Meandering pastural stream
Ea3	Mangapepeke trib	6.3	pasture, grazed wetland	run	0.35	0.02	0.2	Channelised drain adjacent to bush edge. Channel w 0.9m, h 0.3m to 1m. More natural within bush section
Ea3	Mangapepeke trib	6.3		run	0.35			
Ea3a	Mangapepeke trib	6.3	pasture, grazed wetland	drain	0.3	0.02	0.2	Drain recently deepened and widened for cut-off drains (e.g. Ea4)
Ea4	Mangapepeke trib	1.8	pasture, grazed wetland	Ephemeral drain	0.2	0		No water or channel at alignment. Cutoff drain to north, dug out.
Ea5	Mangapepeke trib	4.2	pasture, grazed wetland	intermittent, riffle-run	0.35	0.01		dribble of water disappears to wetland. High erosion. Incised channel to 0.7m
E2	Mangapepeke	306	pasture, grazed wetland	meander	1.4	0.4	0.8	Drains recently excavated. Cattle access to stream
Ea6	Mangapepeke trib	4.4	pasture, forest	step-pool, intermittent	0.35	0.05	0.2	incised channel w 0.6m, h 0.6m. Isolated pools with koura. Partial fish barrier where incised. Dry in places.
Ea7	Mangapepeke trib	6.8	pasture, grazed wetland	step-pool	0.4	0.02	0.5	incised channel w 1.1m, h 2m. Deep pools below drops.
Ea7	Mangapepeke trib	6.8			0.4			
E2a	Mangapepeke	248	pasture, degraded wetland	meander	1.3	0.4	0.5	Single row of manuka along stream edge near this reach.
Ea8	Mangapepeke trib	5.8	pasture, grazed wetland	step-pool	0.4	0.02	0.4	Incised channel w 0.7m, h 0.5m to 1m. Deep pools where log jams.
Ea9	Mangapepeke trib	7.9	pasture, grazed wetland	meander	0.5	0.05	0.15	Incised channel w 1.5m, h 1.4m. Meander along bush edge
Ea10a	Mangapepeke trib	67	Pasture/swamp forest	meander	1	0.3	1.5	Pools >1.2m with 0.8m drops in confined sections
Ea10b	Mangapepeke	149	Pasture/swamp forest	meander	1.2	0.3	1.5	Main stem through Kahikatea remnant. Drops of about 0.8m from root mass forming deep pools. Bank height 0.6 to 1.2m (typically 0.7m)
E3	Mangapepeke	133	pasture, grazed wetland	meander	1.25	0.35	0.45	Cattle causing pugging.
Ea11	Mangapepeke trib	2	indigenous forest	Ephemeral, steep	0.2	0.01	0.2	Ephemeral. disappears in wet ground. No flow on alignment. Too shallow to fish
Ea12	Mangapepeke trib	1.6	indigenous forest	Ephemeral, steep	0.2	0.01	0.1	Ephemeral. No flow on alignment centre. Small koura
Ea13	Mangapepeke trib	9.8	indigenous forest & pasture	step-pool	0.6	0.1	0.3	Narrower through pasture (0.65m wide and 0.1m deep). Longfin, banded, koura (d/s alignment). Pools remain us road.
E4	Mangapepeke	116	indigenous forest, grazed wetland	riffle-run	1.8	0.25	0.4	Cattle access causing pugging and erosion. Vegetation in poor condition and open.
Ea14	Mangapepeke trib	1.7	indigenous forest	Ephemeral. Steep	0.2	0.05	0.08	waterfall below the alignment. Ephemeral to intermittent through alignment. Small pools (fished d/s waterfall). Koura
E5	Mangapepeke	64	indigenous forest	riffle-run	2.5	0.25	1.5	Waterfall at upstream extent of reach.
Ea15	Mangapepeke trib	5	indigenous forest	Ephemeral. step-pool, waterfall	0.4	0.08	0.2	Large waterfall ds alignment. Ephemeral u/s alignment. Banded, koura
Ea16	Mangapepeke trib	36	indigenous forest	step-pool, waterfall	1.2	0.35		TR branch confined gorge. width 0.8-2m. Important to maintain long term fish passage for climbers.
Ea17	Mangapepeke trib	17	indigenous forest	step-pool, waterfall	1	0.15	0.5	TL branch confined gorge. width 0.8-1.3m

Table 2 continued

Site	Catchment	catchment area (ha)	Riparian cover	Morphology	width (m)	depth run	depth pool (m)	Stream description
Ea18	Mimi trib	6	indigenous forest	step-pool	0.5	0.08		TL = smaller. W 0.4-0.7m. Small stream cobbles.
Ea19	Mimi trib	10	indigenous forest	step-pool	0.9			TR channel 2.1m wide.
E6	Mimi trib	21	indigenous forest	riffle-run	1.2	0.15	0.55	Near u/s end width =1m and drops of about 1.6m. 2 L/s on 1 Nov 2017
Ea20	Mimi trib	15	Swamp forest	meander	0.9	0.1	0.5	Swamp forest. SMG/SG. *Tradescantia* present.
Ea21	Mimi trib	3	indigenous forest	Intermittent, step-pool	0.4	0.02	0.35	Small step-pool forest stream. Intermittent. Flow on 31/10/2017 = 0.064 L/s at upstream culverts combined. Koura
Ea22	Mimi trib	1.5	pasture	Intermittent, drain	0.35	0.05		Widens to a degraded wetland with heavy stock pugging
Ea23	Mimi trib	25	Swamp forest to pasture	riffle-run	0.6	0.2	0.45	Kahikatea forest d/s SH3. Incised channel height 0.5m narrow to 0.5m wide through kahekatea. Pools widen to about 0.9m. Banded, koura bully.
Ea23a	Mimi trib	25	forest	riffle-run	0.7	0.1	0.45	Forest u/s SH3.
E7	Mimi	919	pasture	meander	2.1	0.46	0.8	Cattle access to stream.
Ea24	Mimi trib	13	pasture	Drain	0.6	0.1		road cutoff drain and farm drain.
Ea29	Mimi trib	12	pasture	Drain, ephemeral	0.5			Wet but no flow. Watercress in drain. Additional stream length created to convey water to chainage 5450.
Ea30	Mimi trib	2.9		Drain	0.3			Farm cutoff drain affected by fill site. Drain dugout for logging. Very low values
Ea31	Mimi trib	4.1		Drain, ephemeral	0.3			Cut off drain. No water during spring site visit.
Ea25	Mimi trib	208	Swamp forest	meander	1	1		Kahikatea forest.
Ea26	Mimi trib	221	pasture, forest	meander	1.1	0.4		Raupo TL, wood in stream
Ea27	Mimi	630	pasture	meander	1.5	0.55		Main flow of Mimi Stm. Top end about 1.2 to 1.7m wide, moderate velocity.
Ea28	Mimi trib	25	pasture	Drain	0.9	0.17	0.4	Farm drain. Tributary enters at Ea28 from hill. Heavy pugging and sedimentation. Width 0.4m at top and 1.2m at lower end. Pools to 0.3m.
E TL1	Mangapepeke trib	1.3	pasture, scrub	Roadside drain	0.25	0.02		Roadside drain perched. Raupo in drain.
E TL2	Mangapepeke trib	1.9	pasture, scrub	Intermittent drain	0.2	0.02		Very shallow and degraded
E TL3	Mangapepeke trib	2.1	pasture, grazed wetland	Ephemeral drain	0.2	0.02		Heavy pugging, degraded stream, tiny flow.
E TL4	Mangapepeke trib	6.6	pasture, grazed wetland	riffle-run, drain	0.3	0.02		Very incised (1.3m bank hieght)
E TL5	Mangapepeke trib	32	pasture, grazed wetland	riffle-run, wetland	0.5	0.13	0.4	Riffle-run form, channel width about 1m, bank height 0.5m. Drain dug in upper valley. Banded, inanga, longfin, shortfin, koura.
E TL6	Mangapepeke trib	3.1	pasture, grazed wetland	Intermittent	0.3	0.01	0.05	Currently no fish passage

Table 3: Summary of field assessment for habitat, SEV, fine substrate, macroinvertebrates (Macroinvertebrate Community Index ("MCI")) and Quantitative MCI ("QMCI"), and Fish Index of Biological Integrity ("IBI").

Site	Habitat %	SEV	% silt/sand	MCI	QMCI	Fish IBI
E1	33.5					50
E2	44.5	0.57	97	90	5.2	
E2a	47.5					
Ea10	66	0.73	57	127	6.6	54
E3	41	0.58	95	107	5.1	54
E4	55	0.72	17	126	6.9	36
E5	76	0.92	16	130	5.6	26
Ea6	47					
Ea7	54.5	0.73	55	128	7.2	36
Ea12						0
Ea13	73	0.86	35	130	7.4	46
Ea14						0
Ea15	78					36
ETL4	37					
ETL5	40	0.48	90	94	3.9	54
E6	82.5	0.94	12	133	6.3	48
E7	44.5	0.52	66	121	5.8	50
Ea21	69					0
Ea22	28					
Ea23	73	0.78	35	114	6.3	44
Ea26	53.5	0.62	97	126	6.4	54 *
Ea27	38.5	0.54	48	125	7.3	
Ea28	21.5	0.35	98	76	3.2	

Fish IBI: >47 Excellent, 36-46 Good, 27-35 Moderate, 6-26 Poor, 0 no fish.
MCI: ≥120 Excellent, 100-120 Good, 80-100 Fair, <80 Poor.
QMCI: ≥6 Excellent, 5-6 Good, 4-5 Fair, <4 Poor.
* based on site Ea25

Habitat

51. Most waterways directly impacted by the Project works are small; a third (10) have a catchment area of less than 5ha (probably intermittent or ephemeral), and about three quarters (22) have a catchment area of less than 20ha.

52. The habitat quality of sites is consistent with riparian cover. The best habitat occurred at sites with indigenous forest dominating the catchment. This provided shade and woody debris in the streams which in turn provided a diversity of cover and habitat for fish and invertebrates. The sites with the worst habitat scores (E1, Ea22 and Ea28) were characterised by having little riparian vegetation cover, no shade, little cover for fish, uniform hydraulic conditions, considerable sedimentation and bank erosion accelerated by cattle access.

53. The upper section of both catchments and forested tributaries generally had habitat scores above 70%. Generally scores reduced downstream with a reduction in forest cover and more impact from farming.

54. The stream substrate reflected the soft papa mudstone geology. This is a soft rock and the gravels are easily crushed to silt by hand. Fine sediment was present as substrate at all sites. In low gradient sections of the Mangapepeke Stream and Mimi River were primarily soft-bottomed, with stable substrate provided by large wood, aquatic macrophytes, riparian vegetation and occasion gravel riffles (e.g. on Mimi River). Steep forested reaches had papa gravel substrate but even these reaches had about 15% cover of fine sediment (e.g. upstream E4 on Mangapepeke Stream and upstream E6 on Mimi River).

55. The amount of fine sediment on the stream bed corresponded with stream gradient and land disturbance in the form of slips or cattle pugging (e.g. site Ea28). Fresh slips and landslides were common in both the Mangapepeke Stream and Mimi River catchments and sections of streams are often incised where they cut through old landslides (Figures 4 and 5).

56. Site E4 (Mangapepeke Stream) appeared to be near a transition zone where papa gravels still dominated the stream bed but there was a thin layer of fine sediment over the gravels (Figure 6). A similar situation was observed downstream of site E6 (Mimi River tributary) at the beginning of the raupo wetland.

Figure 4: A small slip in the Mangapepeke Stream near site E5 (October 2017).

Figure 5: A recent slip of papa mudstone in ephemeral section upstream of site Ea15, Mangapepeke Stream (October 2017).

Figure 6: Mangapepeke Stream near site E4, a transition zone where papa gravel still dominates the substrate but a lower gradient allows fine sediment to settle and smoother the gravel.

Fish

57. Fish surveys during 2017 found the following species in the Mangapepeke Stream:

    (a) longfin eel;

    (b) inanga;

    (c) common bully;

    (d) giant kōkopu;

    (e) banded kōkopu;

    (f) redfin bully;

    (g) kōura;

    (h) Paratya shrimp; and

    (i) kākahi (freshwater mussel).

58. Most of these species were also found in the Mimi River catchment near Mt Messenger, with the exception of inanga and common bully. The results from the Mimi River are consistent with spot light surveys undertaken by DoC in 2013. The absence of inanga from the Mimi River sites probably reflects its distance to the coast compared to the Mangapepeke Stream.

59. The lower gradient streams tended to be dominated by large longfin eel, adult inanga, redfin bully and giant kōkopu; while the steeper sites tended to have banded kōkopu, longfin eel, redfin bully and kōura, all of which have good climbing ability. Banded kōkopu were also found above waterfalls so long as the stream had sufficiently deep pools present (e.g. site Ea15), but in very small streams only kōura was found (e.g. sites Ea12, Ea14, Ea21).

60. The Fish Index of Biological Integrity (IBI) was calculated for use in the SEV calculations. The lower gradient sites on both the Mangapepeke Stream and the Mimi Stream had 'excellent' Fish IBI scores, while higher up the catchment the scores were 'good'.

Aquatic macroinvertebrates

61. Aquatic macroinvertebrate results provide an indication of stream health and were used in the SEV calculations. The results show generally higher taxa richness and 'excellent' MCI scores at sites with bush catchments; but reducing to 'good' and 'fair' further downstream in the Mangapepeke Stream. MCI scores were indicative of 'excellent' water quality at all sample sites in the Mimi River catchment with the exception of site Ea23 (MCI indicative of 'good' conditions), and farm drains like site Ea28 where MCI scores indicated 'poor'

habitat and water quality conditions. A similar pattern was observed for QMCI scores.

SEV Scores

62. The SEV scores for the forested headwater streams in both the Mimi and Mangapepeke valleys were high, in the range 0.85 to 0.94, and equate to pristine reference site conditions. The SEV scores were moderate (about 0.6 to 0.75) where stream sections were close to the forest margin and were lower again where the streams ran through pasture (typically about 0.5-0.6). The lowest SEV scores (about 0.35 to 0.45) occurred in heavily modified drains with no riparian margin and cattle access.

Offset calculations

63. I calculated the amount of stream lost or directly affect by the Project is 3822m or 3361m^2, and the amount of stream required to be restored to offset this effect is 8627m or 8157m^2 (**Table 4**).

64. Detailed designs are still being developed and it is possible that the amount of stream directly affected by the Project may change (either increase or decrease). If there are substantive changes to designs that affect streams or stream diversion calculations then the offsets will be recalculated. The process for recalculating stream offset to reflect final designs is described in section 8.3.6 of the ELMP. That process is consistent with the method used for the Freshwater Ecology AEE Report and the Freshwater Ecology Supplementary Report.

65. The detailed site-by-site calculation of offset required to address effects of the Project footprint is provided in the freshwater ecology supplementary report (Hamill 2018).

Table 4: Extent of stream affected by the Project and the area of offset required to achieve 'no net loss'.

	Impact		Offset	
Catchment	**Length (m)**	**area (m^2)**	**Length (m)**	**area (m^2)**
Mangapepeke	2799	2678	6110	6234
Mimi	1023	683	2517	1923
Total	3822	3361	8627	8157

EFFECTS ASSESSMENT INCLUDING MITIGATION, OFFSETTING AND MONITORING

Overall effects

66. The potential effects of the Project on freshwater ecology are described below (with further information available in Hamill 2017b). The magnitude of effects from different Project activities is summarised in **Table 5**, using the approach described in the EcIA guidelines.

67. The largest magnitude of effects, after mitigation, will occur from the loss of stream habitat and reduced stream functions due to culverts and stream diversions. This will cause a high magnitude of effect on streams assessed as having high ecological value. The Project will provide stream offsets to address this effect. The offset measures are not factored into the 'with mitigation' effects assessment.

68. Many of the other Project activities have 'moderate' or 'high' potential effects in the absence of mitigation. However, the Project includes mitigation that reduces these effects to 'low' or less. These effects, and the mitigation features proposed to address them, are discussed below.

Table 5: Magnitude of effect for Project activities before and after mitigation

Effect / Activity	Magnitude no mitigation	Reason for impact without mitigation (spatial extent, duration, reversibility)	Key Mitigation	Magnitude + mitigation
Short term effects				
Direct removal of fish	Low-moderate	Direct impact to 14% and 3% of stream length of Mangapepeke East and Mimi Stream. Short term and reversable for population.	Fish Rescue and Recovery Protocols	Negligible
Sedimentation from earthworks	High	Smothering of substrate downstream. Potential impact on banded and giant kōkopu. Short term impact in most cases. Potential impact greater in swamp forest.	Catchment Water Management Plan (CWMP) including monitoring	Low
Vegetation clearance	High	Poor practice has potential to deoxygenate water downstream. Reversible, but persists until woodchip removed from stream.	Landscape and Vegetation Management Plan	Low
Concrete	Low	Small area, distant from waterways and short duration = low risk of spills.	E&S control in CWMP	Negligible
Short term fish passage	Low	Potential loss of recruitment to upper Mangapepeke for a season. Reversible.	Design for passage	Negligible
Short term habitat loss	Moderate	Short term loss of stream habitat and reduced functions. Restored following construction.	Offset.	Moderate (requires offset)
Water takes	Low	Short term and small magnitude. Possible impact downstream.	Intake screened.Take volume <20% of stream flow	Negligible
Long term effects				
Fish passage	High	Long term fish passage lost to about 50% and 8% of Mangapepeke East and Mimi length. Reversible.	Design for fish passage	Negligible to Low
Loss of stream habitat	High	Large amounts of high quality stream habitat lost to piping. Reduced stream functions. Difficult to reverse.	Stream diversions based on Ecological Design Principles in LEDF Offset.	High (requires offset)
Stormwater	Negligible	Very small change in impervious surface from road. No change in vehicle volumes from Project.	Swales, treatment wetlands	Negligible

The proportion of catchment is based on the length upstream of the work area.

Fish injury during stream works

Potential effect

69. Filing-in streams, digging instreams and dewatering streams to install culverts and stream diversion pose a risk of removal, stranding, injury or mortality of fish, kōura and kākahi. The magnitude of risk is dictated by the nature of the activity, the area of the stream disturbed, density of fish present in the stream, and the ability of fish to escape the disturbance.

Mitigation

70. The Project will minimise and mitigate the direct effect of stream works on fish, kōura and kākahi by implementing the Fish Recovery and Rescue Protocols ("**FRRP**") prior to draining, diverting or excavating streams. These are set out in Appendix D to the ELMP.

71. These protocols require fish rescue to occur at all sites but the type and intensity of fish recovery is risk based and dependent on the stream environment. The fish recovery technique that has the least risk to fish, and is often most effective, is allowing the voluntary escape of fish as an area is dewatered. However, this is not possible in every situation and often other fish recovery techniques also need to be used. This is covered in the FRRP.

Sedimentation from earthworks

Potential effect

72. The primary ecological concern regarding sediment in discharges is the deposition of sediment on the stream bed that smothers habitat, fills interstitial spaces and reduces food supply. Most fish species tolerate periods of reduced water clarity and increased turbidity, although banded kōkopu have been found to show avoidance behaviour when turbidity is over 25 Nephelometric Turbidity Units ("**NTU**").

73. The papa mudstone geology around Mt Messenger means both that the land is prone to accelerated erosion and that the streams are accustomed to a naturally high sediment loads. Low gradient streams are soft bottomed and even steep streams, with fast flowing water have relatively high cover of fine sediment in runs. The sediment enters the stream from landslide, bank slumping and, in pasture areas, by accelerated erosion where the surrounding vegetation is disturbed by stock.

74. The part of the catchment likely to be most sensitive to sediment deposition is the kahikatea swamp forest in the Mimi River catchment downstream of the southern tunnel portal. The streams in this swamp forest are soft-bottomed, but excessive sedimentation could compromise their deep and often narrow morphology.

75. This kahikatea swamp forest is naturally buffered from works near the tunnel portal by the raupo swamp on its northern side. The tributary to the Mimi River draining the tunnel and downstream of site E6 dissipates within the raupo swamp. This means that the raupo swamp will be providing an effective filter of sediment entering from the northern tributaries and helps protect the kahikatea swamp forest from any sedimentation due to the Project.

76. Baseline monitoring of sediment concentrations during floods has occurred in the Mimi River and Mangapepeke Stream using passive samplers. These samplers collect a sample at a predetermined level on the rising flood. They provide a standardised measure of the sediment concentrations during a flood event and are conservative because sediment concentration is typically highest on the rising limb of a flood.

77. Baseline sampling to date has shown that during flood events both the Mimi River and Mangapepeke Stream can have very high concentrations of total suspended sediment ("**TSS**") (commonly above 1000mg/L during rising floods) and settlable sediment. On 5 January 2018, during a flood, the Mangapepeke Stream had a TSS of 16,300mg/L and settlable solids of 56mL/L. By way of context, this equates to a theoretical 56mm sediment deposition in a quiescent pool 1m deep.

78. The monitoring results are consistent with field observations of slips, bank slumping, sediment deposition observed amongst vegetation on stream banks, fine sediment deposition on the stream bed where the stream gradients flatten and predominantly soft-bottom streams in low gradient sections.

Mitigation

79. Accelerated erosion and sedimentation can be minimised and mitigated by ensuring good Erosion and Sediment Control ("**E&SC**") practices. The approach to E&SC for various activities is discussed in the Construction Water Management Plan ("**CWMP**") and in the evidence of Mr Ridley.

80. The approach to monitoring E&SC practices is discussed in the Construction Water Discharge Monitoring Plan ("**CWDMP**") and in the evidence of Mr Ridley. It includes ongoing monitoring of impact sites and paired catchment control sites in the lower reaches of both the Mangapepeke Stream and Mimi River. At these sites there will be monitoring of turbidity, TSS concentration and settlable sediment during flood events using passive samplers.

81. Section 8.4.3 of the ELMP describes an approach for monitoring sediment from works near the tunnel portal that might affect the kahikatea swamp forest (Mimi River valley). This involves visual inspection of any sediment deposition near the edge of the kahikatea swamp forest, and where this occurs, additional ecological monitoring is triggered. The ecological monitoring will assess the overall magnitude of any sediment effects from the Project on the

kahikatea swamp forest, and lead to recommendations for further monitoring or remedial actions as necessary.

82. Instream monitoring of sediment deposition on the stream bed is not proposed in the ELMP. This is because the naturally high sediment loads and fine bed substrate means that the streams are less sensitive to effects of residual sedimentation, and it would be difficult to reliably measure any additional sedimentation. Nevertheless, it remains important to minimise sediment loss from the site and maintain a high level of erosion and sediment control measures.

83. In my view, the monitoring proposed in the CWDMP is appropriate for assessing and managing the sediment loss from the site.

Water quality effects from vegetation clearance

Potential effect

84. Woody debris such as logs and branches are an important habitat in streams, however large volumes of woodchip in a stream can have significant adverse effects by depleting dissolved oxygen and promoting heterotrophic growths. In extreme cases there can be loss of invertebrate and fish life downstream until sufficient reaeration or dilution occurs.

Mitigation

85. The adverse water quality effects from vegetation clearance can be largely avoided by applying good practice. The Landscape and Vegetation Management Plan Chapter 4 of the ELMP includes protocols for vegetation clearance that will prevent mulch entering streams and, in my view, avoid adverse effects on water quality. This is primarily through reducing the amount of wood required to be mulched, manually chipping in to the back of a truck, removing any vegetation that falls within 10–20 m of a stream and mulching this at a suitable location.

Water take for dust suppression

Potential effect

86. Water takes primarily affect streams by reducing the habitat available for fish. They can also contribute to increased fluctuations in water temperature if flows get very low. If water take inlets are poorly designed they can entrain fish and cause mortality.

87. The Project is seeking water takes of up to 300m^3/day from the Mangapepeke Stream and up to 150m^3/day from the Mimi River. There is very little flow information available for streams in the vicinity of Mt Messenger, however there are broad scale modelling estimates from the Regional Environment Classification ("**REC**"). This estimates that the Mimi River has a mean flow and

a Mean Annual Low Flow ("**MALF**") of 315L/s and 45L/s respectively; and the Mangapepeke Stream[8] has a mean flow and MALF of 198L/s and 31L/s respectively.[9]

88. Instream habitat within the Mangapepeke Stream and Mimi River are relatively insensitive to changes in flow because of their U-shaped morphology and frequent deep pools that provide a refuge for fish.

89. Taranaki Regional Council ("**TRC**") has guidelines (2005) for allocating water and setting minimum flows in rivers. Minimum flows are set to ensure retaining greater than two thirds of instream habitat present in the river when the flow is at MALF. It is generally a flow in the range of 50% to 75% of MALF but varies with the characteristics of the stream. I applied this approach to the Mangapepeke Stream using information from the habitat survey[10] and extrapolated the results to the Mimi River based on relative flow[11]. I estimated a minimum flow of 19 L/s and 28 L/s for the Mangapepeke Stream and Mimi River respectively.

90. A flow of 19 L/s in the Mangapepeke Stream is about 61% of the MALF, it corresponds to a 3cm reduction in water level and retains about 89% of stream habitat. Shallow runs (15cm deep at MALF) will retain about 60% of the habitat available at MALF, but these comprise less than 10% of the stream reach. For most of the stream reach there was little change in habitat due to the depth and U-shape cross section (see **Figure 7**).

Mitigation

91. The applicant has proposed minimising the effects of the water take by restricting the instantaneous rate of take to 5 L/s up to a maximum of 150 m^3/day from the Mimi River and 300 m^3/day from the Mangapepeke Stream. Conditions are also proposed for screening the water take (section 8.3.7 of the ELMP). This approach does not have a cease limit but has a low risk of reaching my conservative estimate of minimum flow because of the low abstraction rate (5 L/s is about 16% of the MALF in Mangapepeke Stream). In my view this approach is reasonable and appropriate given the nature of the activity being short term. It also has the advantage of being simple to apply and enforce with a high level of certainty.

92. TRC have proposed consent conditions allowing a higher rate of take (i.e. up to 10 L/s) but also requiring that the abstractions shall take no more than 25% of the instantaneous flow. This is also a reasonable approach to managing a

[8] Downstream of the confluence of the east branch and west branch.
[9] On 1 November 2017 the flow in the Mangapepeke Stream was measured at about 77 L/s; this is consistent with the REC results. Other streams in the Taranaki Region were flowing at about two thirds of median flow on the same day (e.g. Timaru Stream).
[10] These estimates are based on the longitudinal stream survey and cross sections measured on 1 November 2017. For the Mangapepeke Stream, water depth and width at MALF and at 19 L/s was back calculated using the stream cross section from a shallow run and assuming no change in water velocity as flows reduce (i.e. a conservative assumption).
[11] The Mimi River is less sensitive because it is larger and the proposed take is smaller.

water take. Compared to the applicant's approach, it would allow more water abstraction when the Mangapepeke Stream is at MALF and only start to become more protective the flow drops below 20 L/s. This is likely to be a rare event, and considering the short-term nature of the consent this approach is likely to be less protective than what is proposed by the applicant. The other difficulty with this approach is that it is considerably more complex to apply in practice – particularly for operators on the ground. It requires gauging flow at multiple levels and continuous recording linked to real time observations.

93. Overall, I support the applicant's approach to water takes. It is appropriate for the nature of the activity, sufficiently protective of the environmental values and simple to ensure compliance.

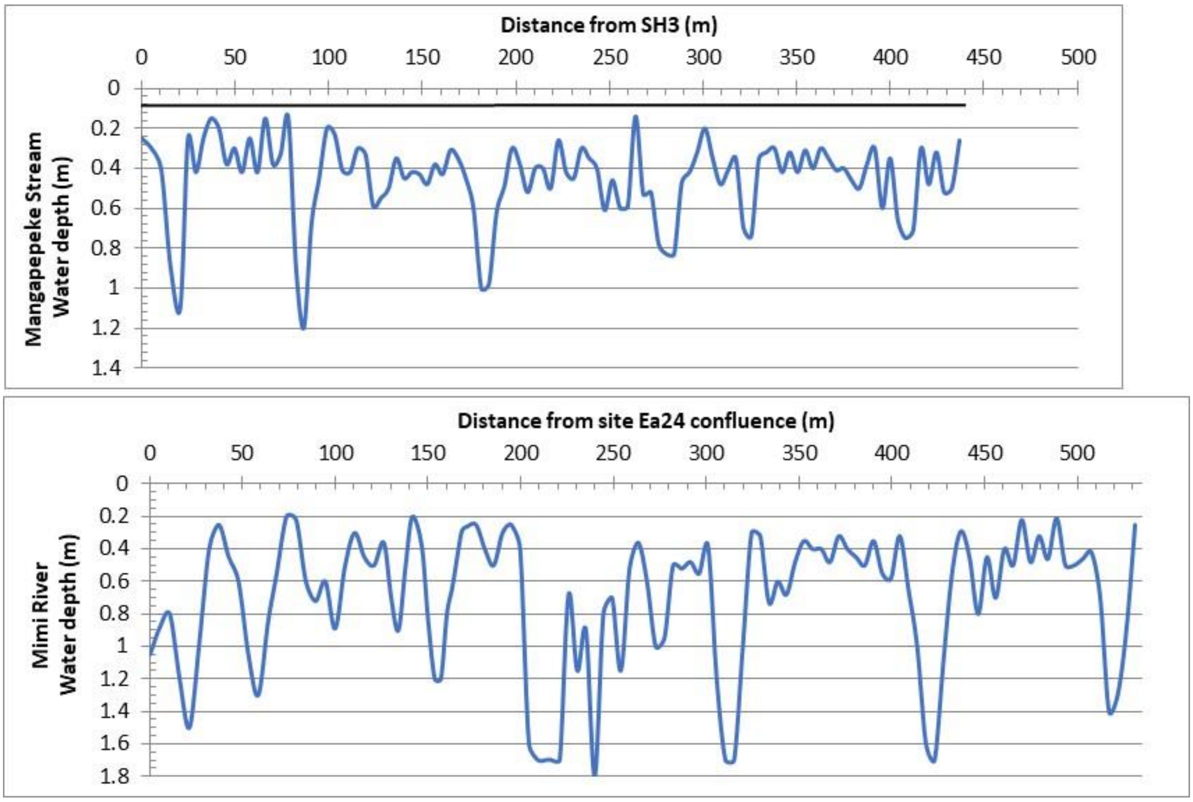

Figure 7: Longitudinal profile of the Mangapepeke Stream (top) and Mimi River (bottom) on 1 November 2017. The black line shows the estimated water level at MALF.

Fish passage during construction phase

Potential effect

94. Many New Zealand fish are diadromous and need to migrate between freshwater and the sea in order to complete their life-cycle.

95. Upstream fish passage could potentially be restricted for a short period during construction when culverts are installed and water is flowing through any temporary diversion pipes. If restrictions to fish passage occur for only a few days the adverse effect on fish communities will be negligible. However, large amounts of fill are required on either side of the tunnel (ie upstream of sites E5 and E6), and it is likely to take many months to fill the valley and establish permanent diversions and culverts.

96. In the absence of any mitigation this construction phase could restrict upstream fish passage to about 50ha of the upper Mangapepeke Stream for a full migratory season. The overall effect of this short-term impedance to fish passage on the fish population of a small stream is likely to be low, nevertheless mitigation is recommended and incorporated as part of the Project.

Mitigation

97. Measures to mitigate the short-term effects of culvert construction on fish passage are described in the Construction Water Management Plan ("**CWMP**"). These include minimising the length of time construction activities cause a fish passage barrier by constructing culverts and diversions in the dry, where possible. In the large area of fill near the tunnel portals, the short-term effects on fish passage will be mitigated either by installing spat rope through the culvert or by implementing trap and transfer (section 8.3.4 of the ELMP).

98. In my view either option (installing spat rope or trap and transfer) is appropriate for mitigating short term effects, especially in the context of these sites having waterfalls and cascades that naturally restrict passage to fish with good climbing ability (e.g. banded kōkopu, longfin eel).

Long term fish passage through culverts

Potential effect-long term

99. Maintaining fish passage upstream and downstream is important to allow upstream fish populations to be sustainable. Most fish in the catchments are diadromous, requiring migration to and from the sea as part of their life cycle. Kōura are not diadromous but maintaining passage for kōura is still important to avoid isolated and fragmented populations.

100. The Project involves installing 21 new permanent culverts plus extending some existing culverts on access tracks. Most of the culverts will be about 25m to 40m long but near the headwaters the proposed culverts are 100m to 210m long. Some will replace existing culverts under SH3. These culverts (and associated inlet and outlet structures) should be installed so as to allow for fish passage to upstream habitat (with the possible exception of where there is no upstream fish habitat). In the absence of sufficient upstream fish passage the upstream fish population will reduce over time.

101. The fish passage should be appropriate for the passage of fish naturally present in the stream. For example, in lowland low gradient streams it is particularly important for culverts to have a flat gradient (similar to the natural stream) and low water velocities to enable passage for species with poor climbing ability such as inanga (e.g. culverts 3, 9, 18, 19, 20 and 21). In steep gradient streams, natural barriers (e.g. waterfalls or cascades) the community is restricted to species with good climbing ability (e.g. banded kōkopu, longfin eel, koura), which allow different options for fish passage. .

102. Nine of the culverts have a low gradient of 1% or less (1:100), and fish passage can be provided by mimicking the natural stream conditions within the culvert. Key to achieving this is ensuring that the culvert inverts are set well below the existing stream bed (see below). Culverts at 1% grade will probably require baffles to retain substrate and in my view the final design process should aim to reduce the grade of low gradient culverts to less than 0.5% and preferably closer to 0.3% unless the natural stream channel is steeper.

103. Nine culverts will require baffles to enable fish passage (culverts 4, 5, 7, 8, 11, 12, 14, 16 and 17), all have small upstream catchments of less than 10 ha (most are ephemeral or intermittent) and all the streams are steep near the location of the culvert inlet with small drops that restrict passage to fish with poor climbing ability. This means that the streams are naturally restricted to fish species with good climbing ability and the available upstream habitat is relatively small.

104. Three culverts have no fish passage incorporated into the design (culverts 2, 10, and 13) because of constraints with the inlet structure, which are manholes with a scruffy dome lid. These streams are all ephemeral and do not provide fish habitat except, perhaps for temporary foraging during rain events. In my view, the effect of not providing fish passage to these ephemeral streams will be small.

Mitigation

105. The design approach for ensuring fish passage is described in the ELMP and construction drawings. In my view the generic design approach submitted with the consent application is generally adequate but aspects will need to be refined during detailed design to ensure:

(a) Type 1 Culvert, steep gradient (ca. >1%): fish passage is provided by installing baffles within the culvert. Baffles will be appropriately spaced for the culvert gradient to ensure continuous fish passage and resting zones.

(b) Type 2 Culvert, shallow gradient (ca. <1%): the culverts will be sufficiently sized to allow for fish passage. The culvert's downstream invert will be set below the existing stream bed [12] by at least 25% of the culvert diameter and not less than 200mm. This is to help retain stream substrate in the base of the culvert.

(c) Type 2 culverts with a grade between 0.5% and 1% will have spoiler type baffles to retain substrate and ensure fish passage.

(d) If practicable, the design of Type 2 culverts with gradients of 1% should be reduced to less than 0.5% grade and preferably closer to 0.3% grade unless the natural stream channel is steeper.

(e) Culvert outlets will provide a resting pool (>300mm deep) and ensure at least 100mm of water depth is retained at the culvert outlet and over the apron.

(f) Energy dissipation structures or erosion protection structures at culvert inlets and outlets shall not impede fish passage.

(g) Where large diameter rock is used for erosion protection on the streambed this shall be either set below the natural stream bed level or layered with fine gravels (e.g. gap 40) to ensure that voids are sufficiently filled so that stream water flows over the rock rather than through the rock.

106. The Project does not propose fish passage though culverts 2, 10 and 13 (sites Ea2, Ea11, and Ea14 respectively). In my view, the effect of this is negligible because the upstream catchment is ephemeral (i.e. only flowing after rain).

107. The Project design also does not allow for fish passage at site Ea6 (between culvert 5 and culvert 6). The design has the stream at this location flowing down a cut face, intercepted by a cut-off drain and diverted to a stormwater pond. This is a very small stream (4.4ha catchment) and has some existing natural barriers, e.g. in places the stream tunnels underground where a landslide has blocked it. The current design may mean that kōura and banded kōkopu are excluded from a small amount of habitat. In my view, while not best practice the overall effect is small.

108. Four culverts are designed with a very steep grade (i.e. >12%): culverts 11, 13, 14 and 17 (sites Ea12, Ea14, Ea15 and Ea21). Achieving fish passage on steep culverts can be challenging, but I consider the proposed approach is adequate because they all have very limited upstream fish habitat. Most were ephemeral near the upstream end of the culvert except site Ea21; at this site the flow was very small (0.07L/s) and a fish survey only found kōura present (Hamill 2018).

[12] The existing stream bed level (prior to construction) should be assessed about 5 to 10m downstream of the culvert outlet to ensure it provides a control point for water level in the culvert itself.

109. In my view, the overall residual effect of the Project on fish passage, after mitigation, will be ‘low’. For some of the very steep culverts, the fish passage will be partial, even with baffles, but the impact is limited due to the small upstream catchment sizes, and the limited stream habitat suitable for fish.

Loss of stream habitat

Potential effect

110. The Project will result in the in the short-term or permanent loss of about 3822 m (3361 m^2) of waterways as a result of culverts and stream diversions. Approximately half the affected stream length is in pristine condition (an SEV score >0.9), and most (>80% by length) of the affected streams are permanently flowing, perennial streams. This is a large-scale loss of moderate to high quality stream habitat, functions and values. It constitutes a very high adverse effect that requires offset.

Mitigation and biodiversity offsets

111. Biodiversity offsets can be used to achieve ‘no net loss’ or a ‘net positive gain’ where residual effects remain after applying a hierarchy of avoiding, minimising and mitigating the effects on ecology. They are measures to counterbalance any residual environmental effects following mitigation. The evidence of Mr MacGibbon explains offsetting in greater detail.

112. As discussed above, the SEV approach was used to calculate that 8157 m^2 of stream area (or 8627m length) is required for restoration in order to offset the loss in stream values and achieve no net loss. This restoration is in addition to creating stream diversions to, in most cases, provide values similar to the current stream condition.[13]

113. In calculating the necessary offsets, I assumed realistic potential outcomes for restored streams using good design, implementation and a c. 10m buffer at restoration sites. I assumed that diversions in lowland streams in pasture catchments will be rehabilitated to their current condition (or better), but the diversion section of pristine forested streams may not attain their current condition – the ECR values reflected this assumption. If a stream section is restored to be substantially better than its current condition, then the incremental improvement of this length could be included as part of the offset package.

114. The Project is proposing to offset the loss of stream habitat by restoration planting along 8627m of stream length with an average riparian width of 10m. In my view, the proposed offsetting will ensure no net loss of stream values

[13] The exception are the stream diversions of pristine stream sections near the tunnel portal. For these streams the final stream diversion was assumed to have lower ecological value then the existing stream and an offset was calculated accordingly.

and probably provide a net gain in the medium to long term. The net gain is likely because:

(a) The proposed offset is based on stream length rather than stream area. This results in more offset than required by the SEV approach because, for this Project, the restoration sites are wider (have more aquatic habitat) than the impact sites.

(b) There will be additional benefits to the Mangapepeke Stream because the restoration will extend across the valley and not just be limited to a 10m buffer. Re-establishing kahikatea swamp forest in the valley is likely to provide particularly high aquatic values in the long term.

(c) Pest management may also provide additional benefits to streams. Removing undulates may reduce stream bank erosion, while reducing rat numbers may reduce predation on kākahi. I have not quantified the magnitude of these particular benefits.

Stormwater runoff

Potential effect

115. Stormwater discharges can adversely affect stream hydrology, water quality and temperature regime. The effect of stormwater on the water quality and hydrology of a receiving water largely depends on the relative volume of stormwater compared to the stream, contaminant sources in the catchment, and type of stormwater treatment.

116. The Project will increase the amount of impervious surface area in both the Mangapepeke Stream and Mimi River catchments, but in absolute terms the amount of impervious area will remain very low (about 2.4% and 0.7% of the lower Mangapepeke Stream and Mimi River catchment respectively). This amount of impervious surface is very low in the context of an SEV assessment and the low-moderate traffic volumes expected over the road.

Mitigation

117. Stormwater from the road will be treated in swales and treatment wetlands situated near site E1 at the northern end and site E7 at the southern end of the Project extent (see operational stormwater design description in Section 4.16 of the AEE, and the Drainage Layout drawings in Volume 2 of the AEE). Wetlands will be vegetated wetlands with a banded design to provide stormwater detainment and treatment.

118. The combination of the Project having a small impervious footprint relative to the catchment, stormwater treatment devices and low to moderate traffic volumes will result in the Project having only a small effect on hydrology, thermal pollution and water quality. In fact, there is likely to be a net

improvement in water quality from the construction of stormwater treatment wetlands that are not currently present on this section of the road.

Overall conclusion on effects

119. The Project will potentially affect the ecology of the Mangapepeke Stream and Mimi River in multiple ways including increasing sediment loads, modifying fish passage and causing the loss of stream habitat.

120. Most of the potential effects on freshwater ecology can be appropriately minimised and mitigated through design and management. However, the loss of stream habitat will be offset as part of the offset package. As a minimum this will achieve no-net-loss, but it is could well achieve a net gain in freshwater ecology values in the medium to long term based the information in Mr MacGibbon's evidence.

RESPONSE TO SUBMISSIONS AND SECTION 42A REPORTS ON FRESHWATER ECOLOGY ISSUES

121. I respond below to freshwater ecology issues raised in submissions on the Project and in the Section 42A Reports on the Project.

Forest and Bird

122. Forest and Bird expressed concern (submission point 12) that the diversity of macroinvertebrate species that may be present in the catchments was not adequately measured. They requested that a survey of adult macroinvertebrates be undertaken to assess biodiversity values in the catchments.

123. The aquatic macroinvertebrate samples from Managapepeke and Mimi River catchment were collected and analysed using standard methods that allow us to assess stream condition and health. For most aquatic insects that method collects the larval stage, it does not collect terrestrial insects without an aquatic larval stage and it does not provide the high level of taxanomic resolution required to identify rare or endangered species. These gaps are addressed by the baseline monitoring led by Landcare Research and discussed in the evidence of Dr Watts.

124. The sampling by Landcare Research found two aquatic insect species that had a threat classification. These were:

(a) *Alloecentrella incisus*, a small Helicophidae caddisfly. It is considered '*Range Restricted'* but Mt Messenger is within its known distribution range.

(b) *Spaniocercoides watti*, a stonefly that is classified as 'Data Deficient' by Grainger et al (2014), this is the most southern record for the species.

125. The presence of these species does not change the overall stream values or effects assessment undertaken using the EcIA approach. This is because most streams affected by the Project had already been assessed as having 'High' ecological value due to the widespread presence of fish species with a threat classification of 'At-Risk Declining'.[14]

Department of Conservation

126. The Department of Conservation (DoC) raised a number of concerns regarding the effects of the Project on freshwater ecology. I met with DoC experts on 28 March 2018 to clarify the issues raised and where possible identify area of agreement. 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.

127. Below I set out my response to each relevant DoC submission point, including my understanding as to whether the point is resolved or not. In a number of cases I rely on Mr Ridley for responses in respect of sedimentation concerns – I set out below where that is the case.

Offset for residual effect of sedimentation

128. DoC requested that the Transport Agency identify and offset for the residual effect of any sedimentation that might occur from the Project. As set out above, I recommended that this approach is taken for the kahikatea swamp forest in the Mimi River valley downstream of the tunnel portal, and a process is described to that end in section 8.4.3 of the ELMP. I recommended that the sedimentation monitoring focus on the Kahikatea swamp forest (Mimi River) downstream of the tunnel portal, because this system has very high ecological values, is potentially sensitive to sedimentation and is downstream of works requiring a large amount of fill which can increase the risk of sediment loss.

129. I have not recommended this approach to monitoring or assessing residual effects of sedimentation to other parts of the Project because most of the streams downstream of the Project works already have considerable sediment deposition from naturally high sediment loads. The streams are accustomed to high sediment loads, and this makes them less sensitive to effects of residual sedimentation and makes it difficult to measure and apportion any residual effects. This does not detract from the importance of minimising sediment loss from the site and maintaining a high level of erosion and sediment control measures, as per the mitigation measures discussed above and in Mr Ridley's evidence.

Detail of assessment

130. DoC submitted that that the assessment of freshwater values in the application was lacking the detail necessary to adequately describe the

[14] The exception was kahikatea swamp forest in the Mimi River, to which I gave a 'very high' ecological value.

existing freshwater environments. Since making the submission, DoC has had the opportunity to view the Supplementary Report - Freshwater Ecology (Hamill 2018). I understand that DoC now consider the detail to be adequate for the purposes of assessing values and effects.

Headwater streams

131. DoC submits that the SEV method for assessing offset does not give sufficient weight to the biological importance of headwater streams. The submission did not consider that the suggested quantum and effects management approach will ensure no-net loss for these freshwater effects.

132. Headwater streams are generally considered to be small streams consisting of springs, intermittent, first- and second order streams. Using this definition all of the streams directly affected by the Project are headwater streams.

133. Headwater streams are an important part of the stream network and contribute cumulatively provide important habitat and rich biodiversity. However, in my view, headwater streams are not more important than larger streams. Furthermore, the SEV method is appropriate for assessing the values of headwater streams. Many of the component functions in the SEV explicitly and implicitly value the connections of the stream network both upstream and downstream.[15] The SEV is widely used throughout NZ for a range of stream sizes and the method has recently been assessed as appropriate to apply to intermittent streams, i.e. some of the smallest of our headwater streams (Neale et al. 2016).

134. When taken as a group, headwater streams (stream order 1 - 2) can have higher landscape diversity of aquatic macroinvertebrates compared to larger streams, i.e. there are more differences in the macroinvertebrate communities among different streams (Finn et al. 2011). One reason headwater streams can have higher landscape diversity is because they are numerous[16], are a branching network of relatively isolated sites and cover a large area of landscape. On a site by site basis[17], headwater streams generally have similar or slightly lower diversity of aquatic macroinvertebrates compared to larger, mid-order streams (Storey et al. 2011, Finn et al. 2011). This supports the importance of maintaining headwater streams in the landscape and giving them similar status to larger streams.

135. Headwater streams can provide important habitat, feeding grounds and refuge for fish. However, fish diversity is generally less in the smaller streams (Meyers et al. 2007). This was observed with fish sampling around Mt Messenger where the size, abundance and diversity of fish were more limited in the small tributaries – probably because they were often very shallow.

[15] e.g. Vpipe, Vbarr, Vwatqual, Vimper, Vfish, Vept, and Vinvert.
[16] 70% of stream channel length by some estimates (Lowe and Likens 2005).
[17] This refers to within site diversity, or alpha diversity.

136. Stream restoration efforts are more successful when contiguous with protected and forested headwaters. Protected headwaters help ensure good water quality to downstream sections and the network of headwater streams contributes to biodiversity downstream. The Project's offset package recognises the importance of headwater streams. It prioritises restoration sites in the Mangapepeke Stream and Mimi River valleys. The restoration is contiguous with existing indigenous forest, which will improve both the quality of headwater streams and connections with headwater streams[18].

Fish Recovery Protocols

137. DoC submitted that fish recovery should occur at all waterways using active fishing methods. The Fish Rescue and Recovery Protocols for the Project are described in the ELMP (Appendix D). These protocols will be applied to all waterways with water in them at the time of works. They provide for multiple methods for fish recovery, the methods applied to any particular waterway will depend on the nature of the stream. The safest way to remove fish from a stream, without causing damage or fatalities from nets or electo-fishing, is to allow them to swim downstream as water recedes. This approach is given priority but will generally need to be applied in conjunction with active fishing methods such as electro-fishing or netting to recover fish from residual pools.

Timing of in-river works

138. DoC requested restrictions on the timing of in-river works to better protect redfin bully and giant kōkopu during their spawning period. In particular, restricting in-river works between August to October for redfin bully spawning during April to June for giant kōkopu spawning[19]. In my view this approach has some merit and could reduce the risk sedimentation affecting the spawning of these species. However, the approach must be considered in the context of its marginal benefit, practical application and the risk of these restrictions increasing overall sedimentation.

139. The preferred approach for construction of culverts and stream diversion (set out in the CWMP section 6) is to avoid instream works and create stream diversions and culverts off-line. However, on-line, instream work is expected at the following areas:

(a) making live any culverts or stream diversions that have been created off-line. Any sediment release from this is very temporary (e.g. less than an hour);

[18] See evidence by Mr MacGibbon.
[19] Giant kōkopu spawn multiple times during the spawning season in dense riparian vegetation. Eggs are deposited while temporally submerged by high water (e.g. floods), they develop terrestrially before hatching when the eggs are re-inundated during later high flows (Franklin et al. 2015). Redfin bully spawn multiple times during spring. The eggs are typically laid underneath a large rock and the male defends the nest for two to four weeks until they hatch. (McDowall 2000).

(b) the extension of culverts under the existing farm access track, true left of the Mangapepeke Stream;

(c) the short-term culverts installed for the access track across the Mangapepeke Stream (these could be installed off-line but this would create a larger footprint and, in my view, would cause a worse ecological effect on the stream); and

(d) the fill leading to the tunnel portal at the head of the Mangapepeke Stream and Mimi River tributary.

140. The first three scenarios have relatively low risk of sedimentation because they are either very short-term (e.g. a) or because they are small sections with the effects managed by procedures for managing instream works (e.g. timing for dry weather, isolating the stream section and pumping around). The large fill near the tunnel portal will likely take several months to complete. Any constraint on the timing of this work needs to be balanced with the risk of it being only part completed before the winter – which, I understand from discussion with Graeme Ridley, could increase the risk of erosion.

141. Overall, I support the approach taken in the ELMP (chapter 8.3.4), being that: "*where practicable, avoid large scale instream works during August to October and April to June (inclusive). These are the spawning seasons for redfin bully and giant kōkopu respectively. This condition particularly applies to the large areas of fill required near the tunnel portals but should be applied flexibly to avoid the work being left incomplete over the winter*."

Water take

142. DoC submitted that the water takes should be restricted based on flow rather than water level and that low flow data should be collected. These comments have been acknowledged and a revised approach to managing the water takes is described in my evidence and the ELMP (section 8.3). In my view, proposed conditions will ensure that potential adverse effects from the water take will be appropriately minimised and mitigated.

Fish passage through culverts

143. DoC notes that the Project requires a number of new culverts, and that some of them are long and steep. They requested that the Transport Agency modify the design to use bridges or arch culverts. Obviously, bridges or arch culverts are better options for providing fish passage and reducing effects – particularly where there are larger upstream catchments (e.g. site Ea10). The design approach and rationale are discussed in the evidence of Mr Boam.

144. Measures to achieve fish passage are incorporated into the culvert design and these are being refined during the design phase. The effectiveness of fish passage through culverts will be monitored as described in section 8.4 of the

ELMP. This includes post-construction inspection of all culverts. Post-construction fish monitoring has focused on the three culverts with the largest upstream catchments i.e. culvert 9 (site Ea10, 67 ha),culvert 15 (site Ea16, 36 ha +14 ha to stream diversion) and culverts 18/19 (site Ea23, 25 ha catchment). The potential effect of these culverts is greater because they have more potential fish habitat upstream.

Invertebrate passage through culverts

145. DoC's submission noted that culverts can potentially restrict the passage of aquatic invertebrates. This potential effect relates to the risk that culverts installed by the Project restrict the upstream aerial dispersal of adult flying invertebrates. Stream corridors are the preferred flight pathway for adult aquatic insects, and road culverts can potentially disrupt passage by constricting the stream channel, disrupting the flight path and increased mortality by predation within the culvert.

146. Road culverts can particularly be an issue when restoring streams in urban landscapes. Studies in urban Christchurch found road culverts acting as barriers to the upstream flight of adult caddisflies. Caddisfly abundance and taxa richness was lower upstream of successive culverts compared to downstream. When adult caddis encountered a road culvert, some are distracted by the surrounding urban conditions (e.g. street lights), and only 30-50% enter the culvert. Of these, about 10-30% do not reach the upstream exit – possibly due to predation (Harding et al. 2005, Blakely and Harding 2006).

147. Studies of aquatic insect dispersal outside of the urban setting has found that the impact of culverts to be minor compared to the surrounding terrestrial land-use; in part because overland dispersal pathways between streams are also important (Tonkin et al. 2014, Smith et al. 2015, Sondermann et al. 2015). This is consistent with studies in rural landscapes that have found no impact of road culverts on the composition of the aquatic macroinvertebrate community (e.g. Wild et al. 2010).

148. There is no evidence that road culverts associated with the current SH3 are affecting the community composition of aquatic macroinvertebrates in streams around Mt Messenger. I undertook a cluster analysis of aquatic macroinvertebrates with an aerial dispersal stage and found no significant difference in the community for streams on either side of the current road, and no significant difference in the number of EPT taxa.[20] This does not mean that the culverts on the current road have no effect, but it does show that the effect (if any) is not apparent in the community composition.

149. In my view, the culverts installed for the Project will have little effect on the aquatic macroinvertebrate community in the upstream catchment. The

[20] During 2017 eight macroinvertebrate samples were collected in west of SH3 and thirteen samples were collected east of SH3. EPT taxa refers to mayfly, stonefly and caddisfly.

culverts may hinder the passage of some insects flying through them, but the overall effect on the community will be limited because, in contrast to urban landscapes, the Mt. Messenger road does not have street lighting, has relatively low traffic volumes, and macroinvertebrate populations are not fragmented by landuse patterns.

Mr Arms

150. Mr Arms asks in his submission if any fish are going to relocated as a result of the works. The answer is yes. Fish will be relocated following the Fish Rescue and Recovery Protocols (Appendix D of the ELMP). Fish will be relocated to suitable stream habitat adjacent to where they were caught. In the long term, restoration work undertaken as part of the offset compensation package will improve habitat values for fish in the Managapepeke Stream and Mimi River.

Section 42A Reports

New Plymouth District Council

151. Paragraph 313 of NPDC Section 42a report lists mitigation and offset measures that "*would substantially increase the likelihood that the adverse ecological effects of the project could be addressed*". This included: "*Retro-fitting any existing perched or broken culverts along the route to facilitate upstream fish passage*". NPDC has included this as their proposed designation condition 25f(iv).

152. Retrofitting fish passage for existing culverts associated with the route is an effective way to minimise adverse effects of existing culverts, offset potential effects on fish passage of new culverts and/or provide a net environmental benefit. In this situation, the benefits will be small because of the small number and small size of stream affected by fish barriers within the Project extent. Nevertheless, I support the proposal to retrofit fish passage where this would be beneficial. Existing fish barriers that I am aware of are:

    (a) Upstream of site Ea21 has two perched culverts under the current SH3 (each with a small upstream catchment of about 1.3ha). Unlikely to be fish habitat upstream due to the small stream size.

    (b) Upstream of site Ea20 there may be a potential fish barrier under the current SH3 (upstream catchment about 3 ha). Unlikely to be fish habitat upstream due to the small stream size.

    (c) Site ETL6 under the farm track has a small perch (upstream catchment 3.1 ha).

(d) Site Ea23 may have a partial fish barrier from a farm culvert at its confluence with the Mimi River. The catchment is 25 ha and fish are present upstream.

153. NPDC have recommended as designation condition 26 that "*The ELMP shall address and specify how the Project will avoid, remedy, mitigate, and offset effects on ecological values…"*. In my view, the ELMP does address issues relating to:

(a) "*restoration of wetland vegetation*" - I have discussed this in my evidence responding to Department of Conservation under the heading "*Offset for residual effect of sedimentation*";

(b) "*fish, kōura and kākahi*" – in the Fish Rescue and Recovery Protocols (appendix D of the ELMP);

(c) "*streams*" – through offset restoration.

Taranaki Regional Council

154. TRC's proposed Diversion consents (16.4) condition 3 reads:

> "*The diversions shall be designed and constructed to replicate the flow capacity and aquatic habitat values of the upstream and downstream channel sections and in such a manner so as to avoid causing any new or exacerbating any existing flooding effects on adjacent and upstream land.*"

155. The emphasis on avoiding flooding in this wording risks compromising the ecological values of the stream diversions with no balancing benefit. In my experience stream diversions are often build too wide because of the emphasis on minimising the risk of flooding or erosion – this is to the detriment of stream ecology. Over-widening a stream results in poor environmental conditions because the stream is too shallow during baseflow and has insufficient energy to form diverse hydraulic features such as pools and riffles. The flood plain is part of the stream and flooding of the flood plain is common in the Mangapepeke Stream and upper Mimi River, it provides ecological benefits and I am not aware of any issues from floods upstream of where the stream diversions are located. In my view, there would be a better environmental outcome if this condition was worded to ensure that stream diversions are designed and constructed to be consistent with the Ecological Design Principles (section 7 of LEDF). As minimum I recommend **deleting** the condition wording that says "…*and in such a manner so as to avoid causing any new or exacerbating any existing flooding effects on adjacent and upstream land".*

156. TRC proposes consent conditions relating to fish recovery protocols. Fish Rescue and Recovery Protocols have been developed (appendix D of the

ELMP). In my view these are appropriate protocols and I understand that the applicant is seeking for these to be approved as part of the consent process.

157. TRC proposes a number of conditions reading "*Between 1 May and 31 October no work shall be undertaken on any part of the stream bed that is covered by water*" (e.g. Diversion condition 9, Temporary Culvert condition 8, Permanent Culverts condition 8). I have discussed the timing of in-river works in my response to the DoC submission above. In my view the approach taken in chapter 8.3.4 of the ELMP is more appropriate and will result in better environmental outcomes. Mr Ridley discusses in his evidence how instream works can be undertaken in a way that has low risk of sedimentation without the need for a blanket winter ban.

158. TRC proposes a number of consent conditions reading "*The culvert shall not restrict fish passage*" (e.g. Diversions condition 4, Temporary Culverts condition 10, Permanent Culverts condition 12). This wording could be interpreted as meaning the culvert shall not restrict any fish passage, for any fish species, at any time. Some culverts would not comply with this interpretation of the wording. Temporary culverts, some of the steep permanent culverts and some of the steep diversions will restrict passage for some fish and at some flows. This also occurs naturally; for example, inanga are not found above site Ea10 because of small cascades caused by roots in the stream, similarly giant kōkopu were not found above steep sections of the Mangapepeke Stream or Mimi River tributaries. In some streams (site Ea15) banded kōkopu are found above a steep waterfall, but the limited amount of suitable habitat available in this small stream means that they would only occur in low abundance even in the absence of the natural barrier caused by the waterfall.

159. In my view the key outcome is for the culverts and diversions to provide sufficient passage of fish that would naturally occur upstream of the culvert/diversion so as to maintain healthy populations. This recognises natural landscape conditions and protects naturally occurring fish populations. The applicant proposes wording the conditions as "*the diversion/culvert shall provide for fish passage in accordance with the ELMP*". This wording is clear and manages the effects on fish passage through the details provided in the ELMP.

Keith Hamill

25 May 2018

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