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ŌTAKI TO NORTH OF LEVIN
SH1-SH57 Connection
Report on Multi-Criteria Analysis of Options

Prepared for New Zealand Transport Agency

November 2013

Allan Planning & Research Ltd

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EXECUTIVE SUMMARY

This report is one of a number of appendices to the SH1-SH57 Scoping Report (the Scoping Report), prepared for the New Zealand Transport Agency by MWH NZ Ltd as part of the investigations for the Ōtaki to North of Levin Roads of National Significance project.

The report describes the methodology, information base, process and outcome involved in the analysis of six route options through a formal Multi Criteria Analysis process between September and November 2013. Five of the six route options were identified by the project team and were the subject of detailed investigations and a structured workshop to "score" the options for further analysis. The sixth option arose from consultation with local tāngata whenua and was investigated and analysed post-workshop.

The five options initially identified arose from ongoing investigations of possible safety and efficiency improvements. These options were developed by the project team to a stage suitable for further detailed evaluation. A number of technical specialists were involved in a briefing and then carried out more detailed investigations of effects, based on the description and preliminary plans of each of the routes proposed. These specialists included experts in landscape and visual evaluations, archaeology and heritage, ecological values, tāngata whenua values, productive land values and hydrological resources. Reports on each of these aspects were prepared. Additional criteria were also identified, and information on these was drawn from the knowledge of the project team.

The eleven criteria taken into account were landscape and visual impacts, ecological effects, implications in terms of archaeology and heritage, cultural values, effects on productive landuses, social and community impacts, fit with district and regional plan provisions, alignment with transport objectives, effects on specific types of land ownership and landuses, engineering degree of difficulty, and costs.

The workshop process confirmed the criteria and shared knowledge and information about each of the criteria and how each of the routes would relate to each criterion. The scoring system ranged from 1 (where a route performed well under that criterion) and 5 (where a route had particular problems in terms of that criterion). Working together, workshop attendees scored the route options under all criteria. The scores ranged across the whole numeric range (1 to 5), depending on the criterion. It was considered whether any of the options contained fatal flaws in terms of any of the criteria, and it was decided that there were no fatal flaws.

The scores from the workshop were then evaluated on the basis of six weighting systems. One of the weightings was derived by agreement at the workshop, where attendees determined that all criteria should be weighted equally. The remaining five weighting systems were developed on the basis of a section 6, Resource Management Act emphasis (emphasis on matters of national importance) and the "quadruple bottom line" considerations of social, environmental, cultural and economic aspects formed the basis for the remaining four weightings.

The analysis demonstrated that the preferred route is Option 5A, which follows the west side of the North Island Main Trunk railway from north of Manakau to north of the Ohau River and then crosses back to rejoin State Highway 1, while a new State Highway 57 crosses both the railway and State Highway 1, to follow a new route across country to join Arapaepae Road north of its intersection with Kimberley Road.

Option 5A was the clearly preferred option under four of the six weighting systems (the workshop weighting and social, cultural and economic weightings), while Option T (the option which arose from tāngata whenua consultation) was preferred under one of the weighting systems (the ecological weighting). For the final weighting system (the Resource Management Act section 6 weighting), Options 5A and T were preferred, but the preference was not sufficiently significant to differentiate a preference between the two. Overall, there was no option other than Option 5A which rated consistently well across the analysis.

The investigations, process and findings make a worthwhile contribution to understanding the implications of a range of alternative route options in the area, and will assist NZTA in making a final decision on the preferred route option.

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1 INTRODUCTION

The New Zealand Transport Agency (NZTA) has been investigating a package of improvements to the existing state highways between Ōtaki and North of Levin as part of its strategic approach to achieving safety and efficiency benefits in the short to medium term, while retaining a long-term option to achieve a four lane highway in the project area.

Since 2011 the project has proceeded through investigation of the opportunities and constraints of an expressway within the wider project area, to investigations to identify feasible targeted improvement projects, and through several stages of consultation. Some of the specific projects have required further consideration following Stage 3 consultation in April and May 2013.

The connection between State Highway 1 (SH1) and State Highway 57 (SH57) is one such project where it proved appropriate to identify a range of route options which could then be subject to a range of analysis to help identify the "best" option to proceed with.

This report explains the basis and outcomes of the analyses undertaken. The method applied is known as multi-criteria analysis or MCA, which is an accepted method when a number of options with a wide range of impacts, benefits and costs need to be evaluated. The methodology follows a series of process steps which are fully explained in this report.

The identification and consideration of options is an important component of investigations which lead to notices of requirement for designations under the Resource Management Act (the RMA), so the process set out in this report, and its findings, will contribute to future statutory processes to secure the preferred route and gain RMA approvals.

This report is presented as an Appendix (Appendix K) to the report entitled "Ōtaki to North of Levin, SH1-SH57 Connection, Scoping Report" (the Scoping Report) prepared by MWH NZ Ltd, November 2013.

The structure of the remainder of this report is as follows:

a description of the area and the six options for evaluation (section 2)
a description of the multi-criteria analysis method and approach to analysis (section 3)
information requirements and technical specialist studies (section 4)
application of the multi-criteria analysis (section 5)
analysis and outcome from the multi-criteria process (section 6)
conclusions (section 7).

Considerable supporting material is provided through a number of appendices attached to this report, as listed in the Contents pages.

2 OPTIONS FOR ANALYSIS

2.1 Geographic Area

The area for evaluation encompasses land that lies in the vicinity of SH1 and SH57, between Manakau township in the south and Levin in the north. The present state highway routes within this area incorporate various features and characteristics which require improvement or alternative resolution. The problems have been fully documented in earlier reports[1] and various options considered for each section.

Between April and August 2013, further work was done on the various route options, taking into account additional design considerations and the findings of Stage 3 consultation. This resulted in identification of five route options, evolved from earlier possibilities as described in section 7 of the Scoping Report for further consideration, as shown in Appendix 1.

For the purpose of analysis each route option had to serve an equivalent function, so each was considered to commence at a common point at the southern end, approximately 1.5 km north of Manakau township. The northern end of each route option was taken to be north of the junction with Kimberley Road on SH1 and/or north of the junction of Kimberley and Arapaepae Roads on SH57.

Later in the process, a further option arose from consultation with tāngata whenua associated with Tukorehe and Wehiwehi maraes[2]. This was described as a "hybrid option" and it was decided that, although not as well developed as the other five options under consideration, it should be added to the range of options to be evaluated in terms of the multi-criteria analysis[3]. A broad sketch was prepared and is also included in Appendix 1.

2.2 Description of Options

Table 1 on the following page sets out the key features of the options to be evaluated. More detail of most of the options, including geometry, staging considerations, and connections to the network are provided in the Scoping Report. Option T, which emerged later, has not been detailed in the Scoping Report. It can be considered to have similarities in description to parts of Options 7A and 3C, with a different central section, and different location for a bridge crossing the Ohau River.

[1] E.g. Project Feasibility Reports for NZTA early 2013 addressing Manakau Ohau Bridge (Report 3), Ohau Settlement (Report 4) and SH1-SH57 Arapaepae Curve, MWH NZ Ltd.
[2] Email – Morrie Love to Phil Peet, 22nd October 2013.
[3] As discussed later in this report, a different analytical method was applied, due to the late identification of this option.

Table 1: Description of Route Options

Route Option Number	Description and key features (from south to north)
3C	Route realigns existing SH1 to the west of the North Island Main Trunk railway line (the NIMT) between new bridges over the Waikawa Stream and Ohau River. North of Ohau the route bifurcates with SH1 comprising two improved lanes on the existing route, , and SH57 connecting to Kimberley Road via an overbridge over both SH1 and the NIMT, with an improved large-radius corner then connecting with Arapaepae Road. Key features: four lanes through Ohau (long term) two new river bridges west of NIMT overbridges north of Ohau maximises use of existing highways.
4A	Route realigns existing SH1 to the west of the NIMT between new bridges over the Waikawa Stream and Ohau River. Route bifurcates just south of Ohau with structures for SH57 crossing SH1 and the NIMT to run through vineyard blocks and cross-country to intersect with Arapaepae Road just north of present Arapaepae Road-Kimberley Road junction. SH1 continues on present route north from south of Ohau. Key features: two lanes retained through Ohau with reduced traffic volumes two new river bridges west of NIMT overbridges south of Ohau affects numerous rural properties minimises length of SH1-SH57 connection.
5A	Route realigns existing SH1 to the west of NIMT between new bridges over the Waikawa Stream and Ohau River. Route bifurcates just north of the Ohau River with more complex structures providing cross-country connection to SH57. SH1 continues on its present route north from just north of Ohau River and through Ohau, while SH57 follows a route further south than Option 4A, avoiding the existing vineyard to the east of SH1 and the totara reserve area. Key features: two lanes retained through Ohau with reduced traffic volumes complex overbridges result in three new river bridges west of the NIMT overbridges well south of Ohau affects numerous rural properties straighter approach to Arapaepae Road merge more closely aligned with property boundaries in this area.

6A	Route realigns existing SH1 to the west of the NIMT with new bridge over the Waikawa Stream, until just south of the Ohau River. From a bifurcation south of the river, the SH1 connection crosses the river on a new structure, and then rejoins the existing SH1 route. The SH57 overbridge crossing of the existing SH1 and the NIMT occurs just north of the urupa, travelling along the south side of the Ohau River with a new bridge crossing just over 1km to the east of the existing SH1 bridge. From the crossing, it traverses farmland to approximately follow the Option 5A alignment to Arapaepae Road. Key features: two lanes retained through Ohau with reduced traffic volumes three new river bridges – two west of the NIMT and one substantially to the east reduced number of rural properties affected straighter approach to Arapaepae Road merge more closely aligned with property boundaries in this area.
7A	Route approximately follows the existing SH1 route between new bridges across the Waikawa Stream and the NIMT at the southern end, and the angle change near St Stephens Church. From this point the route continues approximately 1km north before bifurcating with the SH1 component swinging slightly west to cross the Ohau River 500m east of the current bridge on a new structure. The SH57 connection continues north to merge with the route of Option 6A beyond a new bridge over the Ohau River north of the river. Key features: two lanes retained through Ohau with reduced traffic volumes three new river bridges east of NIMT affects a similar number of rural properties to Option 6A (but different properties south of Ohau River).
T	Route follows existing SH1 route to angle change near St Stephens Church, then continues north for approximately 500m before swinging west and crossing the Ohau River and rejoining the existing route of SH1 just south of the vineyard. It then follows the alignment of Option 3A connection to Arapaepae Road via Kimberley Road. Key features: four lanes through Ohau two new river bridges east of NIMT affects a smaller number of rural properties than all options except 3C.

These options, except for Option T, as noted earlier, were developed to preliminary design stage as provided in the Scoping Report so that their likely environmental and other implications could be reasonably understood for the purposes of information gathering and multi-criteria analysis. As Option T is predominantly a hybrid of other options, its implications are well understood.

3 MULTI-CRITERIA ANALYSIS METHOD

3.1 Background

Figure 1 sets out a schematic representation of the context within which multi-criteria analysis is applied, particularly in relation to significant infrastructure projects.

In the circumstances of the SH1-SH57 connection, Steps 1 and 2 in Figure 1 had been developed in line with the method set out in the Scoping Report, producing options that were considered able to contribute to the achievement of NZTA's objectives for the Ōtaki to North of Levin RoNS project. With the addition of a step which involved collection of more detailed environmental material, these two steps set the scene for the remainder of the steps set out in Figure 1.

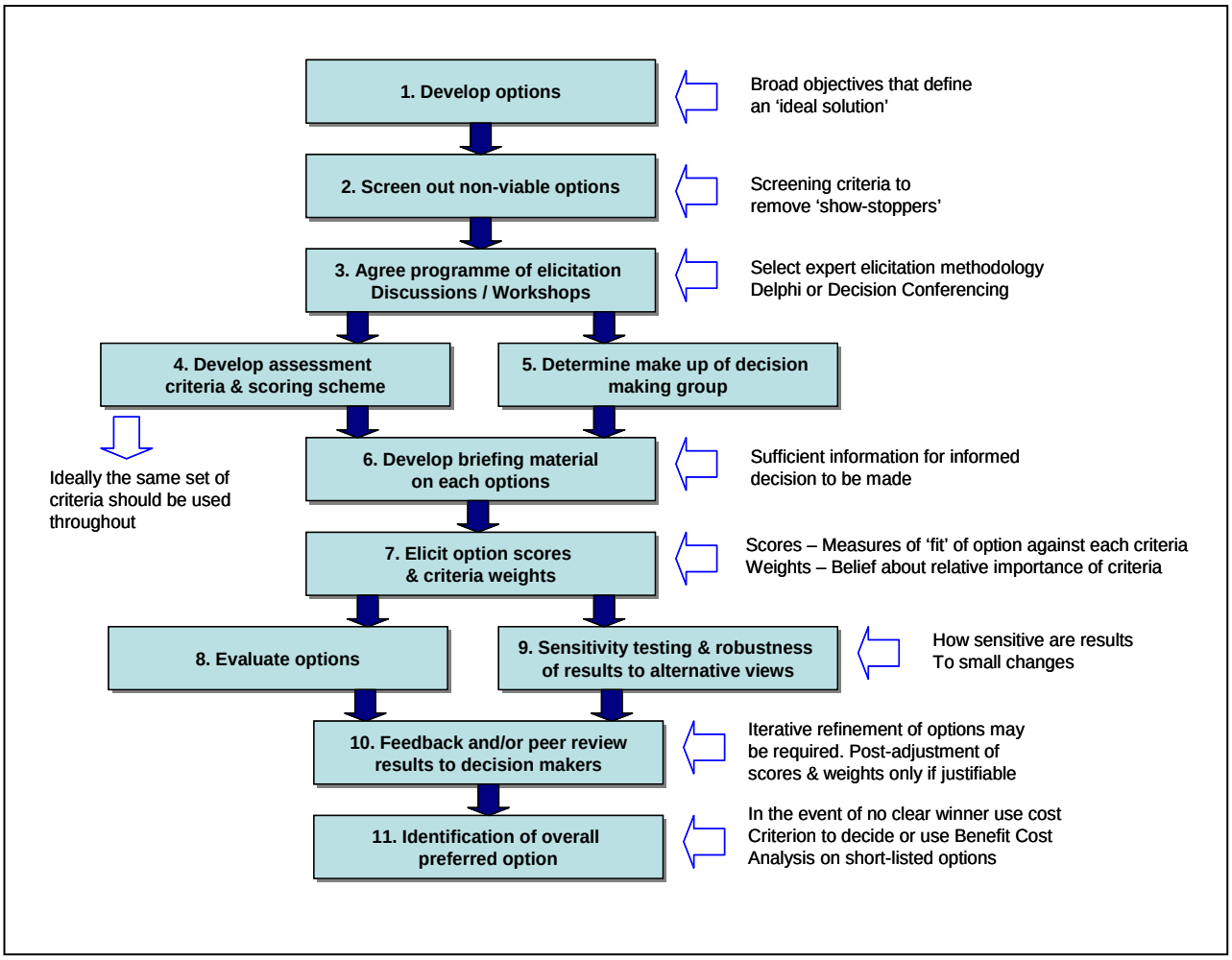


Figure 1: Multi-criteria Analysis Process

3.2 Methodology

The multi-criteria analysis methodology is a key element of analysis, and a useful aid to decision-making. Multi-criteria analysis is particularly applicable when there are several options to choose between, and where there are numerous complex considerations involved. Multi-criteria analysis is thus commonly used in assessments of options for infrastructure. It is a useful tool for evaluations, including those under the RMA and Local Government Act (LGA), to compare and assess alternative proposals where there are multiple objectives, and where there are a range of diverse potential adverse and beneficial effects affecting different areas and/or communities[4]. The range of attributes that are relevant to a decision between options can be numerous and varied, and it is necessary in such circumstances to bring together the information in a reliable and credible way.

Figure 2 on the following page shows how multi-criteria analysis is applied. Key aspects to be taken into account in the decision are identified, defined, and scored on a consistent basis. Once scored, they can then be weighted as appropriate and combined into a single option score. In multi-criteria analysis processes, the scores can be seen as surrogates for measures of value for an aspect (allowing for the effects of diverse criteria, with different units, to be combined). The weights represent beliefs or assumptions about what is important in a particular situation or to a particular group of decision makers.

It is possible to strengthen the analysis by applying a range of different weightings to see whether the preference changes due to weighting systems. It is also appropriate to test the sensitivity of the process by carefully reviewing the scoring and identifying the extent to which scoring would need to change to result in a difference preference.

3.3 Decision-making in the Multi-criteria Framework

Decisions on criteria, scoring and weighting are ideally made by a group of informed people through a process that allows for testing through discussion, questions and answers. When the criteria are diverse and areas of specialist judgment are called-for, the preferred method is through a "decision conference" or facilitated workshop session, at which a participating group of specialists and generalists share information and work through the issues, finally deciding on the score for each criterion[5]. Ideally consensus is reached on the scores.

This reduces individual bias and keeps the process transparent.

[4] The use of multi-criteria analysis is recommended by the NAMS (the New Zealand National Asset Managers Support organisation) and is a key element of the Optimised Decision Making Guidelines promoted by that organisation. It also finds favour (used in conjunction with CBA) in "Decision-making on Mega-projects: Cost-benefit Analysis, Planning and Innovation", Priemus, H; Flybrjerg, B and van Wee, I, Eds – 2008.

[5] The method is based on the demonstrated hypothesis (from international research in the early 1990s on roading projects) that groups of people, given the same information and the opportunity to test the information, will make similar decisions on preferences, regardless of their backgrounds.

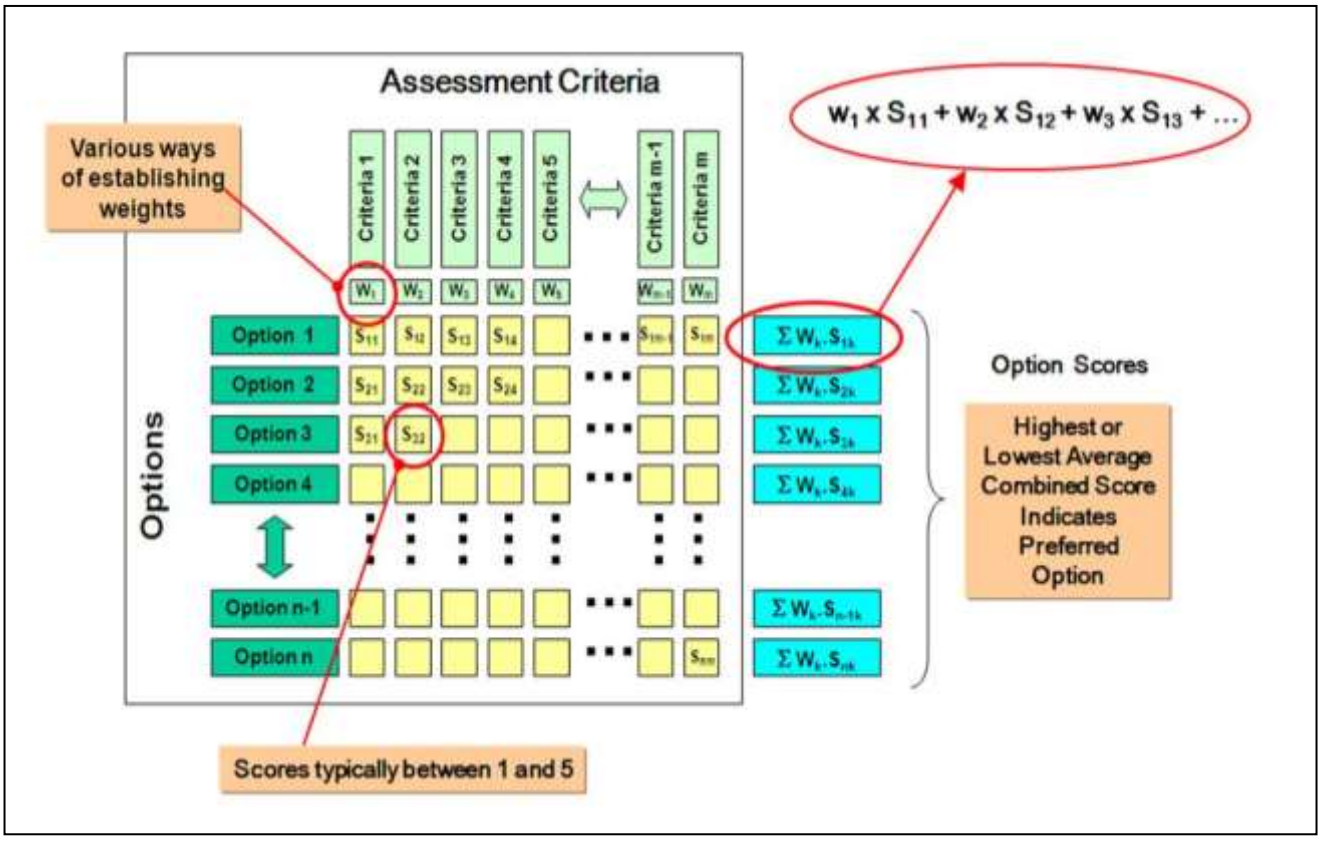


Figure 2: Multi-criteria Analysis Scoring and Weighting (Source: Steve Oldfield, MWH)

An alternative method which can be used is the Delphi method, where criteria are scored by individual technical and specialist experts and combined by an individual generalist who, at the same time, checks the robustness of the assessment. The Delphi method is an accepted method, but lacks some of the benefits of the decision conference method.

These benefits include drawing out the detail of the various assessments through discussion and questioning, and the involvement of project leaders who are particularly familiar with the project and the area, as well as examination and testing of the information through the shared scoring process.

In practice, both decision methods were applied in the multi-criteria analysis undertaken for the SH1-SH57 connection.

4 ADDITIONAL INFORMATION

4.1 Background

Information on the range of constraints that may apply in terms of any route within the area of the Ōtaki to North of Levin RoNS project had been collected early in the project investigations. This information had been added to thorough consultation processes, and as part of the Project Feasibility Reports. However, it was identified that more detailed information would be needed across a range of aspects in order to undertake an adequate evaluation of the identified options.

Aspects where further information was considered to be necessary included:

archaeological values
landscape and visual impacts
terrestrial and aquatic ecological values
productive land values (soil and landuse implications)
tāngata whenua values
the hydrology of the waterways to be crossed, particularly the Ohau River.

Technical specialists were engaged to undertake an appropriate level of investigation. Some had been part of earlier studies on the project, and others were added to the team. They were asked to consider the implications of each of the six route options identified in the Scoping Report in terms of their areas of expertise, to prepare for involvement in a multi-criteria analysis workshop process. Each was to prepare a report.

In addition, project team members with appropriate technical backgrounds were selected and asked to consider information relevant to other aspects of the project which would be applicable to the analysis. This included social and community impacts, district and regional plan provisions and consentability, landowner impacts and implications in terms of engineering and construction.

4.2 Scope, Analysis and Reporting

Prior to undertaking the investigations, the experts attended a briefing workshop on the options. The Agenda and subsequent Memo are provided in Appendix 2 to this report.

Following the workshop, each expert developed their own scope of work for approval by MWH and NZTA.

Field work as necessary was carried out between mid September 2013 and mid October 2013. With few exceptions, field work relied on observation from roads and public areas, although access to the vineyard area was provided by agreement with the landowner for the land specialist investigations.

The analysis was requested to be completed at a relatively high level, with any scoring of route qualities undertaken by a technical specialist using a "+" and "–" based scale. It was explained that this was because the workshop process may reach a different scoring. The approach is set out in Appendix 2, and has been followed in the reports.

The reports produced are provided as Appendices to this report as follows:

Appendix 3 – Ōtaki to Levin RONS (SH1 to SH57) Landscape Report on Route Options, Isthmus
Appendix 4 – Ōtaki to Levin Route Options: Ecology Constraints, Forbes Ecology
Appendix 5 – An Assessment of the Archaeological Risks Associated with Proposed Upgrades to the Connection of SH1 and SH57: Manakau to Levin, inSite Archaeology Ltd
Appendix 6 – State Highway 1 to State Highway 57 – Report on Māori Cultural Issues on Alternative Route Proposals, Raukura Consultants
Appendix 7 – Otaki to Levin Road Realignment Proposals – Land Resources Assessment, LandVision
Appendix 8 – SH1-SH57 MCA Options Evaluation, Hydrology Assessment, MWH NZ Ltd.

A number of other short reports were also prepared relating to the aspects under analysis at the multi-criteria analysis workshop. These are provided as Appendix 9 to this report.

5 APPLICATION OF THE MULTI-CRITERIA ANALYSIS

5.1 Choice of Attributes or Criteria

The attributes for assessment, or assessment criteria, are based on the aspects identified for investigation at earlier stages of the project, and were discussed amongst the project team as well as at the briefing workshop for the technical specialists. The criteria are relatively broadly-based, as is appropriate for the stage of project development, the scale of the project and the nature of the route options being evaluated.

The assessment criteria need to reflect matters that are important within the RMA, and the Land Transport Management Act 2003 and its amendments[6], taking into account the decision criteria that will eventually be brought to bear through RMA processes. They should also be able to be categorized across all of the "four well-being" considerations – social, environmental, cultural and economic, which are part of the sustainable development principles in the Local Government Act 2002. This assessment is shown in Table 2.

The choice of criteria also reflected the area which the route options passed through. Thought was given to whether natural hazards should be a criterion. It was determined that the area had a similarity of exposure to natural hazards, so this would not be a potentially distinguishing factor[7]. Any natural hazards effects (such as hydrological hazards) were built into cost and engineering degree of difficulty. Similarly, it was considered whether any routes could have impacts on life lines sufficient to justify a "life lines" criterion. It was found that no life lines were affected by any route option.

As can be seen from Appendix 2, the specialists were required to scope their own criterion or criteria. This was subject to review as part of the workshop processes. A brief description of the scope of each of the criteria follows in section 5.2.

Table 2: Assignment of Criteria to Generic Evaluation Frameworks

Criterion	NZTS Objective*, and GPS** Priorities, Impacts and Principles	Examples of relevant RMA Aspects	LGA Sustainable Development Principle (S14)
1. Landscape/Visual Impacts	Reducing Adverse Environmental Effects	S5, S6(b), S7(c) and (f)	Environmental
2. Ecology	Reducing Adverse	S5, S6(a) and (c),	Environmental

[6] The LTMA includes an overall objective and requires that NZTA exhibits a sense of social and environmental responsibility and acts in a transparent manner (section 96), and incorporates the Crown's responsibility to take appropriate account of the principles of the Treaty of Waitangi (section 4).

[7] Note that a specialist hydrological report was nevertheless prepared to address risk and any other implications for river crossings.

Criterion	NZTS Objective*, and GPS** Priorities, Impacts and Principles	Examples of relevant RMA Aspects	LGA Sustainable Development Principle (S14)
	Environmental Effects	S7(d)	
3. Archaeology/Heritage	Reducing Adverse Environmental Effects	S5, S6(f)	Cultural
4. Tāngata Whenua Values	All Objectives	S5, S6(e) and (g), S7(a), S8	Cultural
5. Productive Land Uses	Economic Growth and Productivity	S5, S7(b) and (g)	Social/Economic
6. Social/Community Impacts	Reducing Adverse Environmental Effects/Access and Mobility/Positive Health Outcomes/Urban Planning Principles	S5, S7(c)	Social
7. District/Regional Plan Fit/Consentability	Reducing Adverse Environmental Effects/Economic Growth and Productivity/Urban Planning Principles	S5, S104, S171	All aspects
8. Fit to Project Objectives	All Impacts and Principles	S5, S7(b), S171	Social/Economic
9. Specific Land Ownership	Economic Growth and Productivity	S5, S171	All aspects
10. Engineering Degree of Difficulty	Environmental Sustainability/Economic Growth and Productivity	S5	Environmental/ Economic
11. Cost	Economic Growth and Productivity, Value for Money	S5, S7(b)	Economic

* New Zealand Transport Strategy (current version, 2008).
**Government Policy Statement on Land Transport Funding 2012. The focus is on strategic priorities of economic growth and productivity, value for money, and road safety, but alongside these strategic goals are set out a series of "short to medium term impacts" to be achieved.

5.2 Description of Criteria

The scope and extent of each criterion was initially determined by the specialist, or person who had investigated the aspect, and fully discussed and confirmed at the workshop. A brief description follows.

1. Landscape/Visual – This took into account existing landscape character (including degree of modification and presence of structures), route length and presence of dwellings nearby, any outstanding landscape or natural character components, and important landscape/natural features.

2. Ecology – This criterion focused on terrestrial ecology values[8], particularly those relating to patches of indigenous vegetation which are nationally, regionally or locally significant in terms of habitat values and presence of known species.

3. Archaeology/Heritage – This criterion took into account presence of known archaeological and heritage sites and features, and also archaeological risks (i.e. the likelihood of encountering archaeological site).

4. Tāngata Whenua Values – This took into account the range of cultural values including values relating to the natural environment (waterways and wetlands, areas of indigenous vegetation), key areas of settlement (marae, papakainga) and use (food gathering areas), and known wāhi tapu.

5. Productive Land Uses – As reported and discussed at the workshop, this criterion took into account soils and the New Zealand Land Use Capability Classification, in particular classes 1 to 4 (productive land), the current productive landuse pattern, and potential severance effects on productive units.

6. Social/Community Impacts – This incorporated a range of considerations including severance effects, access to and from settlement areas and townships, general urban amenity, connectivity to community services and facilities, recreational effects, and construction impacts. (Note – direct effects on land including dwellings were included under specific land ownership effects.)

7. District and Regional Plans and Consentability – This criterion includes consideration of both zoning and plan objectives and policies, and any major impediments through the plans to a route location.

8. Fit to Project Objectives – This criterion covered levels of service, and efficiency and effectiveness (in terms of best value solutions). The assessment took into account the local network and the various state highway components.

9. Specific Land Owner/Land Use Effects – This criterion considered impacts on areas which could potentially pose difficulties for the location of an option – including Crown Land, Māori multiple-owned land, QEII Trust conservation land, as well as particular landuses.

10. Engineering Degree of Difficulty – This was assessed on the basis of physical components such as volume and balance of earthworks (cut and fill suitability of/issues with material), structures, temporary works, access management, risks around "unknowns", additional provisions to address natural hazards such as hydrological impact, and general degree of difficulty in construction.

11. Costs – Costs took into account the actual capital construction costs, including the range of matters identified under constructability, plus contingencies.

In assessing options, reasonable mitigation was taken into account.

[8] While aquatic ecological values were considered, it was determined that effects would be localised and similar between all options. They would be largely mitigated through design and managed through the construction stage.

There are 11 assessment criteria, which is an acceptable number[9]. The number and scope of the criteria were confirmed by the workshop.

It was noted at the workshop that there was some potential for double counting, particularly with constructability and cost, hazards and lifelines, aspects of social assessment (e.g. visual impact and social impacts), productive land and specific land owner effects, and archaeology/heritage and tāngata whenua values. It was decided that these issues could best be handled during the scoring and weighting discussions. It was also noted that in some cases, the same aspects could justifiably be assessed under two criteria (such as the separate heritage and cultural values associated with some marae and urupa, and the separate ecological and cultural values of streams, waterways and bush). The possibility of removing cost from the analysis and considering it as a separate item was also raised.

It was noted that specific technical advice on noise and air quality had not been sought at this stage. This was not considered to be an issue, as there are usually available options for noise mitigation; transport-related air quality issues are unlikely to be a distinguishing aspect between route options; and both noise and air quality would be partly captured under the social/community impacts criterion. An air quality and noise study undertaken for the RoNS project immediately to the south[10], had confirmed that air quality effects are directly related to the number of people exposed and the volume of traffic – i.e. a route with fewer dwellings and sensitive activities in close proximity would be preferred to one where a greater number of nearby dwellings and sensitive activities are exposed to greater traffic volumes. This would be likely to align with the social/community criteria assessment in terms of other effects.

The acoustic assessment for that project acknowledged that introducing new noise effects into an area with low noise levels can be detrimental, depending on the number of new people affected and whether there are corresponding benefits elsewhere. In terms of the SH1-SH57 route options, there would be acoustic benefits from options that removed stage highway traffic from the route section between the two bridges and that resulted in a reduction in traffic volumes through Ohau. A small number of rural dwellings would be affected to a slightly greater extent as a consequence. Noise mitigation would need to be considered as part of detailed design overall, and the differences would be unlikely to affect the outcome of a multi-criteria analysis.

5.3 Scoring System

For the multi-criteria analysis, the scoring system moved from the provisional assessment provided by the specialists, to a five-point numerical system, as set out in Table 3 on the following page.

[9] Eight to twelve criteria is the ideal. With an increasing number of criteria, each criterion reduces in importance and it can become difficult to distinguish between options.

[10] The Peka Peka to Ōtaki RoNS, described in a letter URS (Michail Smith, Peter Stacey, Dr Stephen Chiles) to S Allan, APR, dated 27th July 2011, included as Appendix 13 to "Roads of National Significance, Peka Peka to Ōtaki Expressway, Route Options Review", Allan Planning and Research Ltd, July 2011.

Table 3: Basis for Scoring Used in the Multi-criteria Analysis

Score	Description
1	The corridor option presents few difficulties on the basis of the criterion being evaluated, taking into account reasonable mitigation proposals. There may be significant benefits in terms of the attribute.
2	The corridor option presents only minor areas of difficulties on the basis of the criterion being evaluated, taking into account reasonable mitigation proposals. There may be some benefits in terms of the attribute.
3	The corridor option presents some areas of reasonable difficulty in terms of the criterion being evaluated. Effects cannot be completely avoided. Mitigation is not readily achievable at reasonable cost, and there are few or no apparent benefits.
4	The corridor option includes extensive areas of difficulty in terms of the criterion being evaluated, which outweigh perceived benefits. Mitigation is not readily achievable.
5	The corridor option includes extreme difficulties in terms of achieving the project on the basis of the criterion being evaluated.

5.4 Decision Process

The structured workshop proceeded in accordance with the agenda and process set out in Appendix 10, which also includes the introductory presentation and the background notes for the workshop. The workshop results and analysis are further outlined in section 6 of this report.

As has been noted, Option T was identified after the workshop as a result of more detailed Iwi consultation. The Delphi technique was used to add this option to the assessment. This involved asking workshop participants by email to score the additional route. All those involved in the workshop responded, with three participants[11] providing scores for all the criteria and the others providing a score for the aspect they had been responsible for at the original workshop. The scoring was undertaken in accordance with the process in section 3.3 of this report, and is incorporated in the discussion of the analysis in the next section.

[11] Phil Peet, Gavin Lister and Sylvia Allan.

6 ANALYSIS AND OUTCOMES

6.1 Scoring Process

The scoring process was done on the basis of a structured workshop involving the 12 participants from diverse and relevant backgrounds set out in Appendix 10. The necessary protocols were followed to ensure that the outcome would be as reliable as possible.

Following preliminary discussion[12], each aspect was described and discussed by the presenter, identifying issues relating to each option. This was followed by questions and discussion. GIS information was presented in relation to some criteria as a visual way of comparing alternatives (this information is provided in some of the specialist reports in the Appendices).

The workshop then proceeded to the evaluation stage, giving each option a specific score for each aspect. Each aspect was evaluated for all options in turn. This was to encourage a balanced view of the relative merits of each option for each aspect before moving to the next aspect. To avoid patterning, the order of scoring options was varied each time a new aspect was evaluated.

The outcomes are presented in Table 4. Note that Table 4 also includes scores for Option T. These were added post-workshop through the Delphi process set out in section 5.4, but this scoring was informed by the previous involvement of the participants in the workshop process.

Table 4: Scoring of Options

Option	Landscape / visual	Ecology	Archaeology / heritage	Tāngata whenua values	Productive land use	Social / community	District & Regional Plan fit	Transport effectiveness and project objectives	Specific landowner effects	Engineering degree of difficulty	Cost
Option 3C	5	3	3	3	2	5	3/4	2	4	5	4
Option 4A	4	5	3/5	4	5	2	3	1	3	2	2
Option 5A	2	5	3	4	3	2	2	1	3	2	2
Option 6A	3	5	2	3/5	4	3	2	2	3	4	2
Option 7A	4	4	1	5	4	4	2	2	4	3	3
Option T	5	3	3	2	2	5	2	2	3	5	4

[12] Which included an outline of the options proposed, a presentation on the multi-criteria analysis methodology to be applied, and a discussion which confirmed the appropriateness and content of the various criteria.

A general commentary on the scoring outcomes for these aspects is given in Table 5 below. Generally, scoring was by consensus, but where there were differences of opinion, these were recorded for subsequent sensitivity testing. This occurred in relation to three scores, as indicated in Table 4 by dual numbers.

Table 5: Commentary on Scores

Aspect	Comments
Landscape/Visual	The scores ranged from 2 to 5, with the sole 5 score being Option 3C primarily because of its effects on Ohau. Option 5A was assessed as being the best due to its limited effects on houses and the fact that its alignment fits in best with the existing landscape characteristics.
Ecology	The scores ranged from 3 to 5 as all options had some negative aspects. The main effects were on stands of native bush and many of the options could not avoid impacting on these in either the short or long term. Option 3C was noted as being the best in this respect as it closely followed existing infrastructure of the railway line and highways. Two particular aspects of concern were the QEII covenant and the Tawa bush area to the west of the railway lines between Manakau and Ohau. Options 3C, 4A, 5A and 6A had different levels of impact on these, which differed again in the short and long term layouts.
Archaeology/Heritage	A potential score of 5 is possible for Option 4A on this criterion, depending on the location of the Wera-a-Whango clearing. Otherwise, the scores ranged from 1 to 3, with Option 7A scoring the best under this criterion as it is located furthest away from existing infrastructure and hence potential historic and archaeological sites.
Tāngata whenua values	Scores for this criterion are again in the high impact range of 3 to 5 which reflects the fact that this is an area of significance to Māori and includes many areas of Māori owned land. Option 3C was seen as being the best route for this criterion as it stayed away from much of the land, whilst Option 7A is rated a 5 as the split in the route causes many more impacts through currently unaffected land. 6A would also score a 5 if it affects the urupa south of the Ohau River, and this could be a fatal flaw[13].
Productive land use	The scores ranged from 2 to 5 depending on the soil types and the impact the options had on the operations currently occurring. Option 3C scored the best in that, although it traversed through high quality soils, it stuck close to existing infrastructure and therefore the impact was minimal. Option 4A scored a 5 primarily due to its impact on the vineyard although it also affected dairy farms.

[13] Subsequent consultation has determined that the urupa is confined within the current site boundaries, so there would be no fatal flaw, but a score of 5 was still considered reasonable (although not by all).

Social/Community	Option 3C scored a 5 under this criterion due to the significant impact on the township of Ohau, including severance impacts. Options 4A and 5A were the best with only minor impacts on communities, noting that the subdivision in the vicinity of the vineyard was not yet an established community. Options 6A and 7A had additional impacts on Kuku which were noted.
District and Regional Plan Fit/Consentability	There was not a large difference in scores under this criterion as it was considered that all options were fairly similar. Option 3C was potentially the worst (3 or 4) as it had the greatest impacts on an urban area with closest settlement. 4A also scored worse than others due to its impact on consents that have been granted through the vineyard area.
Transport effectiveness and project objectives	Whilst all options meet the project objectives, some do so better than others. Options 4A and 5A where assessed as being slightly better than the others due to the directness of the routes for both SH1 and SH57 traffic, the availability of passing lanes in the short term, the removal of SH57 traffic from Ohau and their whole of life costs.
Specific landowner effects	This aspect was noted by the workshop participants as one which would not be a distinguishing factor. All options had particular effects and it was difficult to distinguish on this factor. It was agreed that Option 3C would be worse due to its impact on Ohau and Option 7A was also poor due to the two new greenfield links it creates.
Engineering Degree of Difficulty	Scores on this aspect ranged from 2 to 5. Options 4A and 5A scored the best as they had no particular issues except for the skewed structures which are present in all options. Option 3C scored a 5 due to the number of structures, including an overbridge or underpass in Ohau, traffic management through Ohau during construction and the need to realign the railway line. Option 6A was also considered to be difficult due to the alignment adjacent to the river which could have particular flooding and hydrological risk issues.
Cost	The estimated costs of the long term options range between $100M (Options 4A, 5A and 6A) and $150M (Option 3C) and scores were provided consistent with these.

6.2 Fatal Flaws

Fatal flaws were considered. It was agreed that any infringement of Option 6A into the urupa area would constitute a fatal flaw as there is little opportunity to modify the route due to its geometry and the stream. As noted in footnote 13, subsequent investigations have confirmed this to be a continuing risk but not so high as to constitute a fatal flaw.

The other aspect discussed was the hydrological situation with the river bend in relation to Option 6A. It was decided that this risk could be addressed by design (height and length of structure) and possibly bank protection, and it would not comprise a fatal flaw.

6.3 Weighting

After reviewing the scoring and considering fatal flaws, the workshop discussed the weighting system to apply. It was determined that all criteria should be given the same weight. This can be regarded as the agreed view of the key technical and specialist advisors involved in the project. The workshop was aware that additional analyses would be undertaken as a later stage, along with sensitivity analysis applying the different scores elicited at the workshop.

Weighting systems are usually much more challengeable than scoring, as they can be readily developed from a range of different perspectives. Thus a single result is always vulnerable to criticism that the weighting system is wrong. An alternative means of investigating the robustness of a preference is to subject the scoring to a range of weightings and review the outcomes in terms of their consistency and range of differences.

To analyse the route option preferences, a range of weighting systems was developed subsequently. These are shown in Appendix 11 and are described in general terms below. Note that the first weighting system is the only one subject to discussion by a group. The other five systems have been developed by Allan Planning and Research on the basis of understanding a range of possible relevant considerations[14].

Workshop Weighting – this weighting was developed in discussion and agreement at the workshop and could be described as the technical view of NZTA's project advisors. All criteria are weighted equally.

RMA Section 6 Emphasis Weighting – this places maximum weight on three of the four section 6 RMA aspects potentially at play in respect of the project (ecology, heritage and tāngata whenua values). Landscape values have not been elevated to the same level in this analysis, as "outstanding" qualities and elements were not identified in the area affected by the route options by the specialist involved, and it would thus be inappropriate to elevate them to a very high weight. Some weight is placed on the district plan analysis in this case, as reflective of section 6 matters, but other criteria are left at low levels.

The remaining weighting systems are related to quadruple bottom line considerations. The analysis on this basis is relevant to matters to be taken into account under the LTMA and other national infrastructure policy approaches. It is also pertinent to RMA and LGA considerations.

Social – all criteria have a social component, so all are given some weight. The highest weighting is given to social and community impacts, followed by tāngata whenua and archaeological risk aspects which have a high social component in this area, ownership effects and district plan considerations. All other criteria have some social relevance in this productive rural area, with engineering aspects least relevant.

[14] This type of process has been applied in similar analyses for major infrastructure in the past, to ensure robustness in analysis.

Environment – this places the highest weight on the physical environmental element of ecology, with other criteria which integrate physical environmental considerations with social/community values also given some weighting. Criteria without a physical environment component are omitted.

Cultural – this highly weights tāngata whenua cultural values and archaeology/heritage, followed by ecological and social/community impacts but also acknowledged cultural significance in the established rural landscape and its settlement pattern, and its remaining ecological values, which have a cultural dimension through their protected status.

Economic – this excludes a number of criteria which have little or no direct economic bearing on the project or the local economy. It emphasises cost and productive landuses, but applies some weighting to other criteria with an economic component[15].

6.4 Analysis

The six weighting systems have been applied to the workshop scores set out in Table 6, and shown graphically in Figures 3 to 9 on the following pages.

The same analysis was performed without the cost scores included. This did not change the preferences in the table below.

Table 6: Analysis of Route Options (scores x weights for different weighting systems)

Weighting Systems	Option					
	3C	4A	5A	6A	7A	T
Workshop	3.64	3.27*	2.64	3.18	3.27*	3.27*
RMA 56	3.47*	3.93	3.15*	3.47*	3.31	3.07*
Social	3.67	3.30	2.67	3.11	3.29	3.21
Environmental	3.29	4.67	3.75*	4.08	3.75*	3.17
Cultural	3.61	4.09	3.18	3.48	3.39	3.30
Economic	3.58	3.63	2.21	2.95	3.34	3.45

Notes: - the asterisk (*) denotes where the difference between options is not, or is only marginally, significant
- preferred option highlighted in blue.

As can be seen from Table 6 and Figures 3 to 9, Option 5A is the most frequently-preferred route, being a clear preference under four out of the six weighting systems applied, including the workshop weighting). In these four cases, the difference is significant. Removing the cost criterion retains the preferences, indicating that cost considerations are not causing any distortion to the more subjective scoring systems.

[15] This quadruple bottom-line weighting is a different type of evaluation from the Benefit Cost Ratio (BCR) evaluation normally undertaken by NZTA.

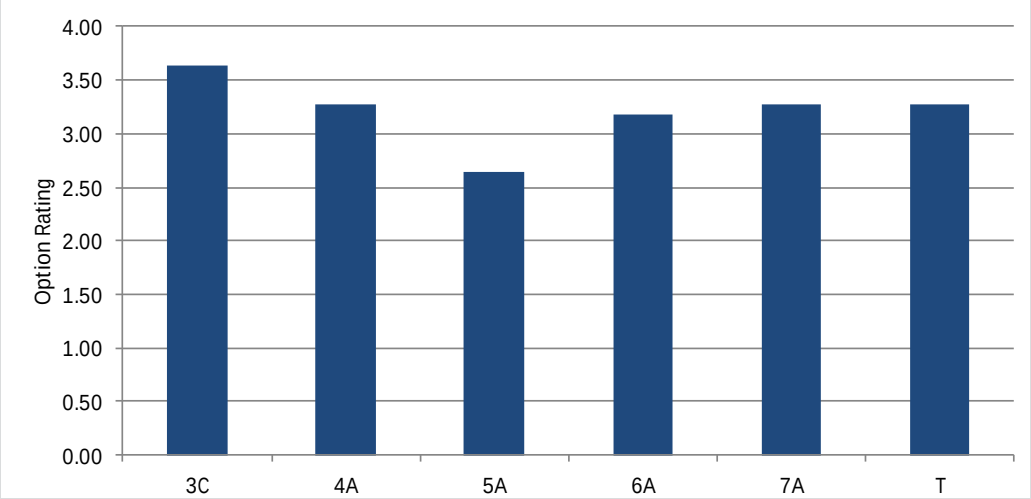


Figure 3: Analysis of Route Options on Workshop Weightings

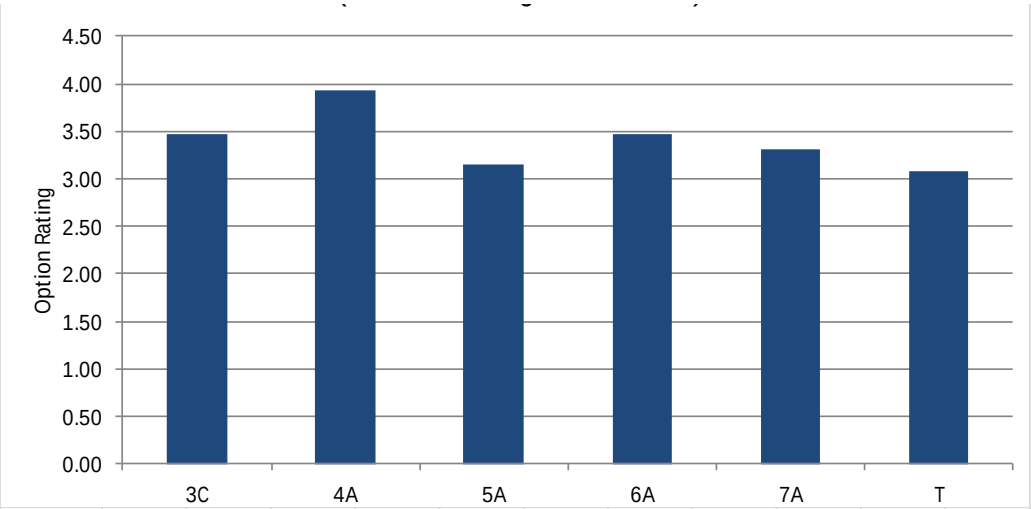


Figure 4: Analysis of Route Options on RMA S6 Weightings

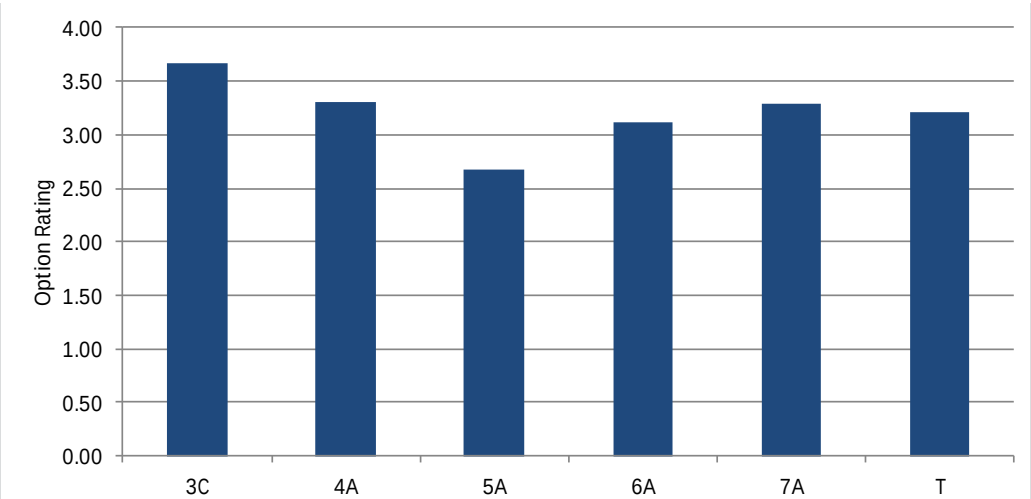


Figure 5: Analysis of Route Options for Social Weightings

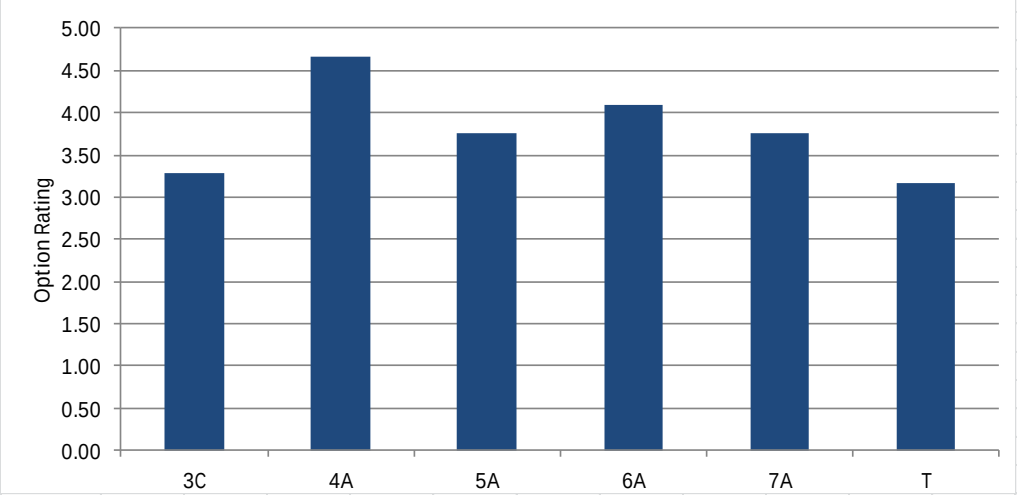


Figure 6: Analysis of 'Route Options on Environmental Weightings

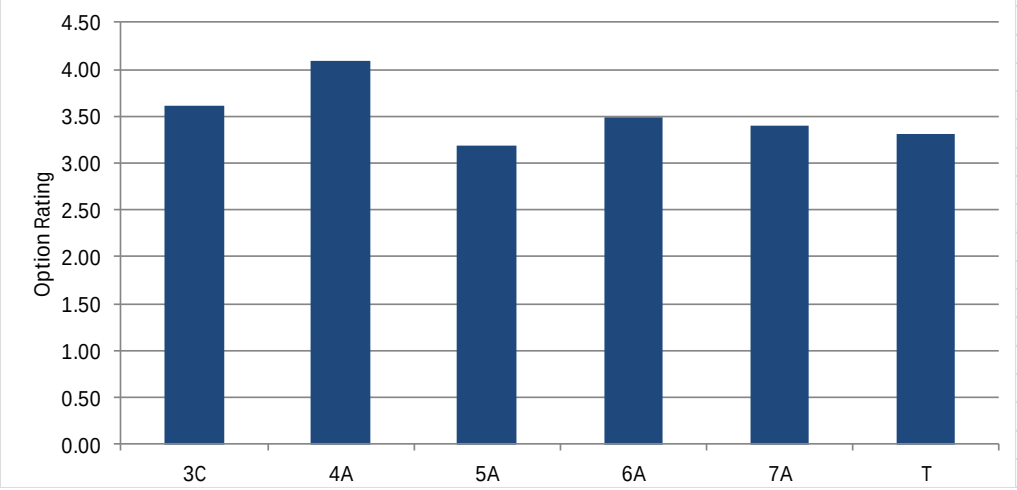


Figure 7: Analysis of Route Options on Cultural Weightings

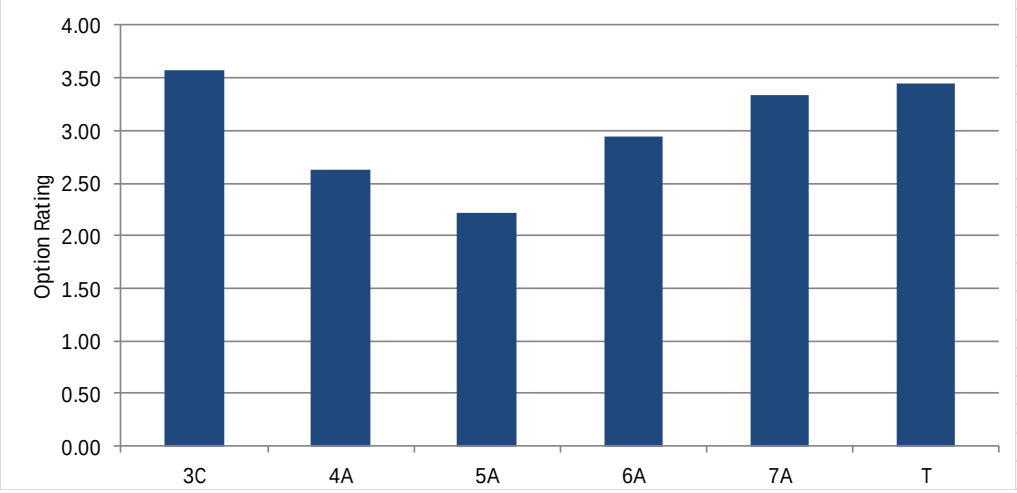


Figure 8: Analysis of Route Options on Economic Weightings

Under two weighting systems, Option T becomes preferred. For one of these – the RMA section 6 emphasis, the difference between Option T and Option 5A is not significant. For the other, the Environmental weighting, Option T is preferred by a clear margin. This is not surprising, given the significant domination of ecological considerations under this weighting system and that all social/community and economic considerations are omitted from the evaluation altogether. The second preference under the environmental evaluation is Option 3C, indicating that this weighting strongly favours options that maximise use of the existing state highway routes.

A final analysis can be undertaken on the basis of the sensitivity of the scoring, where there was not complete agreement on the scores.

The score variations available for sensitivity testing are found on Table 4 and are included in Table 5. Table 7 shows the criteria where alternative scores were noted at the workshop, the routes they applied to, and their general implication in terms of the options they apply directly to.

Table 7: Analysis of Sensitivities, Summary Outcome if all Alternative Scores Applied

Sensitivity	Base	Alternative	Effect of alternative on result
Option 3C – District and Regional Plan Fit	3	4	Makes Option 3C less favourable
Option 4A – Archaeological/Heritage	5	3	Makes Option 4A more favourable (but not enough to make it preferred under any of the weighting systems)
Option 6A – Tāngata whenua values	5	3	Makes Option 6A more favourable (but not enough to make it most favoured under any of the weighting systems)

Thus the alternative scores from the workshop weighting would not make any difference to the preferences, even if all were applied together.

6.5 Findings from Analysis

The overall conclusion from the multi-criteria and subsequent analysis is that route Option 5A is the preferred option in terms of the range of matters that contribute to decisions on route preferences under various legislative requirements. Only under the Environmental weighting system does Option T become the clearly preferred option. This is a relatively conclusive finding from the multi-criteria analysis process. An inspection of the second and third preferences shows that there is no clear "runner up" option, and thus it is unlikely that an analysis on a similar basis but with slightly different criteria or applying other weighting systems would result in a different outcome.

The work involved to reach that finding has been rigorous, including:

development of an appropriate range of route options in the wider area, and a technical check of their practicality
detailed investigation of impacts of options across a range of aspects
investigation of options by people with a range of backgrounds within a framework suitable for multi-criteria analysis
a multi-criteria workshop, eliciting scoring and a single weighting system
analysis of results on the basis, and subsequent further analysis applying additional weighting systems and alternative scorings (the latter from the workshop).

The outcome of the analysis can assist both the community and NZTA in that it provides an understanding of the range of aspects that need to be taken into account when considering route options, and provides more detailed levels of information about these aspects. For NZTA, recognising that multi-criteria analysis is an aid to decision-making, but does not make the decision on behalf of NZTA, it will provide assistance in determining the preferred option to proceed with.

7 CONCLUSION

This report sets out the basis, process and findings of an analysis of alternative routes undertaken for NZTA for the SH1 to SH57 connection as part of the Ōtaki to North of Levin RoNS project.

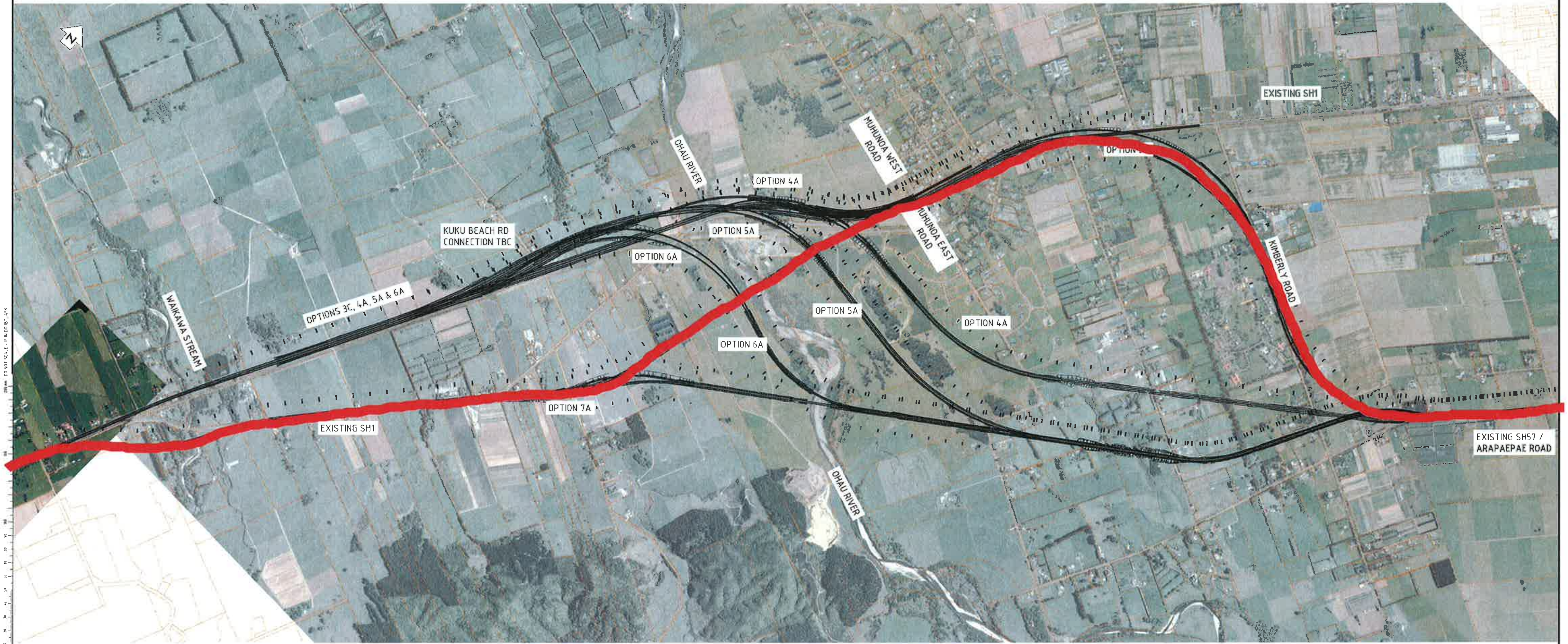
The process has included a review of six route options in the general area, including one option developed from consultation with tāngata whenua.

The process involved preliminary development of the options to an extent where their effects could be assessed in a preliminary manner and to confirm their technical feasibility, followed by specialist investigations of the implications of each of the route options taking into account effects on adjacent land. The analyses by the specialists were brought together through a multi-criteria analysis process, involving best practice techniques such as decision conferencing through a facilitated workshop at which information about the options was shared and tested. As one option was identified later, it was subject to a Delphi analysis methodology. The outcomes have been analysed on the basis of a range of weighting systems, and have also been subject to further sensitivity analysis.

On most analyses, Option 5A was preferred. This takes the route to the west of the NIMT north of Manakau, bifurcating just north of the Ohau River with SH1 remaining more-or-less on its current route to Levin, and SH57 crossing the NIMT and travelling cross-country to run parallel with and then join Arapaepae Road north of its present intersection, with Kimberley Road.

The information this report and its appendices, and the analysis described above, will help contribute to a decision on the preferred route option for the State Highways 1 and 57 between north of Manakau and south of Levin.

APPENDIX 1: OPTIONS TO BE EVALUATED



GENERAL ARRANGEMENT PLAN
SCALE 1 : 8000

ORIGINAL SIZE A0

REV	REVISION	DRAWN	CHECKED	APPROVED	DATE
A	FOR INFORMATION	GC	PP	PP	13.09.13

MWH

NZ TRANSPORT AGENCY
OTAKI TO LEVIN
SCOPING OPTIONS

SH1 SH57 CONNECTION OPTIONS

PLAN
GENERAL ARRANGEMENT

SURVEYED	-	-
DESIGNED	G. CORN	09/13
DRAWN	G. CORN	09/13
CAD REVIEW	-	-
DESIGN CHECK	P. PEET	09/13
REVIEWED	M. OPPENHUIS	09/13
APPROVED	P. PEET	09/13
PROF REGISTRATION	-	

Status Stamp: **FOR INFORMATION**

Date Stamp: **13 SEPTEMBER 2013**

Scales: 1 : 8000 (A0), 1:16000 (A1)

NOT FOR CONSTRUCTION

Drawing No: 80500902-05-005-G000 Rev: A

APPENDIX 2: TECHNCIAL EXPERTS BRIEFING MATERIAL

AGENDA

Briefing Meeting for Technical Experts, SH1 – SH57 Connection

Date: Thursday 11th September, 10am to 12 noon

Venue: MWH Offices, 123 Taranaki Street, Wellington

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1. Introductions – all
2. General background to the O2L Project, where we're heading, general timelines, etc – Jo
3. Explanation/descriptions of the Options for SH1-SH57 connection – Phil
4. Outline of anticipated issues, consultation findings – Sylvia
5. Preliminary "cut" of possible issues and further work needed – Gavin, Adam, Lachie, others
6. Timetable for investigations, reporting, lead in to MCA process – Phil/Jon

NOTES ON TECHNICAL EXPERTS' WORK AND BACKGROUND REPORTS – O2L, SH1 + SH57 CONNECTION OPTIONS

These notes are just to clarify the work you are undertaking in preparation for our Multi Criteria Analysis (MCA) Workshop on 17th October 2013.

The individual studies you are all engaged in will contribute to an overall evaluation of the implications of the five options we are going to analyse (Options 3C, 4A, 5A, 6A and 7A – as per Phil Peet's email of 20th September 2013). This will be via a structured workshop process, and we will send out more notes on this prior to the Workshop.

In the meantime, please take into account the following in your current investigations and report preparation:

1. A key aspect in the statutory decision-making for any proposal under the RMA which may have significant adverse effects is a demonstration that alternatives have been considered. For designations, this includes "routes and methods" for achieving NZTA's objectives. The current process will contribute to the documentation of the overall process and the options considered.

2. The MCA process which we will be using to bring all the considerations together relies on sharing information and as far as possible, undertaking the evaluation through consensus. The individual studies will involve investigation by technical experts who will share their knowledge at the Workshop. It is important that the expert studies and reports do not undertake the final evaluation – rather they are a step on the way.

3. The criteria[16] you are individually working on will broadly encompass:
   ecological implications (terrestrial and aquatic)
   landscape/visual implications
   archaeological/heritage values
   tāngata whenua impacts
   impacts in terms of soils/land quality, plus rural production implications.

   Your work will need to include a description of all the aspects that are encompassed within your criterion, and a single criterion above may be broken into several sub-criteria (if there is a potential for overlap between criteria, e.g. tāngata whenua values and heritage, don't worry too much as we will address that at the Workshop).

4. While we are looking at the routes provided by Phil, take into account the implications of each route on the aspect you are considering, which may extend some distance beyond the actual draft alignment. The extent of the receiving environment will differ depending on your particular specialization (i.e. probably greater for social and cultural effects than for effects on ecological values).

[16] Please note we will also include criteria encompassing engineering degree of difficulty/constructability (including river crossings), social implications, planning/consentability, property implications, alignment with NZTA's objectives and cost.

5. Please note that, to be comparable, the routes will need to all be assessed as covering the same equivalent "length". This means that each assessment will need to cover the complete route from the take-off point for Option 7A at the south to the merge with Arapaepae Road, at the north end.

6. We will also be looking for "fatal flaws". When considering major impediments or fatal flaws, it is important to note that there is still some room to move with the route options. A true fatal flaw would probably have to stretch right across the route and be unavoidable.

7. In carrying out your work, please can you undertake a coarse evaluation of the options (we suggest a scale ++, +, 0, –, – –) with descriptions as below, identifying the key considerations that lead to your conclusion.

Notation	Interpretation
++	Route option is, on average, very good in terms of this attribute
+	Route option is, on average, good in terms of this attribute
0	Route option is neutral, or neither good or problematic, on average, in terms of this attribute
–	Route option includes, on average, minor or intermediate issues or concerns in terms of this attribute
– –	Route option includes, on average, major or intermediate issues or concerns in terms of this attribute

   If you reach an overall conclusion by first evaluating different sub-sections of options, or by considering different aspects within your area of expertise, please briefly record your method.

   This is a coarse assessment method which is just to help us gain an overview of the individual experts' first-cut relative evaluation of the options. Don't get too worried about this assessment – just apply your best judgment.

8. The attribute is to be defined in terms of your area of expertise, taking into account all the aspects that you would normally take into account when doing an assessment of effects on the environment. In your report, can you explain what you have taken into account, and the particular considerations that have led you to the score that you have give for each option.

9. We will do a more comprehensive MCA at the Workshop. Your assistance will be needed in refining the attributes, scoring them and looking at possible weighting systems.

10. It will not be necessary to have completed your reports before the Workshop, but they will be needed by the end of October. The reports need to reflect your work before the Workshop and your own opinions, regardless of where the Workshop process gets to. Your work will need to be sufficiently advanced for each person to make a short presentation about each of the options in terms of the subject at the Workshop and to contribute to an overall MCA evaluation.

APPENDIX 3: ŌTAKI TO LEVIN RONS (SH1 to SH57)
LANDSCAPE REPORT ON ROUTE OPTIONS

isthmus

OTAKI TO LEVIN RONS (SH1 TO SH57)

LANDSCAPE REPORT ON ROUTE OPTIONS

Client:	NZTA
Project:	Otaki to Levin RONS (SH1 to SH57)
Report:	Landscape Report on Route Options
Status:	Final
Date:	8 November 2013
Author:	Gavin Lister
	Isthmus
	PO Box 90 366
	Auckland 1142
	+64 9 309 7281
	gavin.lister@isthmus.co.nz

No.	Date	Details	Author	QA
1	30.10.13	Draft to MWH	Gavin Lister	GL
2	08.11.13	Final	Gavin Lister	GL

CONTENTS

INTRODUCTION

1 The project is a sub-set of assessments into the Otaki to Levin RONS and concerns connections between SH1 and SH57. Five alternative routes were scoped based on earlier assessment work and preliminary consultation. A sixth option (Option T) was subsequently proposed as a result of consultation.

2 This report analyses the options in terms of landscape matters to provide information for the multi-criteria analysis (MCA) process designed to select a preferred route.

EXISTING LANDSCAPE

3 The landscape comprises flat to gently rolling coastal plain and river terraces, against a backdrop of the Tararua Ranges and foothills. It is a productive ('working') landscape including dairying and other pastoral farming, substantial areas of cultivated ground, a vineyard, and more intensive uses such a stud farm, poultry farms and a nursery.

4 The main natural features are

- Ohau River;
- Waikawa Stream;
- Kuku Stream;
- Stands of remnant totara bush on the terraces north of Ohau River; and
- Other scattered small stands of remnant lowland forest, such between Kuku Beach Road and Waikawa Stream and south of McLeavy Road.

5 Housing patterns in the landscape include (i) traditional rural housing typically located in fenced sections close to the road, (ii) scattered lifestyle properties and (iii) a comprehensive lifestyle development south of Ohau based around a vineyard and backdrop of totara bush.

6 The main settlement is Ohau which straddles both sides of SH1. The core settlement comprises an historic street grid west of SH1, but there are additional houses and most of the community facilities east of SH1. Such facilities include the school, play-centre, sports fields, historic church, and café / restaurant (the former diary factory).

7 There are two maraes with associated housing and urupa, both of which are adjacent to SH1. Wehi Wehi Marae is between North Manakau Road and Whakahoro Road, and Tukuorehe Marae is north of Kuku Road.

PROPOSAL

8 The options are depicted on plans prepared by MWH, 'Otaki to Levin Scoping Options, 26 August 2013'. Each of the options comprises a four-lane extension of SH1 to a point at which SH57 and SH1 would peel away from each other by way of overpass bridges. Both SH1 and SH57 would be two-lane wide north of the 'bifurcation point'.

COMPARISON BETWEEN ROUTE OPTIONS

Approach and Method

9 For the purpose of comparison the area was subdivided into eight equivalent geographic sections (including sections devoted to the Waikawa Stream and Ohau River crossings respectively). The relative landscape effects were assessed taking into account the following:

Effects on natural character of the streams and river (including number of bridges required and their proximity to existing bridges and already modified natural character)
Effects on other specific natural features (mainly the totara bush and other remnant native trees)
Effects on settlements including Ohau and the two marae
Effects on houses;
Fit with underlying cadastral and landuse pattern;
Prominence and footprint of the interchange between SH1 and SH57.

Findings

10 Appendix 1 comprises a tabulated commentary comparing the routes section-by-section in terms of the effects listed above. The findings are also collated in Tables 1 and 2 below which compare the routes respectively in terms of (i) types of effect; and (ii) geographic section. Note that the comparison between options is similar across both means of collation (effects and geographic section).

Table 1: Summary comparison of route options in terms of types of effect

	3C	4A	5A	6A	7A	T
Natural character effects	Good 0	Good 0	Good 0	Worst (additional river crossing)	Worst (additional river crossing)	Good 0
Effects on vegetation	Good 0	Better	Worst (effects on totara)	Bad (effects on totara)	Bad (effects on totara)	Better
Effects on communities	Worst significant	Bad	Better	Better	Better	Worst significant
Effects on houses	Worst	Worse	Best	Best	Middle 0	Worst
'Fit' with cadastral and paddock pattern	Middle 0	Middle 0	Best 'fit'	Middle 0	Worst 'fit'	Middle 0
Obtrusiveness of interchange location	Middle 0	Best	Best	Middle 0	Worst	Middle 0

Table 2: Summary comparison of route options in terms of geographic section

Section	3C	4A	5A	6A	7A	T
North Manakau Road to Waikawa Stream	Worse	Worse	Worse	Worse	Better	Better
Waikawa Stream	Better	Better	Better	Better	OK 0	OK 0
Waikawa Stream to Kuku Beach Road or Kuku East Road	Worst	Better 2	Better	Better	Worse	Worse
Kuku Beach Road or Kuku East Road to Ohau River	Better	Best	Best	Better	Worst	Better
Ohau River	Better	Better	Better	Worse	Worse	OK 0
Ohau River to Muhunoa East Road	Best	Worst	OK 0	Better	Better	Better
Mahunoa East Road to McLeavey Road	Worst	Better	Better	Better	Better	Worst
McLeavy Rd to Arapaepae Road	Worst	Worse	Better	Better	Better	Worse

Summary of findings

11 The landscape is generally similar for each of the options: they all traverse a productive rural landscape and they all require crossing the Ohau and Waikawa Streams. The main differences relate to specific features:

11.1 Options 3C and T will have significant severance effects on Ohau settlement.

11.2 Options 3C and T would also affect the greatest number of houses (66 and 65 respectively)[1] while options 5A and 6A would affect the least (34 and 35).

11.3 Option 4A will have significant adverse effects on the comprehensively designed vineyard lifestyle subdivision south of Ohau –it would affect the amenity as a whole of this development.

11.4 Option 5A, 6A and 7C would have adverse effects on remnant stands of totara bush (although these effects could be avoided or minimised by fine-tuning the alignment).

[1] Note that the figures for 3C and T include 8 houses in the Kimberley Centre which may be unoccupied.

11.5 Options 6A and 7C will have greater effects on the natural character of the Ohau River because they would require a crossing in a location with higher natural character in addition to crossing points adjacent to the existing bridges.

OPPORTUNITIES TO AVOID, REMEDY OR MITIGATE ADVERSE EFFECTS

12 There may be potential to avoid or remedy effects on the stands of totara bush by fine-tuning alignments, in which case the relative ranking of options 5A-7A would improve.

13 It is not possible, however, to avoid the effects of options 3C and T on Ohau , or the effects of option 4C on the vineyard subdivision.

14 With all the options there are likely to be options to reduce effects on some houses by fine-tuning the alignment, and more particularly the realignment of access roads and intersections. However, there would be unavoidable effects on individual properties and houses with all the options.

OVERALL SUMMARY

15 Taking these factors together, options 3C, 7A and T ranked worst in terms of landscape matters, option 5A ranked best, and options 4A and 6A ranked in the middle.

Table 3: Overall Ranking in terms of Landscape Factors

Option	3C	4A	5A	6A	7A	T
Ranking	Worst	Worse	Best	Middle 0	Worst	Worst

G Lister

Gavin Lister
Isthmus
30 October 2013

APPENDIX 1: SECTION-BY-SECTION COMMENTARY

Section	3C	4A	5A	6A	7A	T
North Manakau Road to Waikawa Stream	700-1750 As for 4A, 5A, 6A Open, cultivated paddocks. Wehi Wehi Marae (including urupa) and settlement on west side of SH1. Follows existing SH1 alignment, but abandons curve over railbridge and continues on west side of rail line. Fits cadastral and paddock layout. Widening to four lanes will have frontage effects on approximately 7 houses and marae currently facing the west side of SH1 between 900 and 1250 (which are currently accessed from SH1) Close in front of 2 houses at 1350. Close to 1 house at 1600 Removal of 2 houses at 1600 and 1700 (3 houses on opposite side of railway line at 1350-1600 will benefit from removal of SH1 rail overbridge)	700-1750 As for 3C, 5A, 6A	700-1750 As for 3C, 4A, 6A	700-1750 As for 3C, 4A, 5A	500-1750 As for T Open, cultivated paddocks. Prominent shelter belts near Waikawa Stream Curvilinear alignment although fits reasonably well with cadastral and paddock layout. Flyover rail bridge close to 5 houses on east and west at 900-1000 (some positive effects because shifts road further from marae and several other houses in settlement) Moderately close to 3 houses at 1300, 1350 and 1500 (although behind houses and readily screened)	500-1750 As for 7A
Waikawa Stream	1750 Same as 4A, 5A, 6A Parallel with and alongside railway bridge. Section of stream already affected by existing crossing. Existing SH1 bridge to be removed –minor net positive effect on natural character	1750 Same as 3C, 5A, 6A	1750 Same as 3C, 4A, 6A	1750 Same as 3C, 4A, 5A	1750 As for T Adjacent to existing SH1 bridge which would be demolished. Modified section of stream No net change in natural character	1750 As for 7A
Waikawa Stream to Kuku Beach Road or Kuku East Road	1800-4000 Open, cultivated paddocks. Small plantation. Two stands of bush. Alignment is parallel with but separated approximately 100+ from railway line.	1800-4000 Same as 5A, 6A Open, cultivated paddocks. Small plantation. Two stands of bush. Alignment is parallel with and adjacent to railway line Alignment square with the	1800-4000 Same as 4A, 6A	1800-4000 Same as 4A, 5A	1800-3600 As for T Open, cultivated paddocks. Small Kuku Stream (heavily modified in productive landscape). Alignment mostly follows existing SH1 alignment but	1800-3600 As for 7A

Section	3C	4A	5A	6A	7A	T
	Alignment reasonably square with the cadastral and paddock layout. Cuts through stand of bush at 3400 (could be fine-tuned to avoid) and close to bush at 2300-2400 Very close to 2 houses at 2450. Removal of 1 house at 1 cottage at 2750 Reasonably close to1 house at 3400 (house will be affected by views of interchange Removal of 4 houses at Kuku Beach Road interchange. Reasonably close to 1 further house at interchange. Encroaches onto poultry farm at Kuku Beach Rd (new access road could be fine-tuned to avoid)	cadastral and paddock layout (minimal effects) Moderately close to 2 houses at 2450 and 1 house and 1 cottage at 2750. Close to poultry farm (4000)			would be widened to four lanes. Alignment fits existing cadastral and paddock layout (minimal effects). However, road widening would have frontage effects on properties facing SH1 including 15 houses: On east side at 2100 (appears unoccupied), 2200, 2300 2400, 2650, 3400, 3600, 3750, 3775, 3800. On west side at 2700 (may require removal), 3050 (may require removal), 3400, 3425, 3650 Access road would require removal of 2 of these houses on east at 2400 and 3400. Frontage effects on St Stephens Church at 3550. Frontage effects on commercial properties including Kennels, former diary factory and former nursery site.	
Kuku Beach Road or Kuku East Road to Ohau River	4000-5000 Open, low lying cultivated paddocks. Scattered trees. Alignment is parallel with but separated approximately 100+ from railway line. Alignment square with the cadastral and paddock layout. Very close to 1 house at 4750 (likely require removal). Close to 2 houses at 4800 and 4900 (latter appears abandoned)	4000-5000 Same as 5A Open, low lying cultivated paddocks. Scattered trees. Alignment parallel with and alongside railway line Alignment square with the cadastral and paddock layout – minimal effects Close to 2 houses at 4800 and 4900 (latter appears abandoned)	4000-5000 Same as 4A	4000–5000 and 0-2400 Open, low lying cultivated paddocks. Scattered trees. Alignment swings away to west before swinging back to cross railway line and follow the south bank of the Ohau River. SH57 section has curvilinear alignment that cuts across cadastral and paddock layout. Close to urupa adjacent to railway. Parallel with and reasonably close to south bank of Ohau River. Would affect scattered native trees. Close to 1 house at Kuku Beach Road at 4000 SH1 section close to 1 house at 4750 and close to 2 houses at 4800 and 4900 (latter appears abandoned) SH57 section close to 1 house at 1250. Interchange over-passes will be in open paddocks west of railway line –relatively benign location	4000-5200 and 0-600 and 0-850 Open, flat, cultivated paddocks. Alignment is diagonal to cadastral and paddock layout. Interchange will be in prominent location in middle of open landscape behind (east of) Tukuorehe Marae. Interchange and diverging SH1 and SH57 sections will affect productive land.	4000-5200 Similar to SH1 section of 7A Open, flat, cultivated paddocks. Alignment similar to SH1 section of 7A except will be four lanes, and will eschew interchange. Alignment reasonably square to cadastral and paddock layout.

Section	3C	4A	5A	6A	7A	T
Ohau River	5000 Parallel and close to existing road bridge (100m) and short distance downstream of rail bridge (200m) Existing road bridge will be demolished Section of river already affected by two existing bridges and overhead transmission line. In vicinity of concrete plant. Negligible change from existing	5000 Immediately adjacent to existing road bridge (to be demolished and short distance downstream of rail bridge (100m). Section of river already affected by two existing bridges and overhead transmission line. In vicinity of concrete plant. Negligible change from existing.	5000 Similar to 3C	Two Bridges Required Bridge 1 (5000) Similar to 3C except narrower (2 lane) bridge Bridge 2 (2400) Modified rural landscape setting, but river corridor relatively natural and unaffected by existing infrastructure. Relatively wide and braided river bed. Appears to be regenerating vegetation on both banks	Two Bridges Required Bridge 1 (5250) Short distance upstream of rail bridge, and adjacent to concrete plant. Section of river already affected by existing infrastructure. Relatively narrow bridge (2 lane) Bridge 2 (850) Similar to 6A Bridge 2	5200 Similar to 7A Bridge 1, except four lanes. Short distance upstream of rail bridge, and adjacent to concrete plant. Section of river already affected by existing infrastructure.
Ohau River to Muhunoa East Road	5000-6200 Flat, cultivated paddocks, with 'oasis-like' heavily treed Strathcarron Stud Farm Curvilinear alignment that roughly echoes existing SH1 - cuts across corners of existing cadastral and paddock layout. But bisects Strathcarron Stud Farm (racing stables etc). Very close to house at 5200 Close to cottage at 5400 on Strathcarron Stud Farm. (houses on corner of SH1 and Muhunoa East Road discussed in section on Ohau)	5000-6200 and 0-1300 and 0-900 Flat, cultivated paddocks. Heavily treed Strathcarron Stud Farm west of SH1. Vineyard lifestyle park and stands of totara bush east of SH1. Alignment bisects Strathcarron Stud Farm and bisects middle of the vineyard lifestyle park which currently contains 10 houses and undeveloped lots – would detract from amenity of the subdivision as a whole. Removal of 1 house north of Ohau River at 5250 Removal of 2 houses on SH1 at '900'. Close to 1 cottage on east side at '800' –would be dominated by overpass and interchange Passes close in front of 1 house at '1300' Close to 1 house at 850. Interchange will be in open land north of the stand of trees at Strathcarron Stud Farm.	5000–6200 and 0–1300 and 0-1100 Flat, cultivated paddocks. Heavily treed Strathcarron Stud Farm west of SH1. Vineyard and stands of totara bush east of SH1. Alignment bisects Strathcarron Stud and crosses rear fringes of vineyard (including undeveloped lifestyle lots). Separated from centre of lifestyle park by totara bush. Crosses cultivated paddocks nearer Mahunoa East Road. Curvilinear alignment cuts across pattern of paddocks. Cuts through edges of two stands of totara bush and scattered totara trees. Removal of 1 house north of Ohau River at 5200 Close to 2 houses at 850 and 900 (will be affected by outlook to overbridge to south) (Moderately close to houses in vineyard subdivision and on Muhunoa East Road but on opposite side of bush) Interchange will be visually anchored by the stand of trees at Strathcarron Stud Farm.	5000–6200 and 2500-3400 SH1 section similar to 3C except two lanes (rather than four). Curvilinear alignment that roughly echoes existing SH1 - cuts across corners of existing cadastral and paddock layout. But bisects Strathcarron Stud Farm (racing stables etc). Very close to 1 house at 5200 Close to 1 cottage at 5400 on Strathcarron Stud Farm. SH57 section flat low terraces. Mostly open pasture with stands of totara bush. Cuts through edge of stand of totara bush (but could be fine-tuned to avoid) (Moderately close to 1 house on Muhunoa East Road but on opposite side of bush)	5300-6200 and 900-1900 SH1 section passes close to concrete plant and through corner of vineyard. Requires rail overpass . Very close to 2 houses at 5700 and 5850 (likely require removal of both). Close to 1 house at 5900 (houses on corner of SH1 and Muhunoa East Road discussed in section on Ohau) SH57 section same as 6A. Flat low terraces. Mostly open pasture with stands of totara bush. Cuts through edge of stand of totara bush (but could be fine-tuned to avoid) (Moderately close to 1 house on Muhunoa East Road but on opposite side of bush)	5300-6300 Similar to SH1 section of 7A except four lanes. Passes close to concrete plant and through corner of vineyard. Requires rail overpass . Very close to 2 houses at 5700 and 5850 (likely require removal of both). Close to 1 house at 5900 (houses on corner of SH1 and Muhunoa East Road discussed in section on Ohau)

Section	3C	4A	5A	6A	7A	T
Mahunoa East Road to McLeavey Road	6200-7200 Same as T Ohau – a small urban settlement on terrace edge above Ohau River valley. Cultivated paddocks on terrace north of Ohau. Would exacerbate severance between east and west halves of settlement. Require underpass on Muhunoa West and East Roads. Main part of settlement is west of SH1. School, play centre, sports fields, historic church are east of SH1. Embankment and deep cuttings to negotiate edge of terrace Close to 1 house and shop on south-west corner of intersection of SH1 and Muhunoa West Road (but they already front existing SH1) Removal of café (former dairy factory) on north-east corner of intersection. Immediately adjacent to Ohau School and (historic) St John the Baptist Church. Removal of 2 houses east side at 6350 and 6400. Very close to 3 houses on east side at 7250 - 7400 which would be dominated by rail overpass. Removal of 3 houses on west side at 7250 and 7400. New Ohau access road would be very close to 1 house at 7300 and require removal of 3 houses at 7050 and 7100 Realignment of railway estimated to require removal of 4 houses at 6700-6800. Realigned railway would be close to 2 houses at 6600-6650	1000-1800 Undulating terrace –rolling pasture and cultivated paddocks. Scattered lifestyle properties (Ohau Terraces rural residential settlement to west of route with some overlook) Alignment diagonal to cadastral and paddock layout Close to 1 house at 1000 Removal of 1 house at 1200 Close to 1 house on east at 1600 Close to 1 house on west at 1700 Very close to 1 house to east on McLeavey Rd (1800) – would probably require removal Very close to 1 house on west at 1800. Realigned intersection would probably require removal. Moderately close to 2 houses at 1800-1850 on east and west respectively.	1100-2200 Same as 6A and 7A Undulating terraces -rolling pasture and cultivated paddocks. Scattered lifestyle properties Alignment is diagonal to cadastral and paddock layout (but slightly better fit than 4A). Low embankment and moderate cuttings. Passes near stand of bush at McLeavey Road Moderately close to 3 houses on Mahunoa Road East at 1200-1400. Close to 1 house on east at 1650 Removal of 1 house at 1800 Moderately close to 1 house at 2100 Close to 2 houses at McLeavy Road (2200) – realignment of intersection would require removal of both houses	2500-4500 Same as 5A and 7A	1900–3000 Same as 5A and 6A	6200-7200 Same as 3C
McLeavy Road to Arapaepae Road	7200–8000 and 400–1600 and 0-2000 Same as T Flat land. Cultivated paddocks. Glasshouses. Some lifestyle	1800-3400 Flat to gently rolling. Pasture and cultivated paddocks. Horse training track. Prominent	2200-4000 Same as 6A and 7A Flat to gently rolling. Pasture and cultivated paddocks. Prominent shelter belt mid-	1200-2900 Same as 5A and 7A	1200-2900 Same as 5A and 6A	7200–2000 Same as 3C

Section	3C	4A	5A	6A	7A	T
	properties. Former Kimberley Centre institution on south side of Kimberley Road. Alignment partly follows existing Kimberley Road but large curves at north and south ends of this section (i.e. connections to SH1 and Arapaepae Road) cut across existing cadastral and paddock layout Loss of some substantial trees along Kimberley Road frontage (e.g. oaks, poplar, plane, eucalpyt amongst other species) Very close to 1 house on west side at 7550 –will be dominated by overpass. House may require removal. Existing fruit stall would be removed. Very close to 1 house at 1200 (will be sandwiched between lanes, likely to require removal). Removal of 8 houses (may not be occupied) on Kimberley Centre site at 1500-1700 Road reconstruction may affect frontages of 2 houses on Kimberley Road at 250 and 350. Removal of possibly 2 houses at 900-1000 (difficult to tell from roadside and aerial photo) . Close to 1 house and cottage at 1150 Close to 3 houses on Arapaepae Road at 1350, 1450 Removal of 1 house and 1 cottage at 1500.	shelter belt mid-block between McLeavey Rd and Kimberley Rd. Alignment diagonal to cadastral and paddock layout Moderately close behind 1 house on west at 2500. Close to 2 houses west and east at Kimberley Road at 2600 Removal of 1 house at Kimberley Road at 2700 Moderately close to 1 house on west at Kimberley Road at 2750 Close to 1 house on east at 2900 Very close to 1 house at 3050 Removal of 3 houses at 3000, 3150 and 3200	block between McLeavey Rd and Kimberley Rd. Alignment reasonably square to cadastral and paddock pattern. Close to 1 house on west at 2950 Very close to 1 house at Kimberley Rd (3100) -may require removal Close to 1 house at 3250 Very close to 2 houses at 3300 and 3500 (Both houses may be untenable due to proximity) Close to 1 cottage at 3550.			

APPENDIX 4: ŌTAKI TO LEVIN ROUTE OPTIONS: ECOLOGY CONSTRAINTS

Forbes Ecology

Achieving sustainability together

Otaki to Levin Route Options: Ecology Constraints

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November 2013

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Cover photograph: Podocarp dominant indigenous forest remnant at Muhunoa East Road.

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1.0 INTRODUCTION

1.1 Objectives

This report describes the process and results of an assessment of ecology constraints associated with six potential state highway alignment options running between Otaki and Levin, in the Horowhenua District of New Zealand.

The objective of the assessment is to identify and consider specific ecology features within land areas potentially affected by each alignment option. Ecology features are considered in the context of the level of constraint they present to establishment and operation of a state highway alignment. In this assessment the level of constraint is derived from the ecological value of a given ecological feature.

1.2 Assessment Parameters and Scope

1.2.1 Ecology Criterion

The ecology criterion spans terrestrial, freshwater, and wetland ecology aspects. It views the ecological characteristics and values of a site in the context of its ecological setting. To provide the necessary context for an understanding of this assessment the site's ecological setting is described later in this report.

1.2.2 Route Parameters

The parameters for the options are based on the mapped Alignment Option Layout Plans provided by MWH New Zealand Limited (see Table 1). In essence, those plans set out the extent of physical disturbance associated with each alignment option. During field assessment the position of alignment options were visualised using the plans, and the basic understanding that each alignment would affect an approximate width of 50 m was applied, while acknowledging that additional width would be necessary in areas of cutting/filling or where extra design features such as intersection connections would be required.

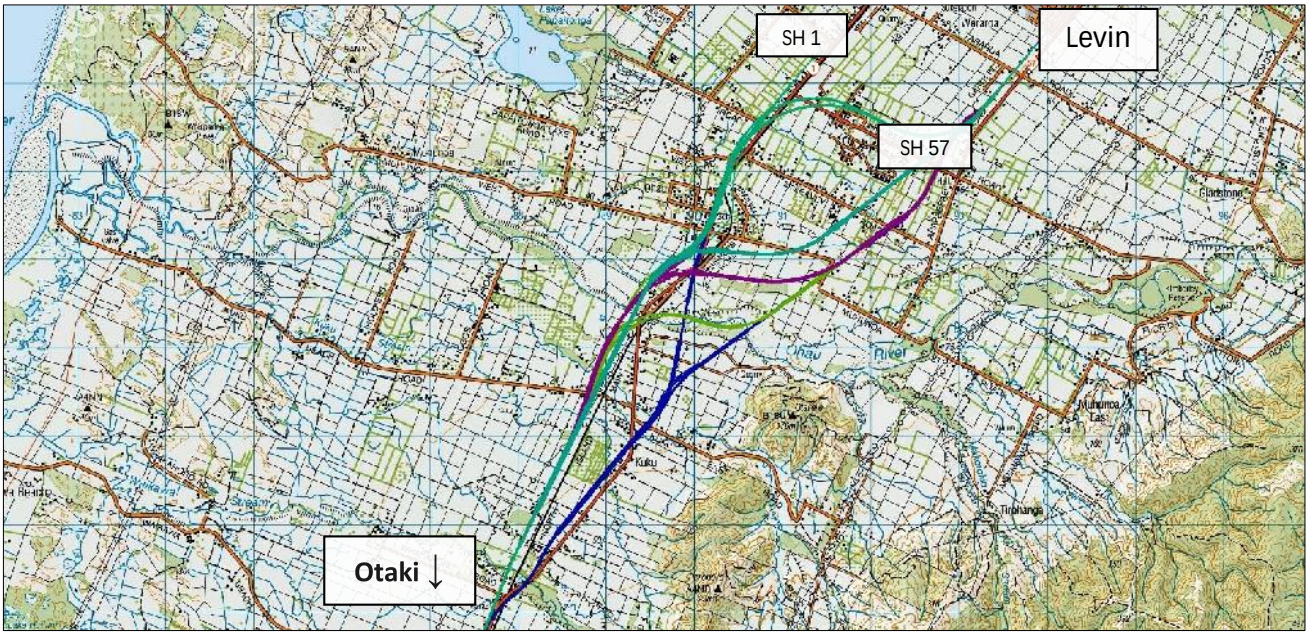
Route Option	Technical Drawing Plan Reference
Overview of Options 3C, 4A, 5A, 6A, 7A	80500902-05-005-G000 Rev. A
Option 3C	80500902-05-003-C001 Rev. A
	80500902-05-003-C002 Rev. A
	80500902-05-003-C003 Rev. A
	80500902-05-003-C004 Rev. A
	80500902-05-003-C005 Rev. A
Option 4A	80500902-05-004-C001 Rev. A
	80500902-05-004-C002 Rev. A
	80500902-05-004-C003 Rev. A
	80500902-05-004-C004 Rev. A
Option 5A	80500902-05-005-C001 Rev. A
	80500902-05-005-C002 Rev. A
	80500902-05-005-C003 Rev. A
	80500902-05-005-C004 Rev. A
Option 6A	80500902-05-006-C001 Rev. A
	80500902-05-006-C002 Rev. A
	80500902-05-006-C003 Rev. A
	80500902-05-006-C004 Rev. A
Option 7A	80500902-05-007-C001 Rev. A
	80500902-05-007-C002 Rev. A
	80500902-05-007-C003 Rev. A
	80500902-05-007-C004 Rev. A
Option T	80500902-05-005-G000 Rev. A (annotated)

Table 1: Technical drawing plan references used for this assessment.

1.3 Options Assessed

Six options have been assessed. Described here in a south – north direction—Options 3C, 4A, 5A, and 6A share a common alignment (with some subtle differences between options) up until the Ohau River at which point the alignment options diverge, crossing at different points to the east where all options converge at the existing State Highway (SH) 57 alignment, around Tararua Road. Options 7A and T generally follow the existing SH 1 alignment in the southern section, up until Kuku, at which point Option 7A takes on two 'legs' – one crossing directly to the north towards existing SH 1, and the second to the north-east towards Muhunoa Road, and beyond to SH 57. From Kuku north, Option T follows the northern leg of 7A, then converges with Option 3C before the Kimberly area.

Figure 1: General arrangement of options 3C, 4A, 5A, 6A, and 7A. Indicative only—alignment options may not be accurately aligned with topographic layer in this Figure. Option T not shown.



2.0 METHOD

2.1 Desk Top Assessment

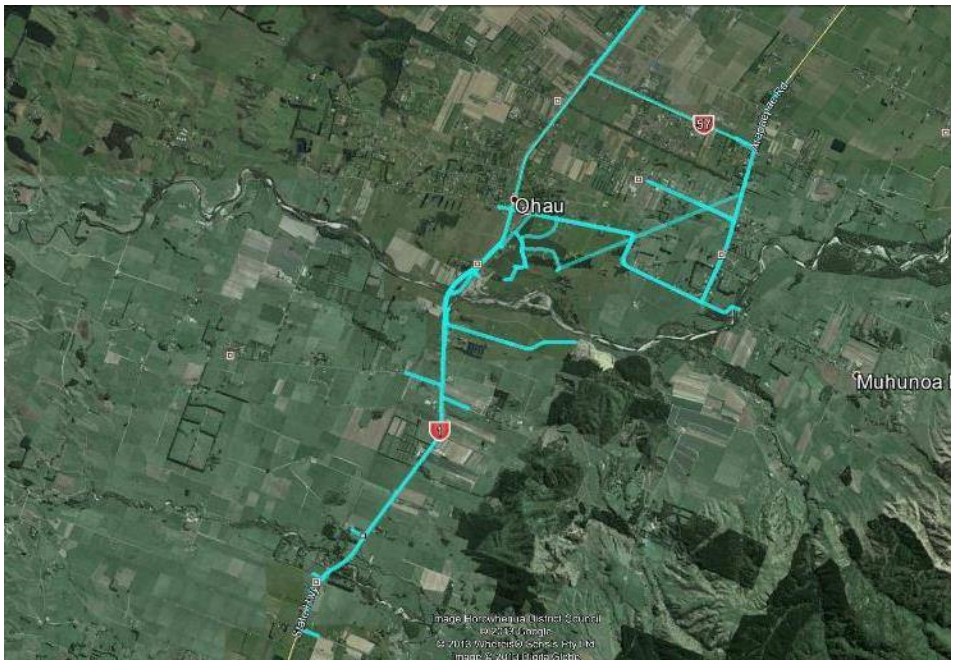
Desk top assessment of ecological sites and values associated with the project area covered the following sources:

Threatened Environments Classification (LCR, 2007),
New Zealand Freshwater Fish Database (NIWA, 2013),
Department of Conservation DOCgis (DOC, 2013a),
Department of Conservation BioWeb—flora, herpetofauna (DOC, 2013b),
Manawatu Plains Ecological District Survey Report for the Protected Natural Areas Programme (DOC, 1995),
Queen Elizabeth II Conservation Covenant GIS shape file layer (QEII, n.d),
Horowhenua District Plan (1999),
Horizons Regional Council, Proposed One Plan (2010).

2.2 Field Assessment

The alignment options were investigated in the field from public roads, vehicle accesses points and other vantages points over two days on the 28th and 29th of September 2013. The GPS track from that investigation shows the area covered during the field based assessment (Figure 2).

Figure 2: GPS track from field based assessment carried out over the 28th and 29th of September 2013.



2.3 Evaluation of Route Options

In order to provide an evaluation consistent with other disciplines involved with this assessment of options, the ecology assessment adopts the following coarse scoring system. A scoring of each route option is applied based on the constraints identified for each respective passage in the Results and Discussion section which follows.

Notation	Interpretation
++	Route option is, on average, very good in terms of this attribute
+	Route option is, on average, good in terms of this attribute
0	Route option is neutral, or neither good or problematic, on average, in terms of this attribute
–	Route option includes, on average, minor or intermediate issues or concerns in terms of this attribute
– –	Route option includes, on average, major or intermediate issues or concerns in terms of this attribute

Table 2: Coarse evaluation criteria adopted by this assessment.

3.0 RESULTS AND DISCUSSION

3.1 Ecological Setting

The area between Otaki and Levin (the project area) falls within the Manawatu Plains Ecological District (MPED) (DOC, 1995). The MPED is characterised by moderate temperatures, moderate rainfall of even distribution throughout the year, moderate hours of sunshine and a considerable amount of wind. At Levin, long term average temperature is around 13 °C, average annual rainfall is approximately 1,120 mm, and average daily wind run is a striking 185 km—from a predominantly west-south-west direction.

Overall these conditions are very favourable for plant growth; which is today reflected in both the predominantly production land use, but also in accounts of pre-human land cover (DOC, 1995). Prior to human settlement of the area, tall indigenous forest covered most of the MPED. Those forests (of varying types), and the MPED as a whole, had a high diversity of species. This can be expected from an area of fertile soils, mild climate, reliable rainfall and generally stable landforms (DOC, 1995).

Today, however, after the impacts associated with 500 – 600 years of human occupation, as well as a series of naturally occurring disturbances such as lightning strikes and wildfires, only a very small proportion of habitats resembling anything close to pre-human times remain. In fact, only ca. <2% of indigenous vegetation cover remains within the MPED, and what does remain are predominantly secondary indigenous communities. Forests in this category are communities which have managed to recover (to varying degrees and levels of development) from past disturbance.

These remnant sites provide a very important natural resource in many aspects of their ecology—from delineating species ranges and life history attributes and retaining diversity at various levels of ecological organisation, to provision of ecological services – such as maintenance of biodiversity and pollination, to provision of an important social reference to the identity of indigenous vegetation communities and their linkages to people – sense of place, and the rest.

The project area falls within an environment categorised as “Acutely Threatened” (LCR, 2007). The basis for this classification rests on the species-area relationship, which is a well-accepted ecological premise that larger areas can be expected to hold a greater diversity of life. In New Zealand’s terrestrial ecosystems it is estimated that a species-area threshold exists, where in the scenario of diminishing area of indigenous cover a tipping-point is reached (i.e., ca. 20% indigenous cover remaining) beyond which for each further increment of indigenous cover which is removed, a disproportionally large loss in biological diversity results (LCR, 2007).

In application, areas (such as the project area) where indigenous cover is only a few percent remaining are usually isolated from other areas of indigenous cover, suffer from the effects of high forest edge : area ratios and pest invasions, and as a consequence will not function in their usual ways. These isolated sites often have a reduced resilience to effects of activities occurring within the landscape around them. In this context, remaining indigenous cover takes on a heightened ecological importance. In functional terms individual specimens or small clusters of mature trees can serve important roles with regard to seasonal food supplies and reserves of genetic diversity.

3.2 Ecological Constraints of State Highway Route Options

3.2.1 Option 3C

Option 3C crosses three main waterways, as described below:

Waikawa Stream. The Waikawa Stream has all Proposed One Plan (POP) Zone Wide Values relevant to it. The Stream is known to hold nine freshwater fish species—three of which hold Declining (Allibone et al., 2010) status. One species, brown trout, is introduced.

Kuku Stream. A tributary to the Ohau River, and not specifically recognised in the POP. This alignment option crosses the Kuku Stream main-stem and a principal tributary. Five freshwater fish species have been recorded from the Kuku Stream—one of which holds a Declining (Allibone et al., 2010) threat status.

Lower Ohau River. The POP recognises all Zone Wide Values as being relevant to the lower Ohau River. Of relevance to ecology constraints is the Reach Specific Value of the lower river reaches as a Regionally Significant Trout Fishery, and its role as a trout spawning resource. In total fifteen freshwater fish species have been found in the Ohau River—six of those hold Declining (Allibone et al., 2010) threat status. One, brown trout, is an introduced species.

Option 3C receives differing levels of constraint from the following terrestrial features:

Option passes close (i.e., <20 m) to one tawa dominant, QEII protected, indigenous forest remnant at 2,300 – 2,500 m, which is on the western side of option alignment and railway tracks.

There would be a direct and substantial effect to the tawa dominant forest remnant at 3,400 m. This is a high value site and the alignment would directly affect ca. 50% of it. See Photograph 1 for a view of this site.

Direct effect/very close to indigenous treeland (at 4,600 – 4,700 m) to the south of market garden, south of Ohau River crossing.

Direct effect/very close to scattered indigenous trees to the north of Ohau River crossing (ca. 5,050 m), within the vicinity of the three-cable transmission line, ca. 5,050 m.

Direct effect/very close to individual indigenous trees amongst exotic trees, north of market gardens (ca. 5,350 m).

Evaluation: *– – Route option includes, on average, major or intermediate issues or concerns in terms of this attribute.*

3.2.2 Option 4A

Option 4A crosses three main waterways, as described below:

> Waikawa Stream. The Waikawa Stream has all Proposed One Plan (POP) Zone Wide Values relevant to it. The Stream is known to hold nine freshwater fish species—three of which hold Declining (Allibone et al., 2010) status. One species, brown trout, is introduced.
> Kuku Stream. A tributary to the Ohau River, and not specifically recognised in the POP. This alignment option crosses the Kuku Stream main-stem and a principal tributary. Five freshwater fish species have been recorded from the Kuku Stream—one of which holds a Declining (Allibone et al., 2010) threat status.
> Lower Ohau River. The POP recognises all Zone Wide Values as being relevant to the lower Ohau River. Of relevance to ecology constraints is the Reach Specific Value of the lower river reaches as a Regionally Significant Trout Fishery, and its role as a trout spawning resource. In total fifteen freshwater fish species have been found in the Ohau River—six of those hold Declining (Allibone et al., 2010) threat status. One, brown trout, is an introduced species.

Option 4A receives differing levels of constraint from the following terrestrial features:

> Option passes close (i.e., <50 m) to one tawa dominant, QEII protected, indigenous forest remnant at 2,300 – 2,400 m, which is on the western side of option alignment and railway tracks.
> Passes close to tawa dominant forest remnant at 3,400 m.
> Direct effect/very close to scattered indigenous trees to the north of Ohau River crossing, within the vicinity of the three-cable transmission line, ca. 5,050 m.
> Direct effect/very close to individual indigenous trees amongst exotic trees, north of market gardens (I) (ca. 5,350 m).
> Option passes close to four podocarp remnants of Muhunoa East Road area.

Evaluation: – Route option includes, on average, minor or intermediate issues or concerns in terms of this attribute.

3.2.3 Option 5A

Option 5A crosses three main waterways, as described below:

> Waikawa Stream. The Waikawa Stream has all Proposed One Plan (POP) Zone Wide Values relevant to it. The Stream is known to hold nine freshwater fish species—three of which hold Declining (Allibone et al., 2010) status—one species, brown trout, is introduced.

Kuku Stream. A tributary to the Ohau River, and not specifically recognised in the POP. This alignment option crosses the Kuku Stream main-stem and a principal tributary. Five freshwater fish species have been recorded from the Kuku Stream—one of which holds a Declining (Allibone et al., 2010) threat status.
Lower Ohau River. The POP recognises all Zone Wide Values as being relevant to the lower Ohau River. Of relevance to ecology constraints is the Reach Specific Value of the lower river reaches as a Regionally Significant Trout Fishery, and its role as a trout spawning resource. In total fifteen freshwater fish species have been found in the Ohau River—six of those hold Declining (Allibone et al., 2010) threat status. Brown trout, is an introduced species.

Option 5A receives differing levels of constraint from the following terrestrial features:

Option passes close (i.e., <50 m) to one tawa dominant , QEII protected, indigenous forest remnant at 2,300 – 2,400 m, which is on the western side of option alignment and railway tracks.
Passes close to tawa dominant forest remnant at 3,400 m.
Direct effect/very close to indigenous treeland (at 4,600 – 4,700 m) to the south of market garden, south of Ohau River crossing.
Direct effect/very close to scattered indigenous trees to the north of Ohau River crossing, within the vicinity of the three-cable transmission line, ca. 5,050 m.
Direct effect/very close to individual indigenous trees amongst exotic trees, north of market gardens (ca. 5,350 m).
Option passes close to six podocarp remnants of Muhunoa East Road area.
Direct effect to small isolated areas of podocarp forest at 1,100 – 1,300 m, near the 90° bend of Muhunoa East Road.
Direct effect to eastern edge of rewarewa/tawa forest located to the south of McLeavey Road at ca. 2,370 m. This is a high value site. See Photograph 2.

Evaluation: – – Route option includes, on average, major or intermediate issues or concerns in terms of this attribute.

3.2.4 Option 6A

Option 6A crosses three main waterways, as described below:

Waikawa Stream. The Waikawa Stream has all Proposed One Plan (POP) Zone Wide Values relevant to it. The Stream is known to hold nine freshwater fish species—three of which hold Declining (Allibone et al., 2010) status. One species, brown trout, is introduced.
Kuku Stream. A tributary to the Ohau River, and not specifically recognised in the POP. This alignment option crosses the Kuku Stream main-stem and a principal tributary. Five freshwater fish species have been recorded from the Kuku Stream—one of which holds a Declining (Allibone et al., 2010) threat status.

Lower Ohau River (2 × crossings). The POP recognises all Zone Wide Values as being relevant to the lower Ohau River. Of relevance to ecology constraints is the Reach Specific Value of the lower river reaches as a Regionally Significant Trout Fishery, and its role as a trout spawning resource. In total fifteen freshwater fish species have been found in the Ohau River—six of those hold Declining (Allibone et al., 2010) threat status. One, brown trout, is an introduced species.

Option 6A receives differing levels of constraint from the following terrestrial features:

Option passes close (i.e., <50 m) to one tawa dominant, QEII protected, indigenous forest remnant at 2,300 – 2,400 m, which is on the western side of option alignment and railway tracks.
Passes close to tawa dominant forest remnant at 3,400 m.
Direct effect/very close to indigenous treeland (at 4,600 – 4,700 m) to the south of market garden, south of Ohau River crossing.
Direct effect/very close to scattered indigenous trees to the north of Ohau River crossing, within the vicinity of the three-cable transmission line, ca. 5,050 m.
Direct effect to indigenous forest at 1,300/2,300 m—on the Ohau River flats (Photograph 3).
Direct effect to podocarp forest remnant at the 90° bend of Muhunoa East Road. This is a high value site which carries a high level of constraint.
Very close to rewarewa/tawa forest located on the brow of the hill to the south of McLeavey Road. This is a high value site. See Photograph 2.

Evaluation: – – Route option includes, on average, major or intermediate issues or concerns in terms of this attribute.

3.2.5 Option 7A

Option 7A crosses three main waterways, as described below:

Waikawa Stream. The Waikawa Stream has all Proposed One Plan (POP) Zone Wide Values relevant to it. The Stream is known to hold nine freshwater fish species—three of which hold Declining (Allibone et al., 2010) status. One species, brown trout, is introduced.
Kuku Stream. A tributary to the Ohau River, and not specifically recognised in the POP. This alignment option crosses the Kuku Stream main-stem and a principal tributary. Five freshwater fish species have been recorded from the Kuku Stream—one of which holds a Declining (Allibone et al., 2010) threat status.
Lower Ohau River (2 × crossings). The POP recognises all Zone Wide Values as being relevant to the lower Ohau River. Of relevance to ecology constraints is the Reach Specific Value of the lower river reaches as a Regionally Significant Trout Fishery, and its role as a trout spawning resource. In total fifteen freshwater fish species have been found in the Ohau River—six of those hold Declining (Allibone et al., 2010) threat status. One, brown trout, is an introduced species.

Option 7A receives differing levels of constraint from the following terrestrial features:

Option passes close to Tatum Park (at 2,000 m) – which includes a mixed exotic/indigenous forest stand.
Direct effect to indigenous forest remnant at 5,500 m (at the back of the aggregate industrial site) (north-eastern leg, see Photograph 4).
Close to indigenous forest remnant at 250/550 m.
Direct effect to podocarp forest remnant at the 90° bend of Muhunoa East Road. This is a high value site which carries a very high level of constraint.
Direct effect to rewarewa/tawa forest located on the brow of the hill to the south of McLeavey Road. This is a high value site. DoC Herpetofauna database records of ornate skink (At Risk, Declining) (15/08/1993, Brown's Bush). See Photograph 2.

Evaluation: – – Route option includes, on average, major or intermediate issues or concerns in terms of this attribute.

3.2.6 Option T

Option T crosses three main waterways, as described below:

Waikawa Stream. The Waikawa Stream has all Proposed One Plan (POP) Zone Wide Values relevant to it. The Stream is known to hold nine freshwater fish species—three of which hold Declining (Allibone et al., 2010) status. One species, brown trout, is introduced.
Kuku Stream. A tributary to the Ohau River, and not specifically recognised in the POP. This alignment option crosses the Kuku Stream main-stem and a principal tributary. Five freshwater fish species have been recorded from the Kuku Stream—one of which holds a Declining (Allibone et al., 2010) threat status.
Lower Ohau River. The POP recognises all Zone Wide Values as being relevant to the lower Ohau River. Of relevance to ecology constraints is the Reach Specific Value of the lower river reaches as a Regionally Significant Trout Fishery, and its role as a trout spawning resource. In total fifteen freshwater fish species have been found in the Ohau River—six of those hold Declining (Allibone et al., 2010) threat status. One, brown trout, is an introduced species.

Option T receives differing levels of constraint from the following terrestrial features:

Option passes close to Tatum Park (at 2,000 m) – which includes a mixed exotic/indigenous forest stand.
Close to indigenous forest remnant at 250/550 m.
Direct effect to indigenous forest remnant at 5,500 m (at the back of the aggregate industrial site) (north-eastern leg, see Photograph 4).

Evaluation: – Route option includes, on average, minor or intermediate issues or concerns in terms of this attribute.

4.0 CONCLUSIONS

4.1 Summary of Ecology Evaluations

	(++) Route option is, on average, very good in terms of this attribute	(+) Route option is, on average, good in terms of this attribute	(0) Route option is neutral, or neither good or problematic, on average, in terms of this attribute	(–) Route option includes, on average, minor or intermediate issues or concerns in terms of this attribute	(– –) Route option includes, on average, major or intermediate issues or concerns in terms of this attribute
Option 3C					●
Option 4A				●	
Option 5A					●
Option 6A					●
Option 7A					●
Option T				●	

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ATTACHMENT 1: SITE PHOTOGRAPHS

Photograph 1: Part of tawa forest at 3,400 directly affected by Option 3C.

Photograph 2: Part of rewarewa/tawa forest near McLeavey Road, affected by Options 5A, 6A, 7A.

Photograph 3: Indigenous forest affected by Option 6A.

Photograph 4: Part of indigenous forest affected by Option 7A and T.

ATTACHMENT 2: FRESHWATER FISH DATABASE RECORDS

Ohau River		Kuku Stream		Waikawa Stream	
Common name	Threat status	Common name	Threat status	Common name	Threat status
Shortfin eel		Shortfin eel		Shortfin eel	
Longfin eel	Declining	Longfin eel	Declining	Longfin eel	Declining
Torrentfish		Inanga		Torrentfish	
Koaro	Declining	Common bully		Inanga	
Banded kokopu		Koura		Shortjaw kokopu	Declining
Inanga				Upland bully	
Shortjaw kokopu	Declining			Redfin bully	Declining
Lamprey	Declining			Koura	
Crans bully				Brown trout	Introduced
Upland bully					
Common bully					
Bluegill bully	Declining				
Redfin bully	Declining				
Koura					
Brown trout	Introduced				

New Zealand Freshwater Fish Database Records retrieved 14/10/2013.

APPENDIX 5: AN ASSESSMENT OF THE ARCHAEOLOGICAL RISKS ASSOCIATED WITH PROPOSED UPGRADES TO THE CONNECTION OF SH1 AND SH5: MANAKAU TO LEVIN

APPENDIX 6: STATE HIGHWAY 1 TO STATE HIGHWAY 57 – REPORT ON MĀORI CULTURAL ISSUES ON ALTERNATIVE ROUTE PROPOSALS

STATE HIGHWAY 1 TO STATE HIGHWAY 57 – NORTH OF OTAKI TO NORTH OF LEVIN

REPORT ON MĀORI CULTURAL ISSUES ON ALTERNATIVE ROUTE PROPOSALS

MORRIE LOVE, RAUKURA CONSULTANTS - 4 NOVEMBER 2013

INTRODUCTION

This section of the O2L project along State Highway 1 runs from just north of Waikawa Beach Road to the junction with SH 57 and along SH 57 where it becomes Arapaepae Road.

This report will look at 6 potential options on the connection between SH 1 and SH 57. The factors that come into play with the options include but are not limited to the following:

1. Māori sites of significance including; Urupa, Pā or Marae, Māori archaeological sites and other known sites.
2. Māori land being one of the 5 classes of Māori land under Te Ture Whenua Māori.
3. Māori ecological sites including where taonga species are located, are taken or protected.
4. Land with the potential for use in the settlement of Treaty of Waitangi claims.
5. Māori businesses.

There are two marae along this part of the State Highways which are currently in active use for all the usual functions of a marae. Associated with these marae are two active urupa also located on SH 1. It could be said as a general rule, that the more westerly the route goes the more likely it is to interact with important Māori sites of significance and the converse for the routes which are more eastward.

It is noted that there are many sites of importance to Māori that are on land that is no longer owned by Māori. Much of this land was Māori owned with some only recently being alienated. Of these some key ones are the old Pā site where Te Uawhaki meeting house stood located on the south side of the Waikawa Stream bordering the railway. The full extent of the old Pā extended around where the old meeting house was located. A remnant of bush remains of the important site known as the Wehipeihana Bush. This Bush is just south of Kuku Beach Road. In the not too distant past the bush was much larger and today is still a significant nesting site for Ruru (owl) and Kereru (wood pigeon). This bush is adjacent to the Kuku Stream and close to the Waikokopu Stream. Many of the options will compromise these important sites along with other Maori sites west of the Railway between Kuku and Ohau.

The largest piece of Crown-owned land which could be used in Treaty claim settlements is the old Kimberley Centre currently held by the Mid-Central District Health Board. The 46

Hectare property was landbanked with the Office of Treaty Settlements but was released. However another claim has seen it being again investigated as a settlement asset. Its situation may change and it could be released for general sale. The Kimberley Centre is on Kimberley Road just off SH 1 with option 3C going through that land.

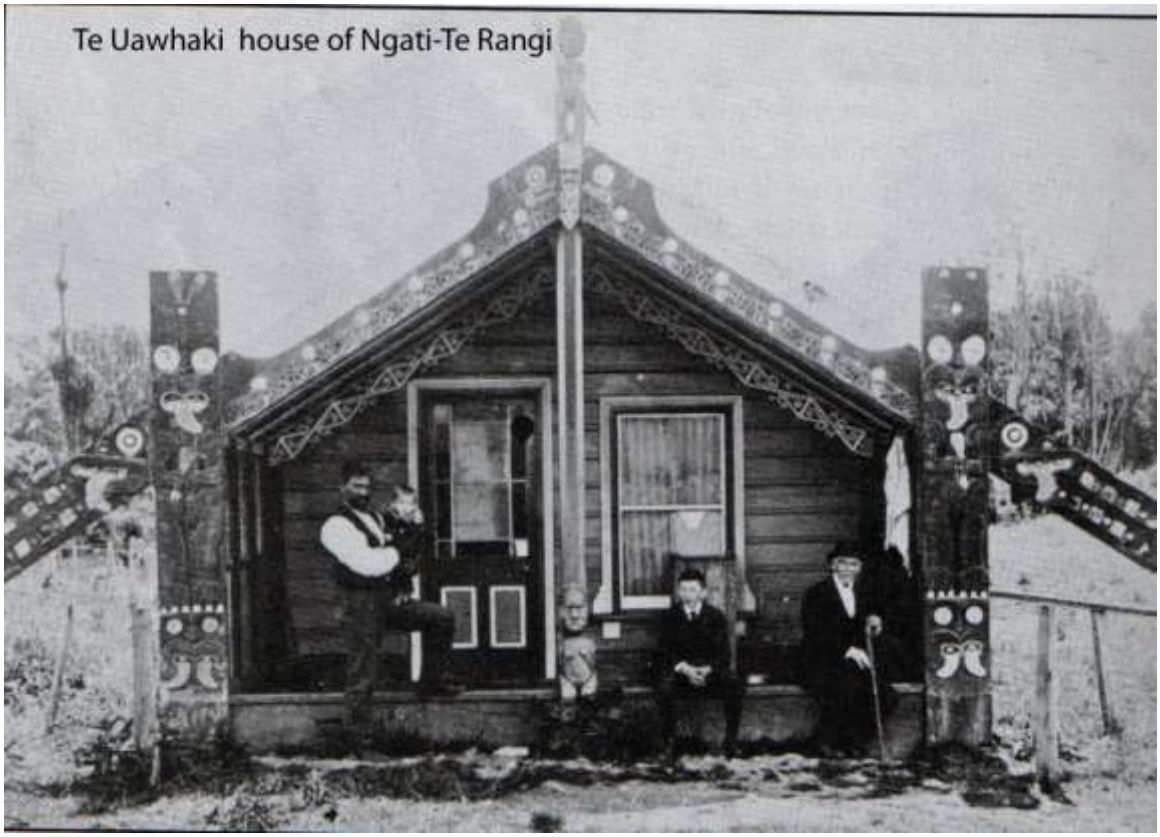
THE OPTIONS

Option 3C in the southern end would depart from the route of SH1 around Wehiwehi Marae and would follow the Main Trunk Railway line immediately to the west of the railway. The route is in part common with alternatives 4A, 5A, & 6A to around the interchange at Kuku Beach Road.

This part of the route will proceed virtually unchanged to the east of Wehiwehi Marae and urupa. The changes would involve a new proposed access around to the west of Wehiwehi Marae and would connect to Whakahoro Road which would not connect to SH 1.

There would be a new bridge crossing the Waikawa Stream which would need to be examined more closely when the options are narrowed. The site of the old Te Uawhaki meeting house needs further examination.

At Kuku Beach Road a new interchange would be built which raised many concerns from Ngati Tukorehe as the interchange has the effect of moving the road further west of the railway and so into sites. At Kuku Beach Road there was an old piggery which is no longer used and has no cultural significance.



This house was close to the Waikawa Stream near SH1 on the south side of the river

This option however from Ohau north (Muhunoa Road – East and West) brought less objection from Ngati Tukorehe. It is likely that the old Kimberley Centre would be cleared from the Treaty Settlement Landbanking freeing it for sale by Mid- Central Health.

Overall from the cultural perspective this option is rated [- -]

Option 4A

This option has the problem of the Te Uawhaki site at Waikawa, however it location closer to the Main Trunk Railway takes it away from patches of bush such as the Wehipeihana bush. This option avoids the important urupa adjacent to the SH 1 Rail bridge just south of the Ohau River (Ngati Tukorehe). The section of this option from the Ohau River north and east, raised issues not only about Māori sites and the proposed road, but also about what happens to maintain access after the existing old bridge(s) are closed. The river crossing of the Ohau is probably a preferred location from the cultural perspective.

This option south of Muhunoa East Road stays clear of the important stand of totara which has some cultural significance.

This option would go through a block of Maori land although little was known about this block and the owners have not had a significant presence (Block Muhunoa 1B1B is managed by the Maori Trustee). This route compared with 5A tends to cut the Māori block in half making it much less useable.

Rating [0]

Option 5A

This option is similar to 4A going through the Te Uawhaki site at Waikawa and goes through the more preferred route close to the west of the railway line. From just south of the Kuku Beach Road this route swings west away from the railway. That route over to the Ohau River swings eastward more or less parallel to Muhunoa East Road. In this route it runs to the south of the large stand of totara. Like option 4A it cuts through the Maori block Muhunoa 1B1B, but in this case closer to the Ohau River and so the piece cut off that block is smaller but on balance the effect is similar.

Rating [0]

Option 6A

This option is in common with the other options with respect to the Te Uawhaki site. This route runs a little away from the rail in the south. The route veers west, south of Kuku Beach

Road and starts to split into two with the lane going to SH57 perhaps even cutting into the Tukorehe Urupa. The route heads east more or less parallel to the Ohau River to cross the river well upstream. This part of the route then heads over to the Arapaepae Road. From the hapu perspective this is a very bad option. The SH1 route is also not acceptable cutting into a number of sites before joining the existing SH1. Many from the hapu thought this route was fatally flawed.

Rating [- -]

Option 7A

This option follows a very different route to the others but from the hapu perspective has some attractive points. The route veers left off the existing SH 1 just south of the Wehiwehi Marae and then crosses the Waikawa Stream avoiding Te Uawhaki and Wehiwehi and crossing the railway to a new river bridge over the Waikawa stream to the east of the existing SH1 and re-joining SHI. The route departs from the existing SH 1 where the road turns due north and follows a similar direction which is around North East. The route bifurcates with the SH1 section heading due north to Ohau joining the existing SH1 at the Muhunoa Road intersection. On route this travels to the east of Tukorehe Marae without going through any houses. That part crosses the Ohau River to the east of the existing bridge. This part of the route is vey favoured by the hapu from Tukorehe who are land-owners even along that part of the route. It is favoured because it avoids most if not all of the sites of significance for Maori.

The part connecting to SH57 would head in a north easterly direction to cross the Ohau River and joins Option 5A to connect to Arapaepae Road

Rating [+]

Option T

This option arose from the hui with Tukorehe and is a hybrid which takes part of the alignment to the south of Ohau of option 7A. This option would not bifurcate to go to SH 57. In this option it would connect with part of Option 3C at Ohau and to go along the present SH 1 with the split with the route going through Kimberley and then to the SH 57.

The support for this proposal hinges in the section from Wehiwehi marae to Ohau village. The significant sites for Māori in some places coincides with bush areas to the west of the Railway line. This route avoids the stretch of SH 1 in front of Tukorehe Marae and would significantly improve conditions there. There would also be significant improvements for Wehiwehi as their frontage would become a local road.

This option does not involve two road bridges over the Ohau River as with 7A. The route would involve some Māori land in the southern section, however in discussion with Māori land owners they saw gains in this option compared with the others.

The section from Ohau along the existing SH 1 raised few issues for Māori. The route through the old Kimberley centre raised few issues.

Rating [+ +]

APPENDIX 7: ŌTAKI TO LEVIN ROAD REALIGNMENT PROPOSALS - LAND RESOURCES ASSESSMENT

Otaki to Levin Road Realignment Proposals

Land Resources Assessment

October 2013

LandVision Ltd

PO Box 7191

WANGANUI

1 SUMMARY

In evaluating the six different proposals on soil quality and landuse, it highlighted the following:

The elite soils (the Levin silt loam soils) occur at the northern and southern ends of the realignment options. These soils have negligible limitations to productive capability and are noted in both the District and Regional Plans. Avoiding these elite soils is not practical or possible however some options have less impact than others.

At the southern end of the re-alignment, options 7A and T generally follow the existing road line through the elite soils and the other options follow the railway line. Consequently all options have limited impact on these soils at the southern end. At the northern end of the re-alignment, the options that have the greatest impact on the elite soils are 4A, 5A, 6A, 7A and T. The other options generally follow the existing road corridor but with some corner re-alignment.

Other soils within the area have varying productive potential. There is a large area of stony soils that has a lower productive potential under pasture, however the soil physical properties are ideally suited to growing grapes. The Te Horo silt loam soils on the intermediate terrace have the ability to grow grass but they can be prone to pugging and treading damage by heavy cattle when wet. The Te Horo silt loam compared with the Levin soils is less suited to market gardening due to the inability to work this soil in the spring and autumn.

There are approximately five dairy farms within the realignment area. The sizes of these units are considered small to average. Four of the options have a significant impact to at least one or two of the dairy units (not always the same dairy unit) making them an unviable economic unit(s) by reducing the productive land area or creating access issues when the farm is divided. This is especially so where the road realignment is a cutting. None of the dairy properties have a common boundary and there are no opportunities for land swapping to negate any access issues. The least impact on dairying comes from options 5A and T.

The vineyard is located on stony soils that are particularly suited to grapes. The impact to the vineyard from the different options varies significantly. Options 6A, 7A and T have insignificant impact whilst the other options will reduce the grape canopy cover by between 5 ha and 10 ha.

The impact on gardening is difficult to ascertain. Often gardening land is leased to gardeners for 2 to 5 years and then returned back to pastoral farming. Gardening however is generally concentrated on the good to elite soils (i.e. the Levin and Manawatu soils and occasionally the Te Horo silt loam soils) and generally in small pockets.

The impact on land use and the soil quality from the six options was analysed using a scoring system from - - to ++ where ++ has less impact or degree of difficulty to achieve the re-alignment option. The overall results of this are shown in the following table.

	Option 3c	Option 4a	Option 5a	Option 6A	Option 7A	Option T
Critical analysis scoring (1-5)	+	–	0	–	–	++

2 TABLE OF CONTENTS

3 BACKGROUND INFORMATION

MWH have requested land resource information along the lines of the different road realignment scenarios between Otaki and Levin. In total there are six options that need to be investigated.

Access to the land along most options has been somewhat restrictive, so a range of information sources has been relied on. The area occupied by the Ohau vineyard has been most closely investigated.

4 LAND RESOURCES

The land resources in the region have been described and evaluated according to the Land Resource Inventory (LRI) and Land Use Capability (LUC) Classification system.

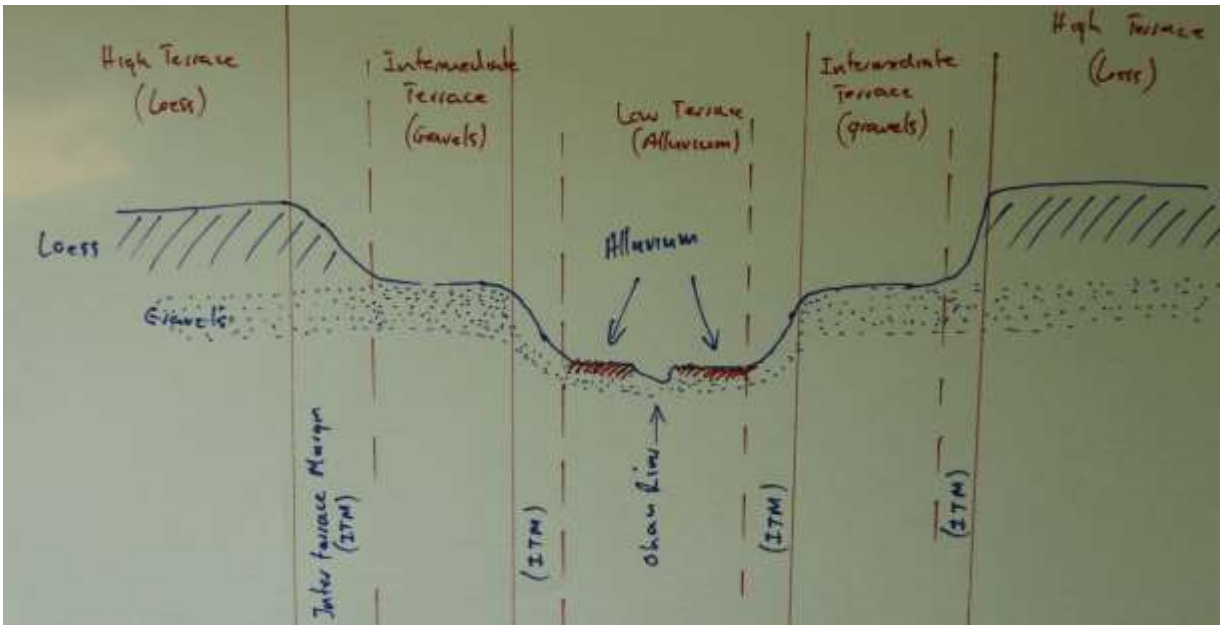
The LRI system involves mapping landscape units according to five inventory factors. These include rock type, soil unit, slope class, erosion type and severity, and vegetation.

From the LRI assessment, the area was then classified into LUC classes according to the level of limitations present for productive use. LUC classes range from class I land (elite land) through to class VIII land (no productive value) The LUC classes are then further broken down according to the most dominant limitation to production. These limitations include erosion, wetness, soil or climate. Finally the LUC unit is derived from a combination of the LUC class and subclass along with the five land resource inventory factors. Hence it groups land with similar productive capability, levels of limitations, and land resource inventory factors.

A detailed land resources survey was undertaken of the vineyard at a scale of 1:7,000 scale. Outside the vineyard, the mapping scale was significantly reduced due to access and varied between 1:20,000 and 1:50,000 scale.

Appendix 2 and 3 details the soils and landuse capability units found in the area and the extent of these is shown in Appendix 4. A detailed soils map of the vineyard is shown in Appendix 5.

The land resources present can best be described using the cross sectional diagram shown below.



Both the northern and southern parts of the area containing the six different options occur on the high terrace. The soils present are the Levin silt loam and the Waitopu silt loam soils formed from moderately weathered quartzo feldspathic loess derived from greywacke. The main difference between the two soils is the drainage with the Levin series being well drained and the Waitopu series being moderately well drained. Both these soils

(particularly the Levin silt loam) are considered very elite soils and have very little physical limitations to intensive land use.

The land use capability classification of the high terrace is class Ic1 land where it is flat. As this slope increases to undulating or slightly rolling the LUC classification changes to class IIe1 or IIIe1 land.

In the middle of the cross section, the landforms drop down from the high terrace to the intermediate terrace. The intermediate terrace is where the river level was during the last glaciation (8-15,000 yrs ago). Loess material was blown from this terrace up on to the high terrace during the last glaciation. Since then the river has cut down through the gravels of the intermediate terrace to its current level on the low terrace.

On the intermediate terrace the soils are formed from deep alluvial gravels derived from greywacke. The stone content and the depth of topsoil or soil development will vary significantly and will determine the soil type present. Where the soils are well drained and there is greater than 35% content of stone present the soils are classified as the Ashhurst stony series. Where there is less than 35% stone content they are classed as Te Horo soils. Where the drainage is imperfectly to poor then they are called the Paraha stony silt loam soils.

The landuse capability units found on the intermediate terrace are influenced by soil type or depth to the stones. Where there is significant soil depth they are classified as Class IIs3 land. As the soil depth decreases, so does the classification to class IIIs2 land.

On the low terrace the drainage patterns and the soil texture also influence the soil type. The free draining areas prone to frequent flooding are the Rangitikei series whilst the poorly drained soils prone to flooding are the Parawanui series. On a slightly elevated part of this terrace that is well drained are the Manawatu series. These soils are also prone to flooding but very infrequently.

The landuse capability classification of the low terrace reflects the drainage class and texture present. Those areas of free draining Manawatu soils are classed as IIs1 land whilst the poorer draining Parawanui series are classified as IIIw1 land.

5 LANDUSE

Landuse with the area was determined from a combination of ‘on the ground visual’ and the use of the Land Cover Data Base (2008). The dominant economic land uses include dairying (estimated 5 dairy farms within the area), dry stock farming, gardening (vegetable crops), horticulture, and grapes (44 hectares).

The extent of gardening in the region is never fixed. Often the land that is gardened is leased for several years before returning back to pastoral farming.

When determining the impacts on dairying several things are taken into account. These include the amount of area lost to production, whether this reduced area renders the property unviable, whether the new road will create access difficulties if the property is divided. Also considered is the ability to undertake land swaps as a result of dividing properties.

When considering production losses for dairying, typical production figures on this sort of country should be producing 1,200 kg milk solids per hectare at $7/kg ($8,400/ha gross). Approximately half of this will be production costs. The minimum size for an economic dairy unit is about 180-250 cows and is dependent on debt levels.

The financial impact on grapes can be based on the lost area. Currently grapes are net returning around $10K per hectare.

6 DISCUSSION

Generally the soil types and land forms run perpendicular to the proposed re-alignment options. The elite soils are found at the northern and southern boundaries up on the high terrace. In between these elite soils are a range of soil types where the quality can vary significantly from very stony gravels with limited topsoil through to deep alluvial soils with very few limitations.

Ideally elite soils should be kept for production purposes and policies in both the District and Regional Plans promote this. In this situation however, it is not practical or possible to avoid the elite soils with any of the options. What is possible is to minimise their destruction by locating the options along existing roading corridors or adjacent to the railway line. To a certain degree this has happened, especially in the southern part of the area.

Since avoidance of elite soils is not possible or practical then consideration needs to be given to landuse within the proposed re-alignment area. To minimise the impact on productivity, emphasis needs to be placed on avoiding economic units or at least minimising the impact to these. The following table summarises the impact on landuse from the different options.

Option 3c	Option 4a	Option 5a	Option 6A	Option 7A	Option T
Probably significantly affects one dairy unit potentially making it unviable (removes 10 ha from a 55 ha dairy unit – 12,000 kg MS reduction). Minor effect on another dairy unit. Significant impact on the vineyard (probably affecting 9 ha out of 44 ha – estimated $90K per year net reduction). Some effect on gardening but not sure of the extent.	Probably significantly affects one dairy unit potentially making it unviable (removes 10 ha from a 55 ha dairy unit – 12,000 kg MS reduction). Minor effect on another dairy unit Significant impact on the vineyard (probably affecting 9 ha out of 44 ha – estimated $90K per year net reduction when vineyard fully productive). Some effect on gardening but not sure of the extent.	Reduction in canopy of vineyard by about 5.8 ha ($58K/yr net income). Greatest impact appears to be on dry stock farming plus lifestyle blocks. Plus some gardening.	The Manawatu soils are slowly accumulating and can be prone to infrequent flooding (once every 5-10 years). Significant impact on two dairy units – probably making one marginally viable (removal of 10 ha out of an estimated 80 ha) and creating access difficulties through the other. Approach to the Ohau River (Shannon branch) is on an outside bend which would require armouring. Probably affects about 3.5 ha of grapes.	Dissects 3 dairy units probably making 2 of them unviable. Certainly creates access difficulties.	Minor impact on 2 dairy units creating access difficulties only. Impact on the vineyard (probably affecting around 1.8 ha out of 44 ha – estimated $18 K per year net reduction when vineyard fully productive). Limited impact on access apart from needing to cross the state highway.

This approach is not suggesting that smaller blocks with non-traditional farming land uses have no value. It does work on the principle that their productive opportunities are significantly reduced when compared with a larger property.

Following consideration of above the impact of the different options on landuse and soil resources was evaluated using the method described in Appendix 1. The results of this are shown in the following table.

	Option 3c	Option 4a	Option 5a	Option 6A	Option 7A	Option T
Critical analysis scoring	+	–	0	–	–	++

7 APPENDIX 1 – CRITICAL ANALYSIS SCORING CRITERIA

The following table details the scoring descriptions used in the evaluation.

SCORE	DESCRIPTION
++	Route option is, on average, very good in terms of this attribute
+	Route option is, on average, good in terms of this attribute
0	Route option is neutral, or neither good or problematic, on average, in terms of this attribute
–	Route option includes, on average, minor or intermediate issues or concerns in terms of this attribute
– –	Route option includes, on average, major or intermediate issues or concerns in terms of this attribute

8 APPENDIX 2: SOIL RESOURCES

The following table describes the dominant soils found in the general area of the different scenarios.

	Name: Ashhurst stony silt loam. LUC map symbol: AH2 Parent material: Alluvium over gravels. Drainage status: Well drained. Soil consistence: Friable when moist, plastic when wet. Degree of topsoil development: Moderately to weakly developed. Compaction susceptibility: Low. Profile description: 10-15 cm moderately to weakly developed, medium nut and crumb, friable when moist, plastic when wet, dark blackish brown (10 YR 2/2) stony silt loam with few fine to small gravels. On: 20 cm weakly developed, medium to fine crumb and nut, very friable when moist, plastic when wet, dark blackish brown (10 YR 2/2) stony silt loam with profuse small to medium gravels. On: weakly developed, medium to fine crumb and nut, very friable when moist, plastic when wet, dark yellowish brown (10 YR 5/4) stony silt loam with profuse small to medium gravels. On alluvium over gravels. Comments: Predominant soil on the property found on the intermediate terrace. Management considerations: Ideal soil for growing grapes due to fertility and drainage.
	Name: Te Horo stony silt loam LUC map symbol: TH1 Parent material: Alluvium over gravels. Drainage status: Moderately well drained. Soil consistence: Friable when moist, plastic when wet. Degree of topsoil development: Moderately to weakly developed. Compaction susceptibility: Low. Profile description: 15cm moderately to weakly developed, medium nut and crumb, friable when moist, plastic when wet, dark yellowish brown (10 YR 3/3) stony silt loam with few fine to small gravels. On: weakly developed, medium to fine crumb and nut, very friable when moist, plastic when wet, yellowish brown (10 YR 5/6) stony silt loam with profuse small to medium gravels. On alluvium over gravels. Comments: Found on the intermediate terrace. Management considerations: Ideal soil for growing grapes due to fertility and drainage.

	Name: Paraha stony silt loam LUC map symbol: Pa2 Parent material: Alluvium over gravels. Drainage status: Imperfectly drained. Soil consistence: Friable when moist, plastic when wet. Degree of topsoil development: Compaction susceptibility: Moderate. Profile description: 15-20 cm moderately to weakly developed, medium nut and crumb, friable when moist, plastic when wet, greyish brown (10 YR 5/2) fine stony silt loam with few fine to small gravels. On: weakly developed, medium to fine crumb and nut, very friable when moist, plastic when wet, brown (10 YR 5/3) stony silt loam with profuse small to medium gravels. On alluvium over gravels. Comments: Found on the intermediate terrace. Management considerations: Limited area of this soil. Care with machinery when wet to minimise compaction damage.
	Name: Parewanui silt loam. LUC map symbol: P1 Parent material: Alluvium over gravels. Drainage status: Imperfectly to poorly drained. Soil consistence: Friable when moist, very plastic when wet. Degree of topsoil development: Moderately to weakly developed. Compaction susceptibility: High. Profile description: 12-15 cm moderately to weakly developed, medium nut and crumb, friable when moist, very plastic when wet, greyish brown 10 YR 4/2 silt loam with few gley and orange mottles. On: moderately to weakly developed, medium nut and crumb, friable when moist, very plastic when wet, light greyish brown 10 YR 4/3 silt loam with few to many gley and orange mottles and many small to medium gravels. On alluvium over gravels. Comments: Found on the lower terrace. Management considerations: Limited area of this soil. Less suited to growing grapes due to poorer drainage. Care with machinery when wet to minimise compaction damage.

	Name: Levin silt loam. Soil map symbol: L1 Parent material: Loess. Drainage status: Moderately well drained. Soil consistence: Friable when moist, plastic when wet. Degree of topsoil development: Moderately to weakly developed. Pugging susceptibility: Moderate to low. Effluent application risk: Low. Profile description: 25 cm moderately to weakly developed, fine to medium nut and crumb, friable when moist, plastic when wet, 10 YR 4/3 silt loam. On: moderately to weakly developed, fine to medium nut and crumb, friable when moist, plastic when wet, 10 YR 6/6 fine sandy silt loam. On loess. Comments: Levin silt loam is a well drained soil having a dark brown, well structured, friable silt loam textured A horizon overlying yellowish brown nd brownish yellow, friable, generally non mottled silt loam or silty clay loam textured Bw horizons with moderately developed nut and granular structure. Wet consistence is smeary and non sticky throughout, with the upper Bw horizon having a weak to moderate reaction to the NaF field test. Matrix colours are always yellowish brown or brownish yellow throughout. Few (up to 2%) low chroma colours can occur with the Levin silt loam but usually only at depths exceeding 80 cm. few (up to 2%) ochreous mottles sometimes occur between 60 and 80 cm.
	Name: Manawatu fine sandy loam LUC map symbol: M3 Parent material: Recent undifferentiated alluvium. Drainage status: Moderately well to well drained. Soil consistence: Friable when moist, slightly plastic when wet. Degree of topsoil development: Weakly developed. Profile description: 12 cm weakly developed, fine crumb and nut, friable when moist, slightly plastic when wet, pale orange grey (WO 1e) fine sandy silt. On: weakly developed, fine crumb and nut, friable to loose when moist, slightly plastic when wet, greyish weak orange (WO 2d) fine sandy silt. On recent undifferentiated alluvium. Comments: found on the low terrace. Prone to occasional flooding. Potential for seasonal soil moisture deficits. Potential for wind erosion if vegetative cover is removed. Management considerations: Use cultivation methods such as zero-tillage and direct drilling to maintain vegetative cover.
	Name: Waitohu silt loam LUC map symbol: W1 Parent material: Moderately weathered, stiff, uncemented, quartzo-feldspathic loess from greywacke.

	Drainage status: Moderately well drained. Soil consistence: Very friable when moist, plastic when wet. Degree of topsoil development: moderately developed Compaction susceptibility: Moderate. Profile description: 20 cm moderately developed dark brown nutty silt loam on 33 cm moderately developed fine nutty yellowish brown silt loam, on 30 cm of moderately developed fine granular yellowish brown silt loam on moderately developed medium blocky light yellowish brown medium blocky clay loam. Comments: Waitohu silt loam is similar to the Levin silt loam, and has a friable brownish silt loam textured A horizon over yellowish brown and brownish yellow silt loam and clay loam textured Bw horizons. It is however less free draining than the Levin silt loam, having a denser and more compact subsoil with firmer moist consistence and with stickier and more plastic wet consistence below a depth of 60 cm. Waitohu silt loam has a lower permeability than the Levin silt loam and has perched water table at depth. It shows generally paler matrix colours with distinct low chroma colours present below 60 cm. deeper horizons of Waitohu silt loam show coarse blocky structure. Management considerations: Limited area of this soil. Care with machinery when wet to minimise compaction damage.

9 APPENDIX 3: LAND USE CAPABILITY

This section details the Land Use Capability units found in the general area of the different scenarios and that within the vineyard property.

9.1 General Area Land Use Capability

LUC description	Parent material	Dominant soil type	Slope (^{0})	Strengths	Limitations	Landuse suitability	Conditions of use
Ic1 Flat to gently undulating, high and medium-height terraces with a mantle of loess and minor tephra. The soils are deep, fertile and well drained. The terraces typically occur between 10-60 m a.s.l. where rainfall is 1000-1200 mm p.a. Occurs between Shannon and Otaki. 	Loess and minor tephra.	Levin silt loam (L1)	0-3	Contour. Access. Deep, fertile soils. Good natural drainage.	Potential to dry out slightly in the summer.	Intensive pastoral farming.	Maintain soil health and fertility.

LUC description	Parent material	Dominant soil type	Slope (0)	Strengths	Limitations	Landuse suitability	Conditions of use
IIe1 Undulating high and medium-height terraces with a mantle of loess and minor tephra. The soils are deep, fertile and well drained. There is a potential for slight sheet and rill erosion when cultivated. Occurs in the Levin district. 	Loess and minor tephra.	Levin silt loam (L1)	4-7	Contour. Access. Deep, fertile soils. Good natural drainage.	Potential for slight sheet and rill erosion when cultivated.	Intensive pastoral farming.	Care with cultivation to avoid sheet and rill erosion. Use minimum tillage techniques.
IIs1 Flat, low river terraces and levees of the floodplains with alluvial soils. The soils are sandy in texture and moderately deep overlying gravels. They are fertile and well drained although they tend to dry out in summer. Occurs on Manawatu, Ohau and Waikanae floodplains.	Fine-grained alluvium.	Manawatu fine sandy loam (M3).	0-3	Contour. Access. Deep, fertile soils. Good natural drainage.	Potential to dry out slightly in the summer. Potential for slight streambank erosion where adjacent to a stream.	Intensive pastoral farming.	Avoid over-cropping. Maintain soil health and fertility. Plant shrub willows on pressure points of the stream.

LUC description	Parent material	Dominant soil type	Slope (0)	Strengths	Limitations	Landuse suitability	Conditions of use
IIs3 Flat, medium-height alluvial terraces with well drained, moderately deep soils overlying gravel. Soils dry out in summer.	Fine-grained alluvium over gravels.	Te Horo silt loam (TH1)	0-3	Contour. Access. Good natural drainage.	Dries out in the summer.	Intensive pastoral farming.	Care with cultivation to avoid soil exposure to wind erosion. Use minimum tillage techniques. Maintain a vegetative cover through grazing management and soil fertility.
IIIe1 Dissected terrace land formed from unconsolidated sands and conglomerate. Soils are intergrades between yellow-brown earths and yellow-brown loams developed from loess and minor tephra. Potential for moderate sheet and rill erosion when cultivated. 	Loess and minor tephra.	Waitohu silt loam (W1)	4-15	Contour. Access. Good natural drainage.	Potential for moderate sheet and rill erosion when cultivated.	Intensive pastoral farming.	Contour cultivation to reduce potential for sheet and rill erosion. Use minimum tillage techniques.

LUC description	Parent material	Dominant soil type	Slope (0)	Strengths	Limitations	Landuse suitability	Conditions of use
IIIw1 Flat, narrow alluvial valley floors with imperfectly to poorly drained soils developed from fine-grained alluvium. 	Fine-grained alluvium over gravels. (Al/Gr)	Parewanui silt loam (P1)).	0-3 (A)	Contour. Access. Fertile soils.	Potential for compaction from machinery when soils are wet. Prone to occasional flooding (every 5 years). Moderately high water table.	Vineyard.	Avoid compaction from machinery. Maintain soil health and fertility.
IIIs2 Flat, medium height alluvial terraces with somewhat excessively drained soils developed from stony alluvium. 	Alluvium over gravels. (Al/Gr)	Ashhurst stony silt loam (AH2). Te Horo stony silt loam (TH1)). Paraha stony silt loam (Pa2).	0-3 (A)	Contour. Access. Good drainage.	May dry out in summer.	Vineyard.	Maintain soil health and fertility.

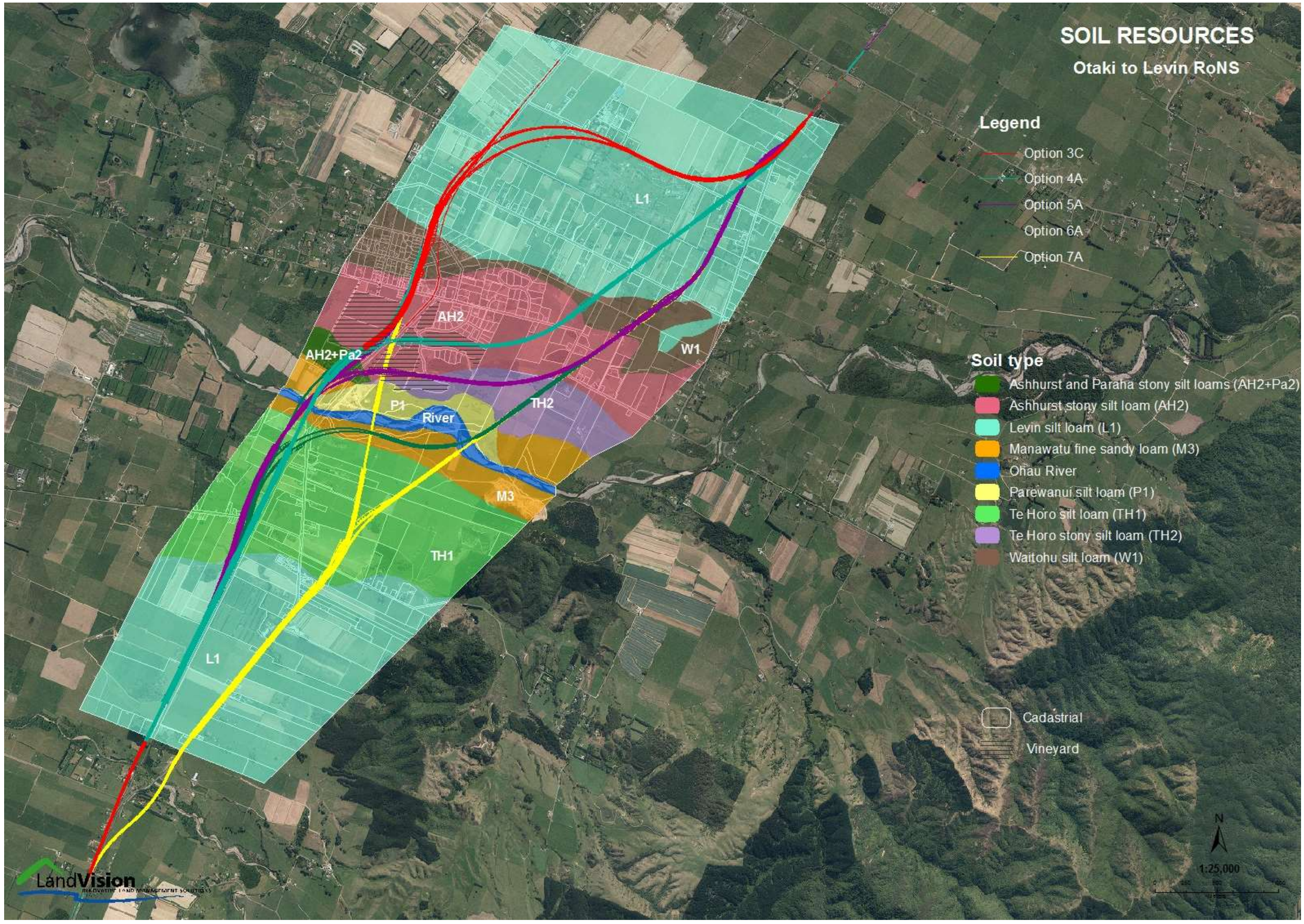
LUC description	Parent material	Dominant soil type	Slope (0)	Strengths	Limitations	Landuse suitability	Conditions of use
VIIs2 Flat river terraces in with alluvial soils varying in texture from coarse sandy to bouldery. Soils are free draining and subject to periods of soil moisture deficits. Some areas may be prone to flooding. 	Gravels & coarse alluvium.	Rangitikei series (R1)	0-3	No susceptibility for pugging or treading damage. Ideal winter cattle country. Sheltered country.	Low natural fertility. Summer dry. Limited pasture production potential during summer and autumn. Some areas prone to flooding.	Extensive pastoral farming. Winter feed pad potential.	Maintain vegetative cover during summer. Consider fertiliser policy for N based rather than P based due to the summer dryness. Protection planting of stream banks.

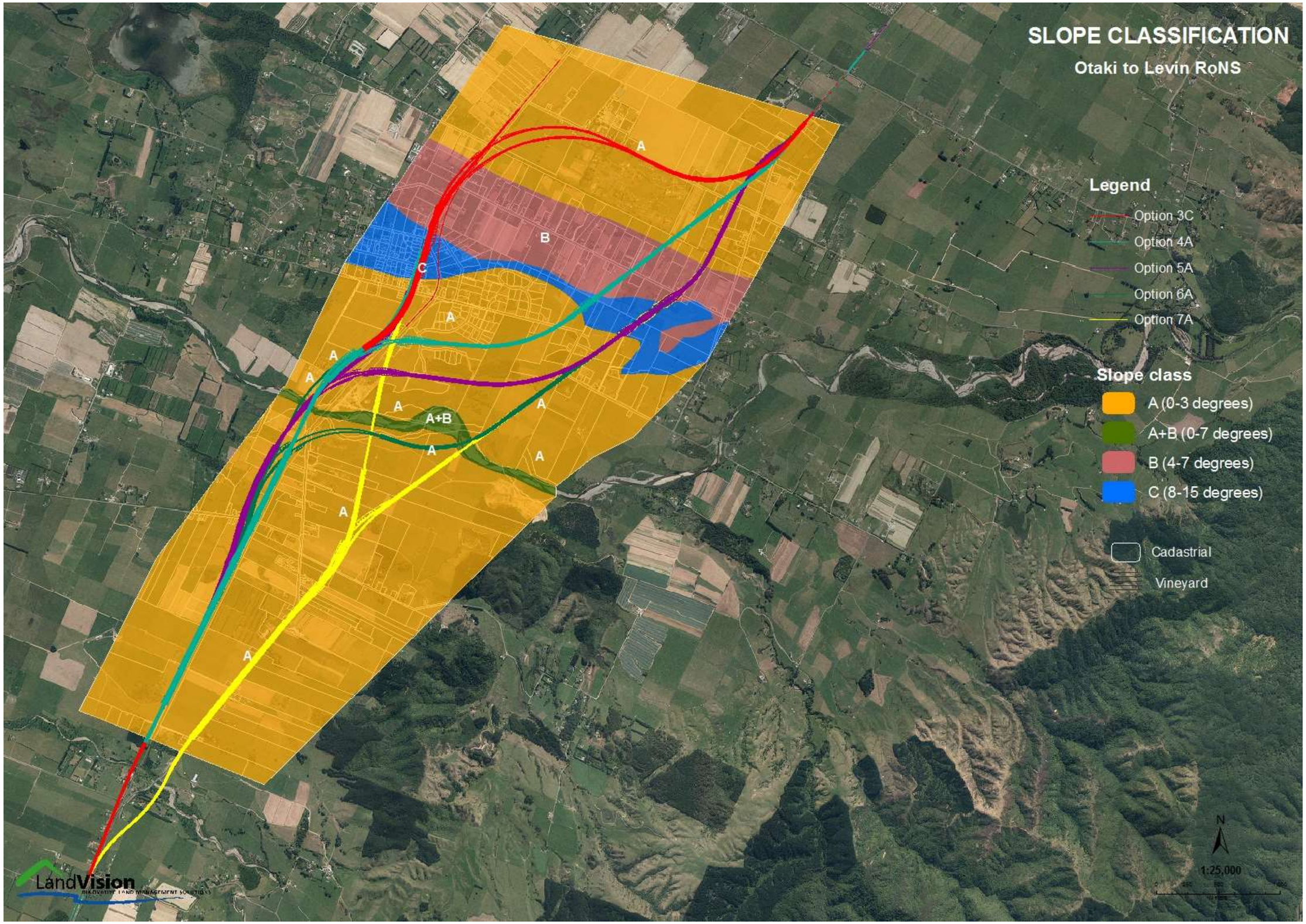
9.2 Vineyard Land Use Capability

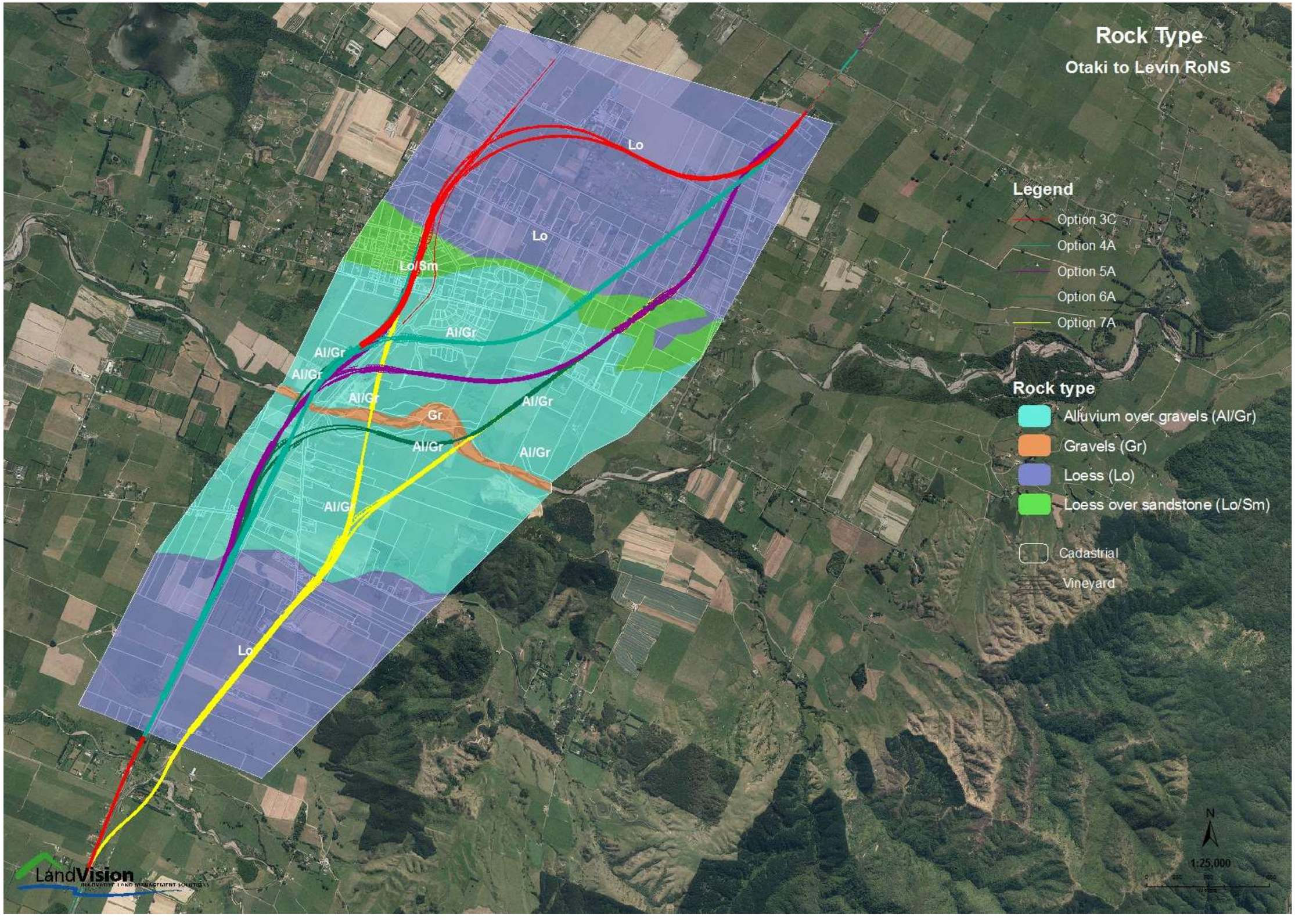
The following table describes the land resource inventory and land use capability units (LUC) units found on the vineyard.

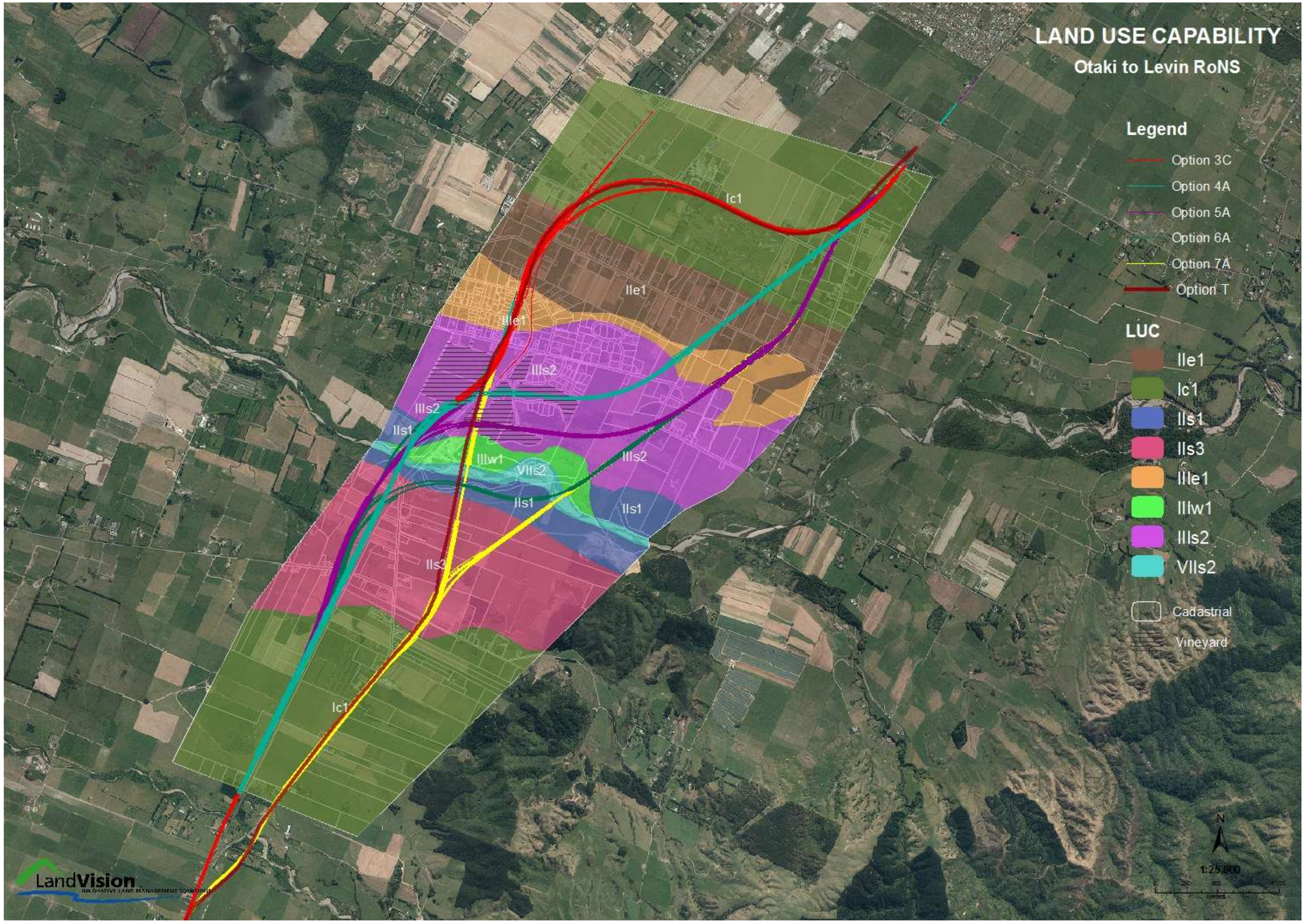
LUC description	Total Area (ha)	Parent material	Dominant soil type	Slope (degrees)	Vegetation	Area (ha)	Strengths	Limitations	Landuse suitability	Conditions of use
IIIw1 Flat, narrow alluvial valley floors with imperfectly to poorly drained soils developed from fine-grained alluvium. 	0.3	Fine-grained alluvium over gravels. (Al/Gr)	Parewanui silt loam (P1).	0-3 (A)	Vineyard (cG).	0.3	Contour. Access. Fertile soils.	Potential for compaction from machinery when soils are wet. Prone to occasional flooding (every 5 years). Moderately high water table.	Vineyard.	Avoid compaction from machinery. Maintain soil health and fertility.
IIIs2 Flat, medium height alluvial terraces with somewhat excessively drained soils developed from stony alluvium. 	44.3	Alluvium over gravels. (Al/Gr)	Ashhurst stony silt loam (AH1). Te Horo stony silt loam (TH1). Paraha stony silt loam (Pa2).	0-3 (A)	Vineyard (cG).	44.3	Contour. Access. Good drainage.	May dry out in summer.	Vineyard.	Maintain soil health and fertility.

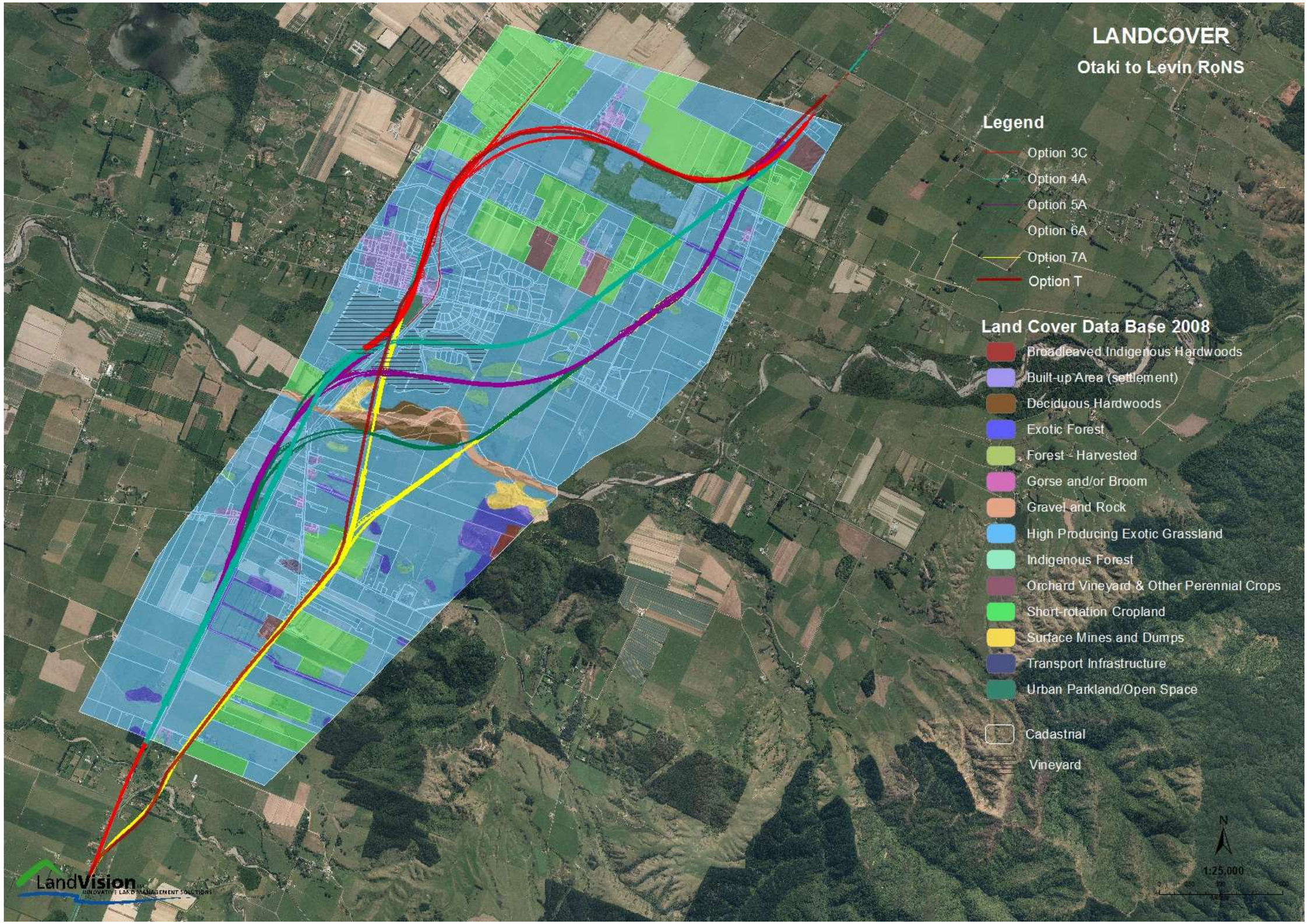
10 **APPENDIX 4: MAPS FOR THE GENERAL AREA**



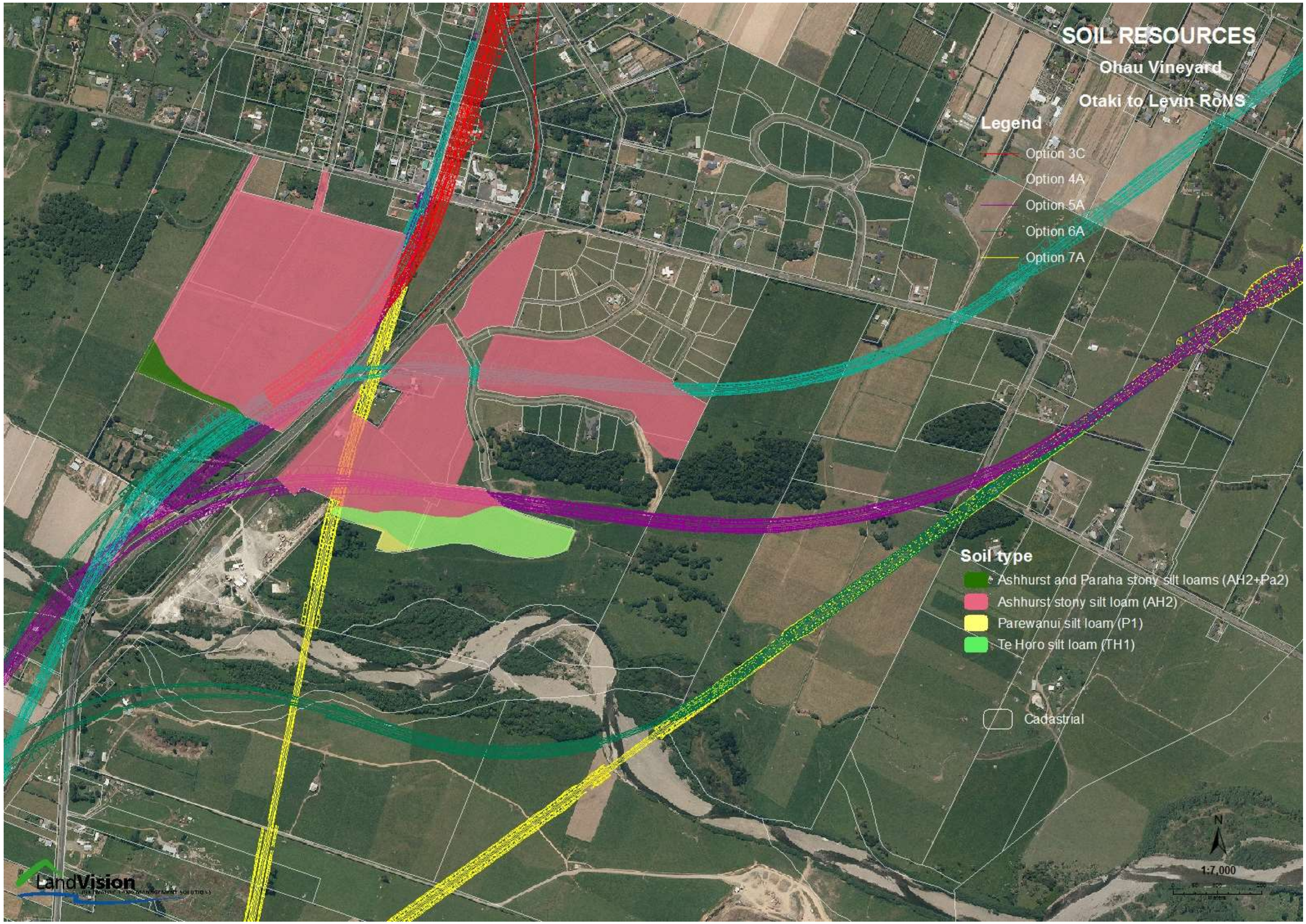

SLOPE CLASSIFICATION
Otaki to Levin RoNS
Legend
Option 3C
Option 4A
Option 5A
Option 6A
Option 7A
Slope class
A (0-3 degrees)
A+B (0-7 degrees)
B (4-7 degrees)
C (8-15 degrees)
Cadastrial
Vineyard
N
1:25,000
LandVision


Rock Type
Otaki to Levin RoNS
Legend
Option 3C
Option 4A
Option 5A
Option 6A
Option 7A
Rock type
Alluvium over gravels (Al/Gr)
Gravels (Gr)
Loess (Lo)
Loess over sandstone (Lo/Sm)
Cadastrial
Vineyard
Lo
Lo
Lo/Sm
Al/Gr
Al/Gr
Al/Gr
Al/Gr
Gr
Al/Gr
Al/Gr
Al/Gr
Lo
N
1:25,000
LandVision


LAND USE CAPABILITY
Otaki to Levin RoNS
Legend
Option 3C
Option 4A
Option 5A
Option 6A
Option 7A
Option T
LUC
IIIe1
IIc1
IIIs1
IIIs3
IIIe1
IIIw1
IIIs2
VIIs2
Cadastrial
Vineyard
IIc1
IIIe1
IIIe1
IIIs2
IIIs2
IIIs1
IIIw1
VIIs2
IIIs1
IIIs1
IIIs3
IIc1
N
1:25,000
LandVision


LANDCOVER
Otaki to Levin RoNS
Legend
Option 3C
Option 4A
Option 5A
Option 6A
Option 7A
Option T
Land Cover Data Base 2008
Broadleaved Indigenous Hardwoods
Built-up Area (settlement)
Deciduous Hardwoods
Exotic Forest
Forest - Harvested
Gorse and/or Broom
Gravel and Rock
High Producing Exotic Grassland
Indigenous Forest
Orchard Vineyard & Other Perennial Crops
Short-rotation Cropland
Surface Mines and Dumps
Transport Infrastructure
Urban Parkland/Open Space
Cadastrial
Vineyard
N
1:25,000
LandVision
INNOVATIVE LAND MANAGEMENT SOLUTIONS

11 **APPENDIX 5: SOIL MAP FOR THE VINEYARD**



APPENDIX 8: SH1-SH57 MCA OPTIONS EVALUATION, HYDROLOGY ASSESSMENT

SH1 - SH57 MCA Options Evaluation: Hydrology Assessment

Prepared for NZTA

30/10/2013

QUALITY STATEMENT

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SH1 - SH57 MCA Options Evaluation: Hydrology Assessment

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1 Introduction

The purpose of this investigation is to carry out a desktop study to assess the high level feasibility of the proposed options for Otaki to Levin SH1-SH57 connection with regard to flood risk for the 1% Annual Exceedance Probability (AEP). There are five options considered as described in Section 7 Options Assessment. The findings of this study contributed to a Multi Criteria Analysis Workshop to evaluate the options.

Each option crosses the Ohau River. For some options two separate crossings are necessary. This study reviews past work on the hydrology of the Ohau River and assesses the magnitude and potential impacts of the 1% AEP event on each option. A steady state hydraulic model was used to test each option. A full unsteady model was outside the scope of this study but will be required for later phases.

2 Data Collection

The following reports and information were collected and reviewed:

Ohau River: Muhunoa Bridge To Mouth .Scheme Investigations: Flood Mitigation & Channel Management, Gary Williams, May 2008, G & E Williams Consultants Ltd.

Ohau Manakau Scheme Review and Future Management Strategy (stamped Draft) Manawatu-Wanganui Regional Council, June 1996.

LiDAR of Ohau River Corridor

Cross Sections From Ohau River (supplied by Horizons Regional Council)

Ohau at Rongomatane (Site No. 32106) stream gauge records for 1978-2008

Aerial photos for 1942 and 1999/2000

3 Hydrology

The Ohau River rises in the Tararua Ranges, draining a portion of the western side of the range. It emerges from the ranges and flows across marine terraces to the coast. The catchment is affected by north-westerly air flows which cause orographic rainfall in the headwaters.

The Ohau River has a total catchment of 189km^2. The catchment upstream of the State Highway One bridge is 137 km^2. There is a flow gauge at Rongomatane where the river leaves the Tararua Ranges, below the confluence with the Makahika Stream. The catchment area upstream of the gauge is 105km^2.

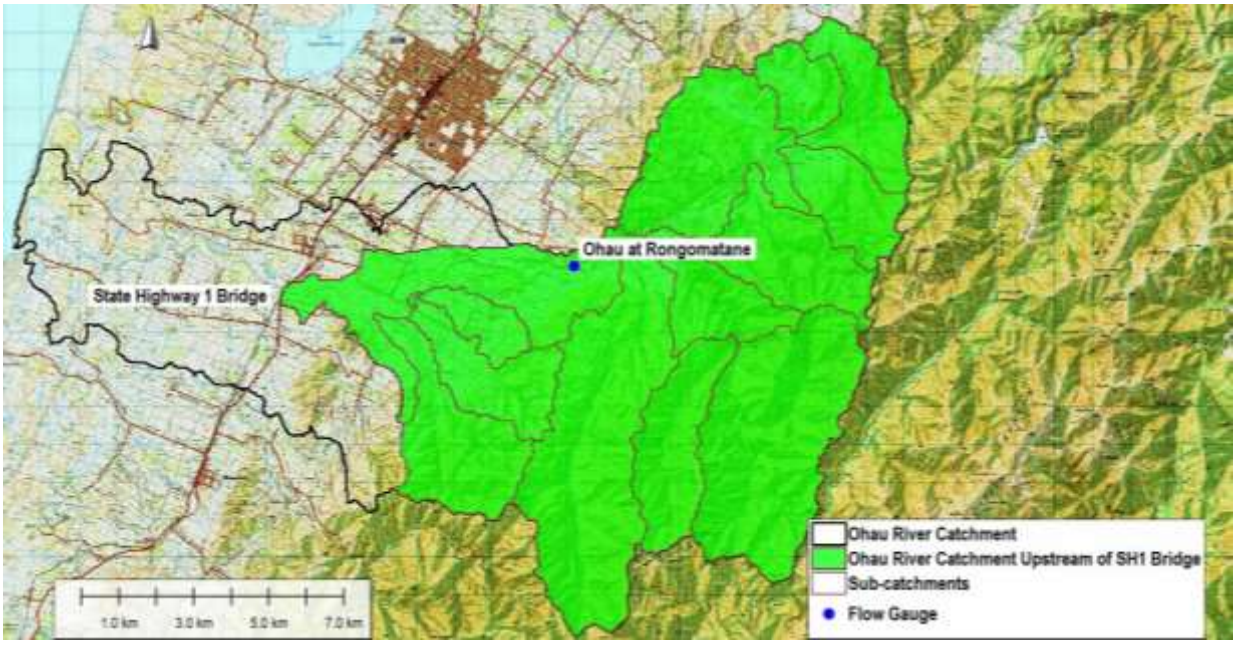


Figure 3-1: Ohau River Catchment and Ohau at Rongomatane Level Recorder Location

The rainfall map provided by NIWA shows that the mean catchment rainfall is 2204 mm, however the mean annual rainfall varies considerably across the catchment, from above 4000mm in the headwaters in the Tararua Ranges to 1000mm on the coastal plains (refer to Appendix A). Mean annual runoff follows a very similar pattern with high runoff in the ranges and much lower runoff on the coastal plains (refer to Appendix B).

Figure 3-2: Ohau River Aerial Photo 1942 (existing SH1 road alignment shown in red)

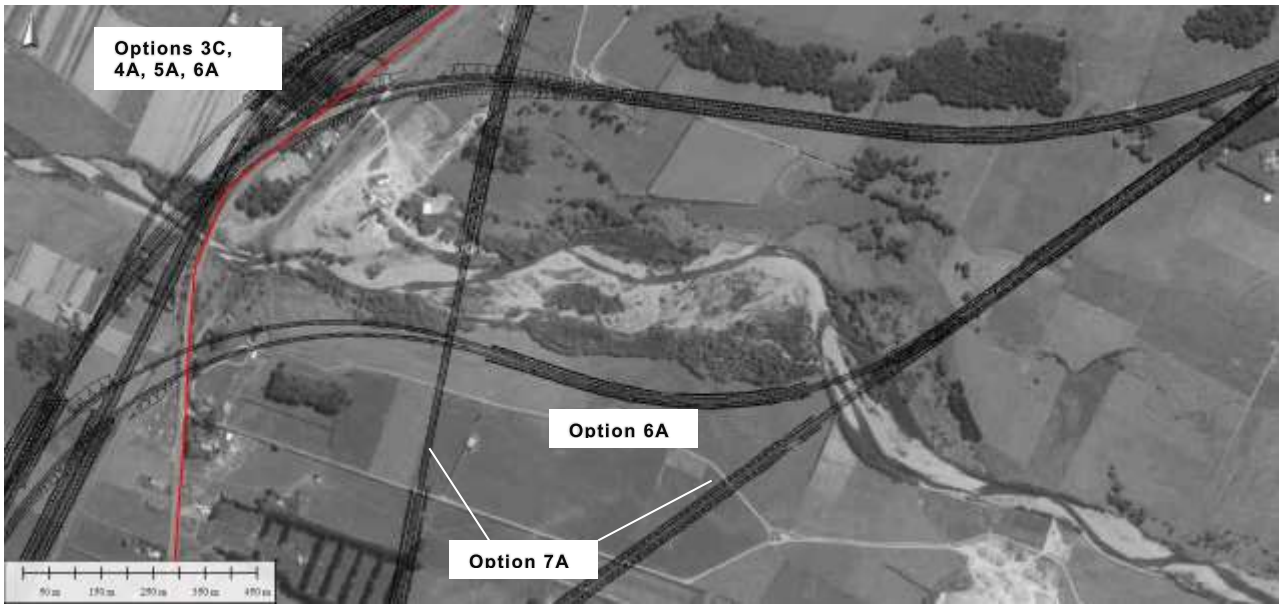


Figure 3-3: Ohau River Aerial Photo 1999 (existing SH1 road alignment shown in red)

The aerial photos from 1942 and 1999 (Figure 3-2 and Figure 3-3) show that the river channel has drifted south, closer to Option 6A and the river bends around Option 6A and 7A bridges have migrated downstream. It appears that there is active erosion where the Option 6A and 7A bridges leave the left bank. A willow planting scheme may account for some of the increase in vegetation on the edges of the riverbed.

4 Flood Frequency Analysis

The design level for Roads of National Significance is that "the finished surface level of the expressway main alignment pavement shall have a 500mm freeboard to the 1% AEP flood level where crossing floodplains".

The Horizons Regional Council carried out a flood frequency analysis for the Ohau at Rongomatane flow gauge site. When historic floods in 1940, 1949, 1950 and 1959 were included they found the 1 % AEP flood peak was 656 m^3/s including flow measurements up to 2006. Analysis was undertaken for this study using Tideda for flow gauge data from July 1978 to January 2008 provided by Horizons Regional Council. Using the Log Pearson III Distribution, and without the historic floods this provided a 1% AEP of 652 m^3/s650 m^3/s was adopted as the 1% AEP flood flow at the Ohau at Rongomatane flow gauge for input to the hydraulic model. This was the value used by Williams (2008).

The flow gauge is located 12.6km upstream of the State Highway 1 Bridge. To account for the 32km^2 of catchment that contributes to the Ohau River between the flow gauge at Rongomatane and the State Highway One bridge the peak flow was adjusted by a factor of 1.31 (based on the difference in catchment size) to give a 1% AEP estimate of 850 m^3/s. This is likely to be a conservative estimate as the rainfall in the additional 32 km^2 is between 1000 and 1500 mm compared to rainfall in excess of 4000 in the upper reaches of the catchment.

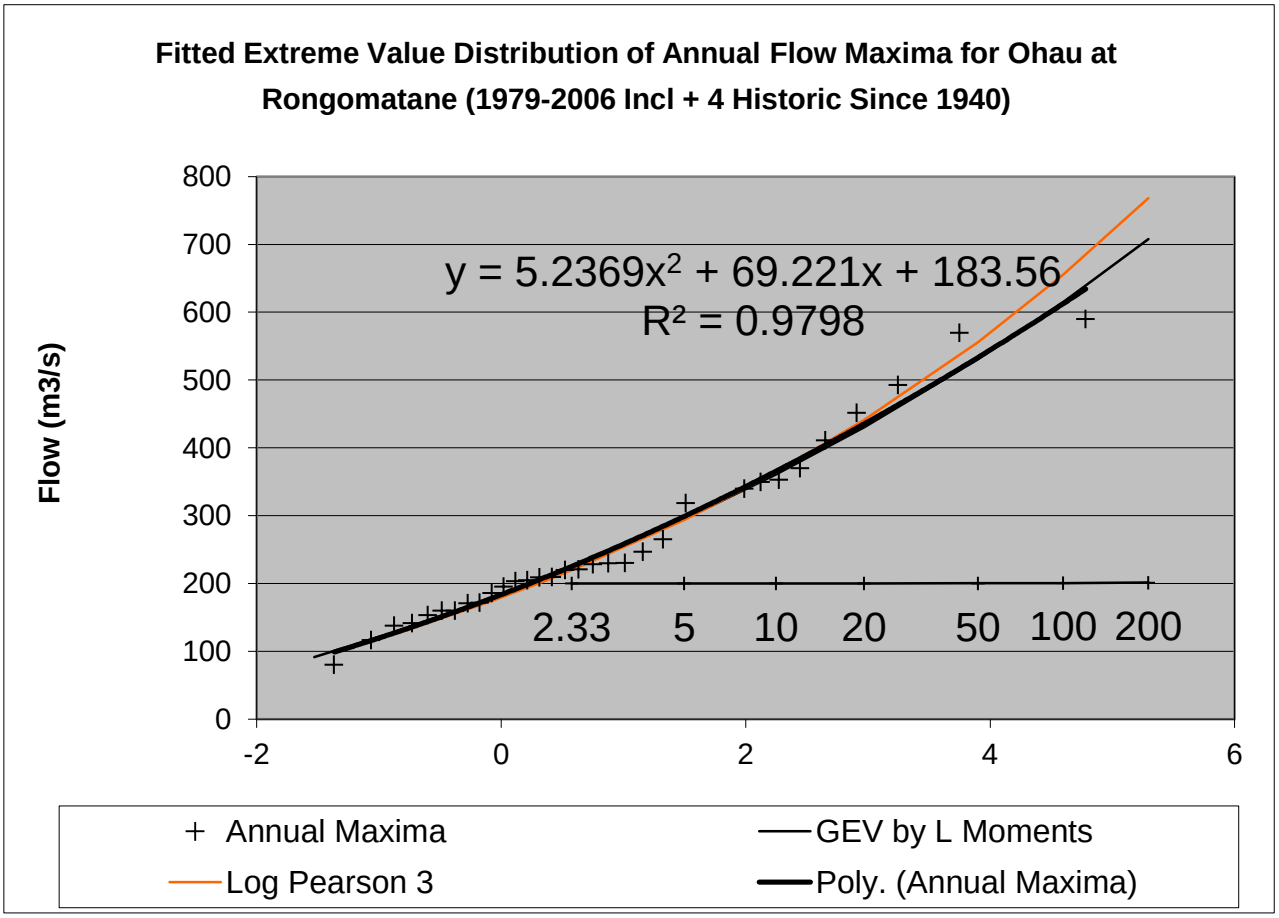


Figure 4-1: Flood Frequency analysis provided by Horizons Regional Council, including historic floods.

4.1 Uncertainty and Climate Change

The flood frequency analysis of Ohau at Rongomatane flow data has a range of uncertainty around the estimated A1% AEP of ±20%. This is a combination of the accuracy of the flow measurements taken (water levels are converted to flows based on flow gaugings at various water levels) and the frequency analysis. A peak flow of +20% would be 1017m^3/s.

The effects of climate change were not considered in this report. However greater extremes in rainfall are expected under climate change and higher peak flood levels would be expected over time.

5 HEC-RAS Model Build

HEC-RAS is a 1-D hydraulic modelling tool developed by the Hydrologic Engineering Center of the US Army Corps Engineers. It is designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels. Cross sections of the channel and river banks are used to calculate water surface profiles for steady gradually varied flow.

A HEC-RAS model was used to replicate the results reported by Williams 2007, and to update flood river levels using the 2011 survey data where available. Survey cross sections were available for 2007 and 2011. A model using the survey cross sections from 2007 was calibrated to match the results reported by Williams, 2007. The default channel Manning's n roughness of 0.03 and floodplain roughness of 0.05 gave results that matched the model sufficiently well so no alterations to roughness were required.

The model was then updated using the 2011 survey cross sections to provide the most up to date flood levels available. The model extended from cross section 54 2.3 km upstream of the State Highway One bridge to cross section 44 400m downstream, of the bridge. For the 2011 version, cross sections 44, 47, 52 and 53 were extended using LiDAR as the modelled flows could not be contained within the surveyed cross section. An example of the extended cross section is shown in Figure 5-1.

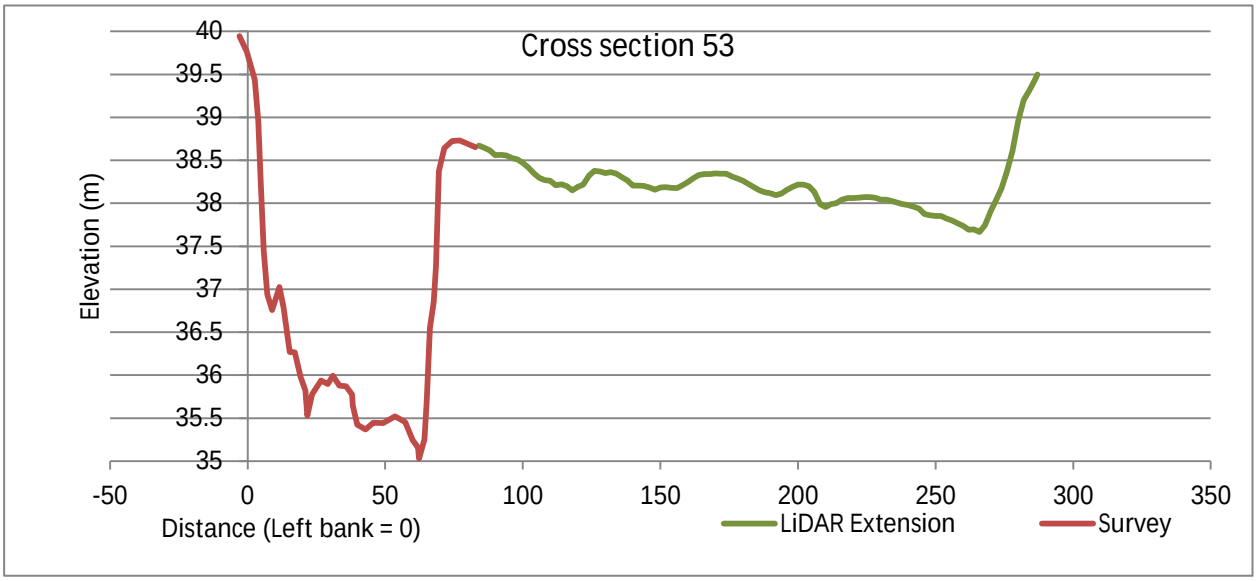


Figure 5-1: Extension of cross section 53 using LiDAR

The model extent is shown in Figure 5-2. The existing State Highway One and Rail bridges were not included in the model so any impacts from these are not represented in the modelled flood levels.

The model was run for a steady flow of 650 m^3/s, as used by Williams (2008) and the levels compared to those reported by Williams are shown in Table 6-1. Williams only reported levels at cross sections 46

and 53 within the model extent. A steady state model for the increased flows of 850 m^3/s at the bridge, and the additional uncertainty factor of + 20%, 1017 m^3/s were modelled.

An unsteady state model was not run as it was outside the scope of this study. Any backwater and volumetric effects are therefore not considered.

The results were mapped using RAS-Mapper which is a built in tool within HEC-RAS which uses the water surface profile calculated by HEC-RAS and creates a floodplain boundary based on a digital elevation model of the underlying terrain. This provides an indication of the flood extents based on the terrain but assumes a constant water level across the entire cross section and lateral flows are not accounted for within HEC-RAS.

The intention was not to create a new hydraulic model. Rather the intention was to use HEC-RAS to replicate the results reported by Williams to allow the extents he found to be mapped and compared to the route option locations. It has also enabled an investigation of the effects of the updated survey and increased flow at the location of interest. The LiDAR digital terrain model used for the floodplain boundary mapping is shown in Figure 5-3.

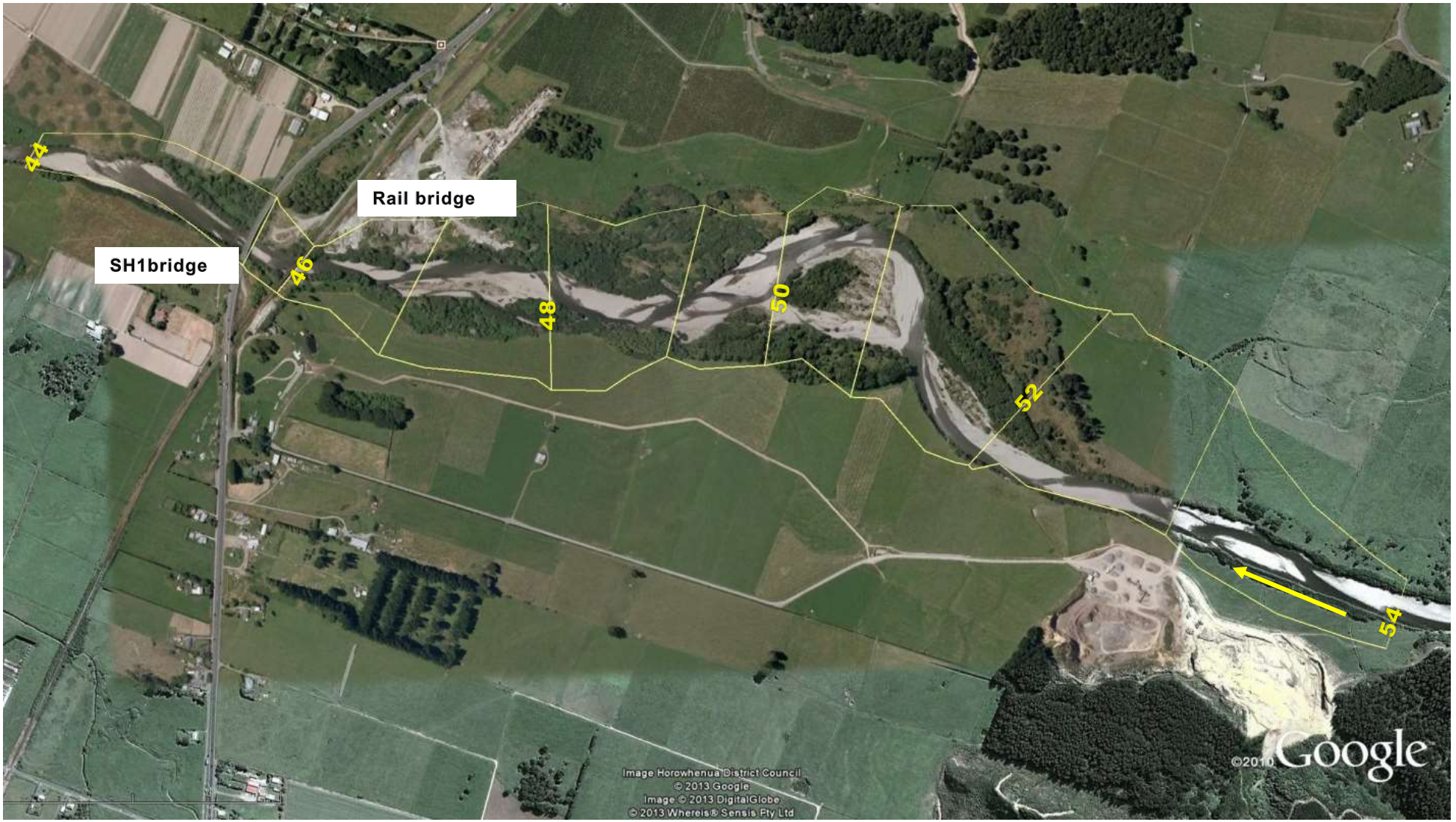


Figure 5-2: HEC-RAS model extent and cross section locations

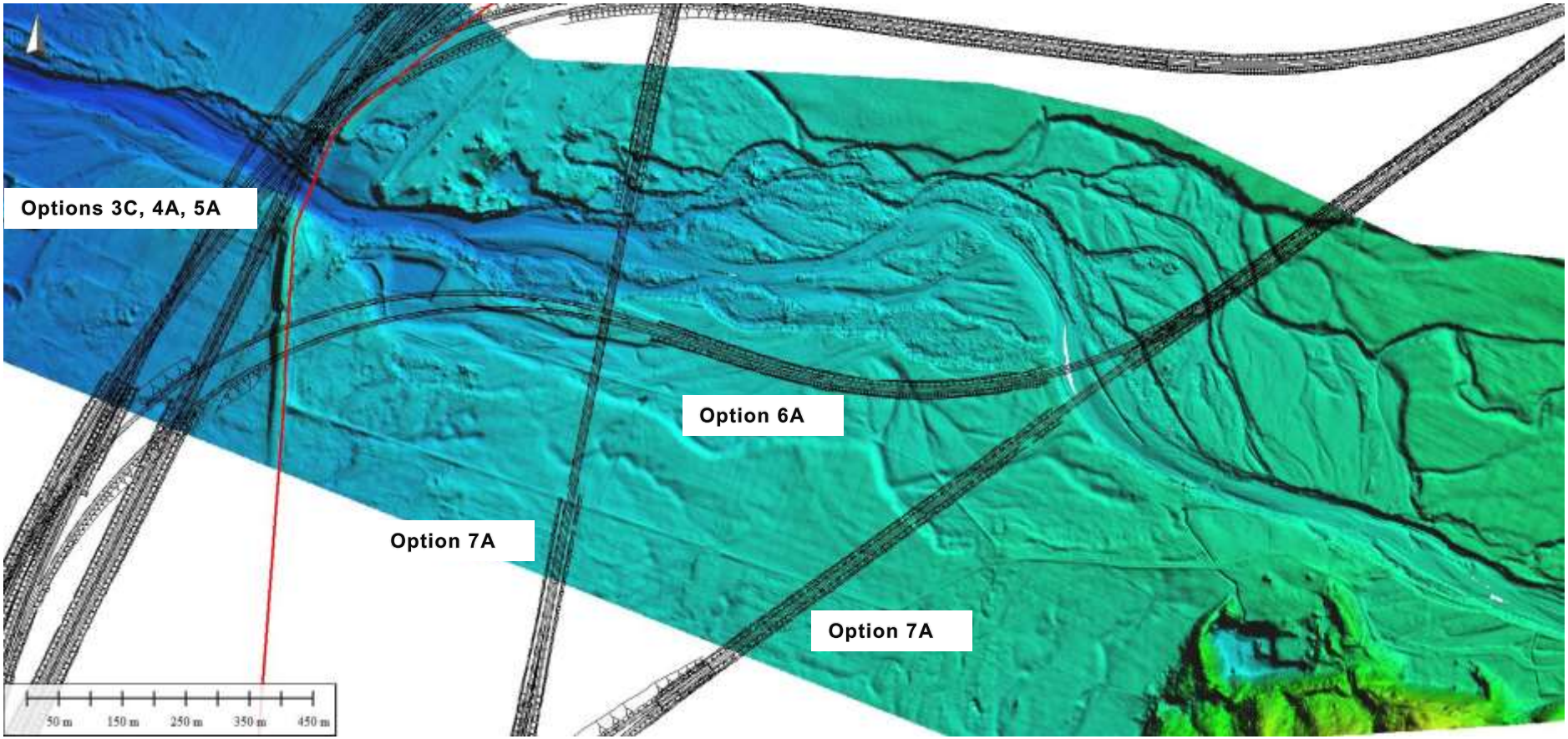


Figure 5-3: LiDAR of riverbed and floodplain

6 Modelling Results

The results of the modelling are shown in the following maps and cross sections. The flood extent may encroach on current ground levels for Option 6 where it follows the river bank in an old channel. Flow paths may be quite different during a 1% AEP flood than during normal flows or a 20% - 10% AEP flood.

6.1 Flood levels

In his report Williams (2008) modelled the 20 year, 50 year and 100 year ARI floods using HEC-RAS, calibrating the model against measured flows from 1986 and 2008 floods.

Upstream of the State Highway One bridge Williams (2008) provided levels at cross sections 53 and 46 (refer to Figure 3-1 for cross section locations). These compared well with the results from the model so the increased flows and the updated and extended cross sections were applied to the model and the results of these are presented in Table 6-1.

Table 6-1: Modelled 1% AEP water levels in the Ohau River

Cross Section	Minimum Bed Level (m)		Levels from Williams (2008)	Modelled Water Surface Elevation (m)			
Modelled Flow (m^3/s)			650	650	650	850	1017
Survey data	2007	2011	2007	2007	2011	2011 extended	2011 extended
54	37.91	37.86		41.19	40.95	41.4	41.74
53*	35.03	34.08	38.63	38.35	37.77	38.67	38.91
52*	32.14	32.14		35.6	35.61	35.75	35.98
51	30.35	28.65		32.68	32.81	33.01	33.04
50	27.6	28.41		31.03	30.86	31.11	31.27
49	26.8	27.3		30.06	30.07	30.36	30.59
48	25.5	25.4		28.34	28.16	28.4	28.6
47*	23.6	23.5		27.29	27.28	27.96	28.41
46 (Rail Bridge)	22.3	22.41	26.8	26.84	26.86	27.52	27.92
45 (SH1 Bridge)	22.28	22.28		25.69	25.81	26.32	26.9
44*	19.18	19.64		24.19	23.21	23.92	24.22

*cross section extended using LiDAR as water levels exceeded surveyed river section.

Figure 6-1 shows the long section profile of the 1% AEP event. Figure 6-2 is a map of the full flood extent and demonstrates that the area of the flood plain that is inundated is fairly extensive. In some areas the extent is limited by the model extent. A closer view of modelled water levels and flood extents at selected cross sections are presented in Figure 6-3 to Figure 6-10.

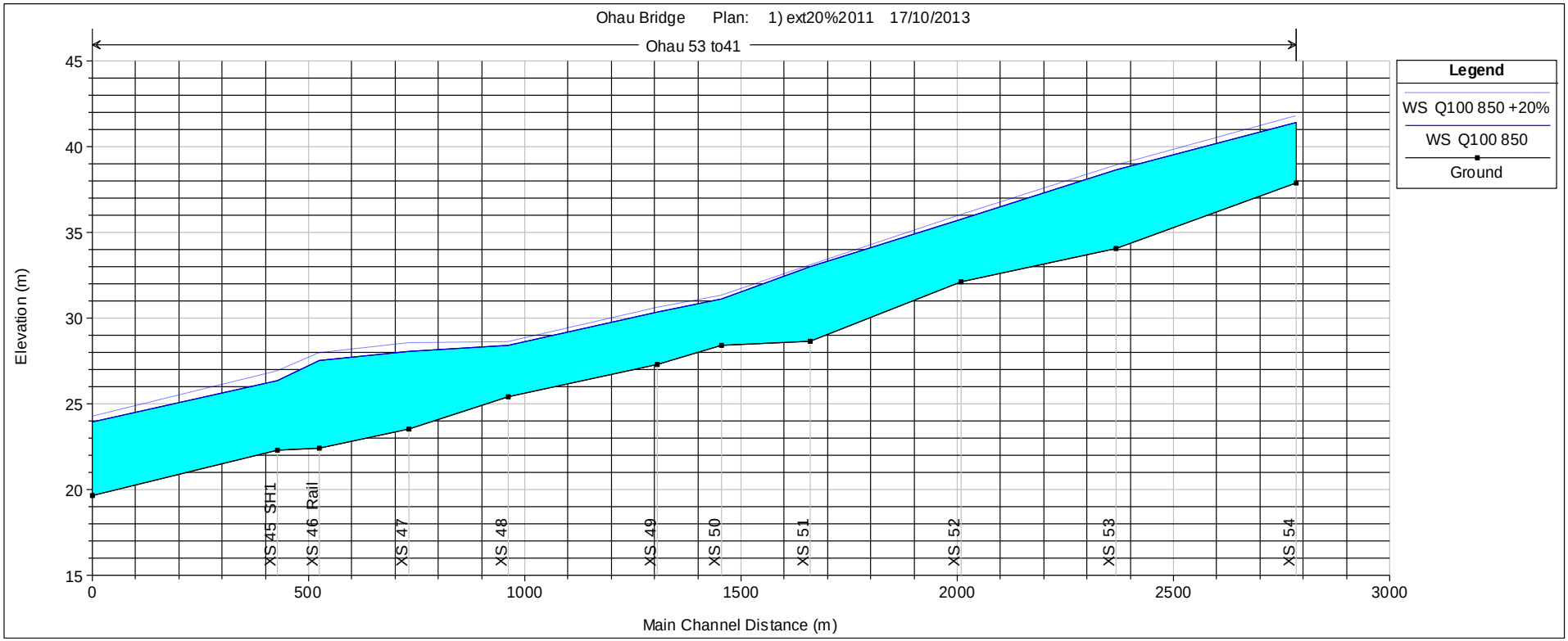


Figure 6-1: Long Section Profile of Modelled 1% AEP

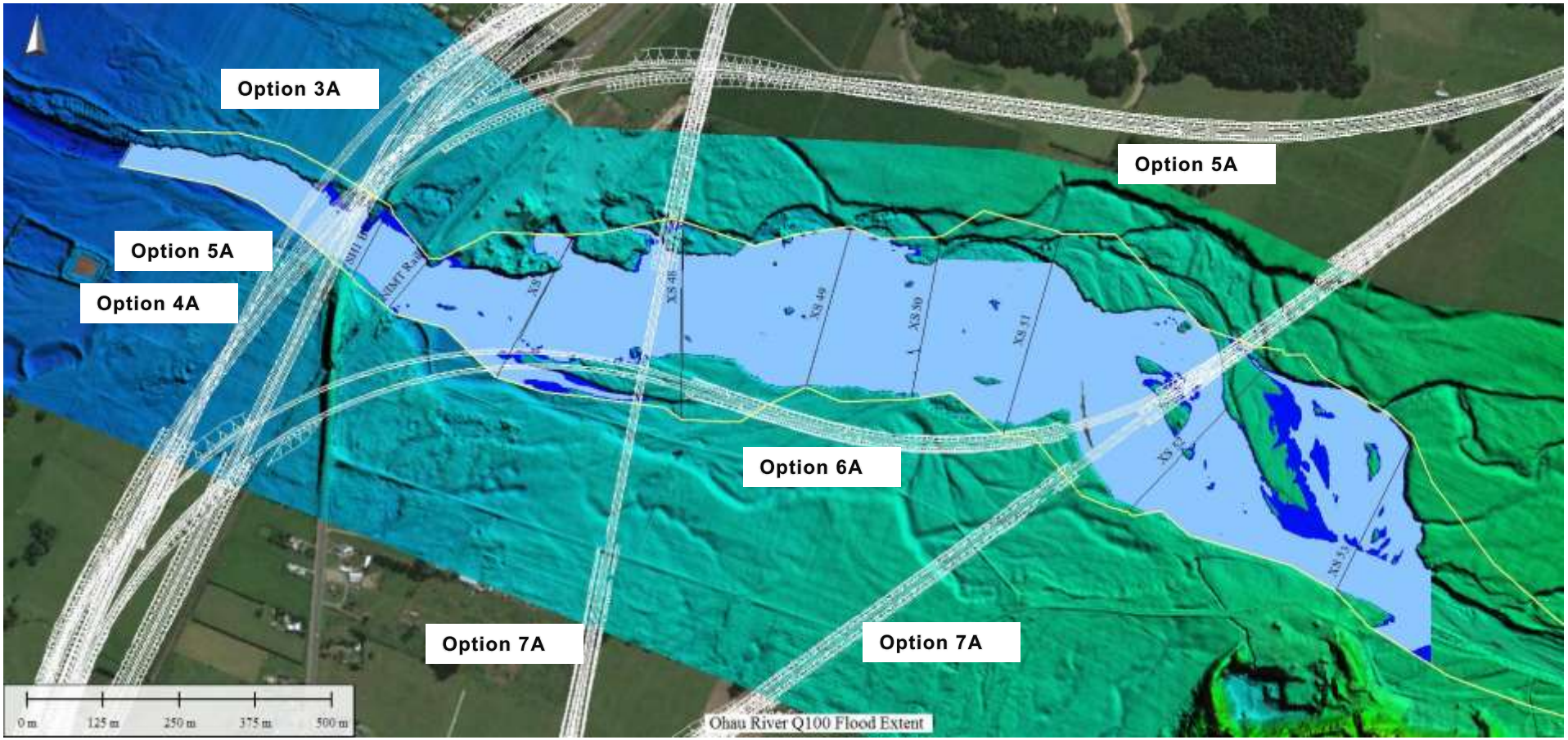


Figure 6-2: Flood Extent of 1% AEP dark blue is 1% AEP plus 20% uncertainty

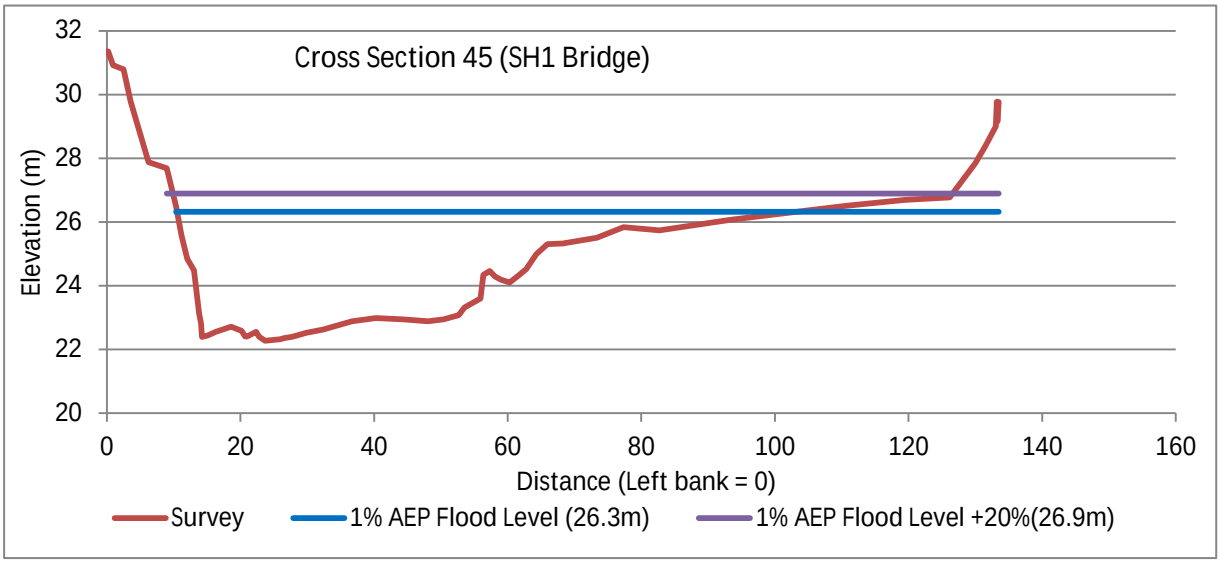


Figure 6-3: 1% AEP Water levels at cross section 45 SH1 Bridge, 2011 extended survey

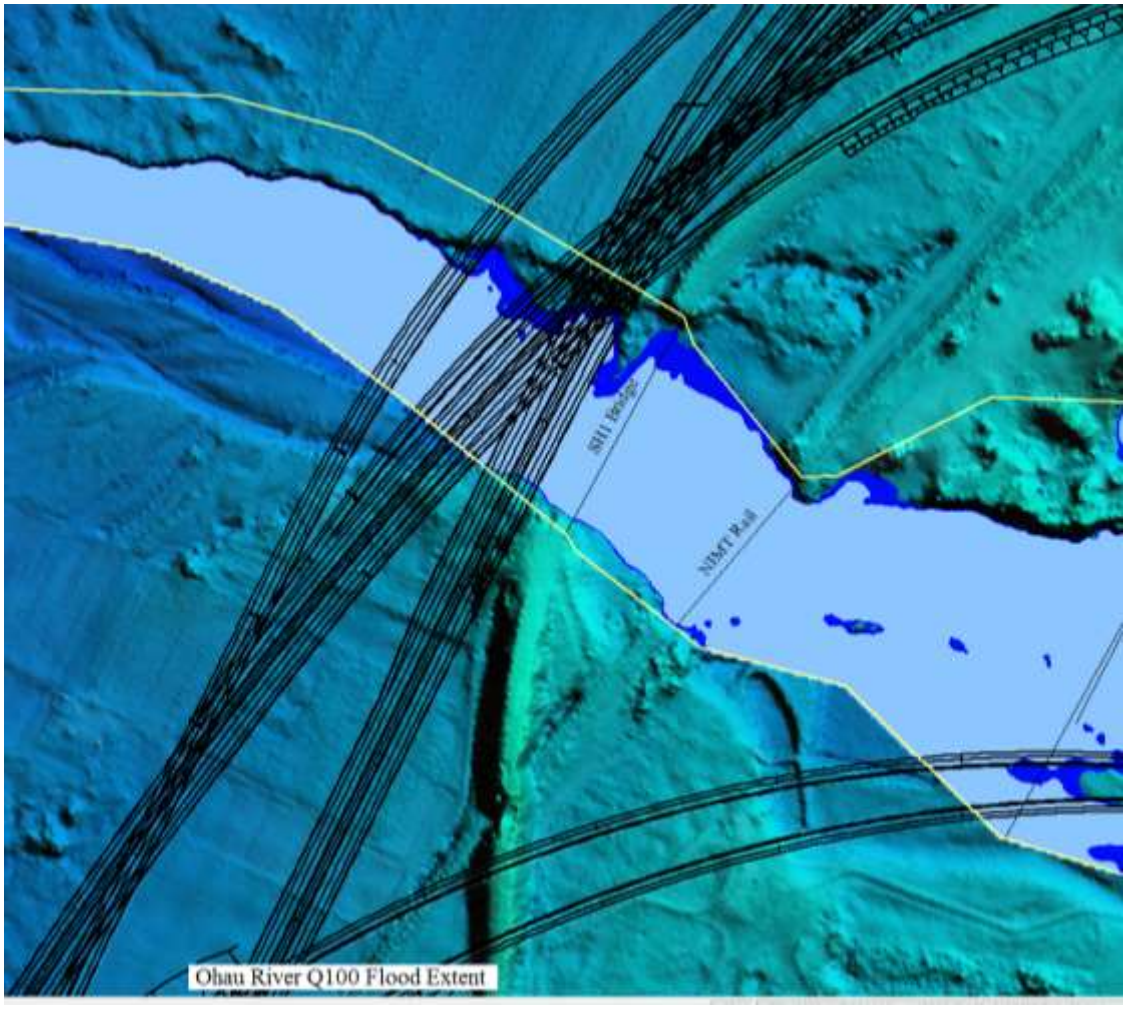


Figure 6-4: 1% AEP Flood extent at cross section 45 SH1 Bridge, 2011 extended survey. Dark blue is 1% AEP plus 20% uncertainty.

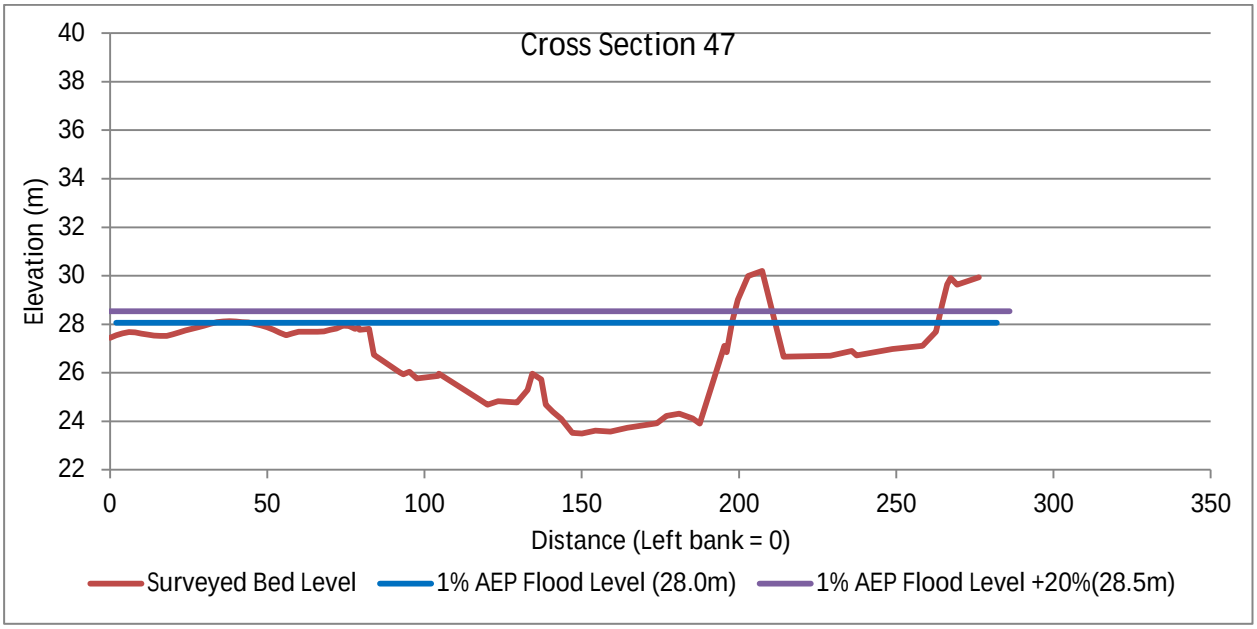


Figure 6-5: 1% AEP Water levels at cross section 47, 2011 extended survey

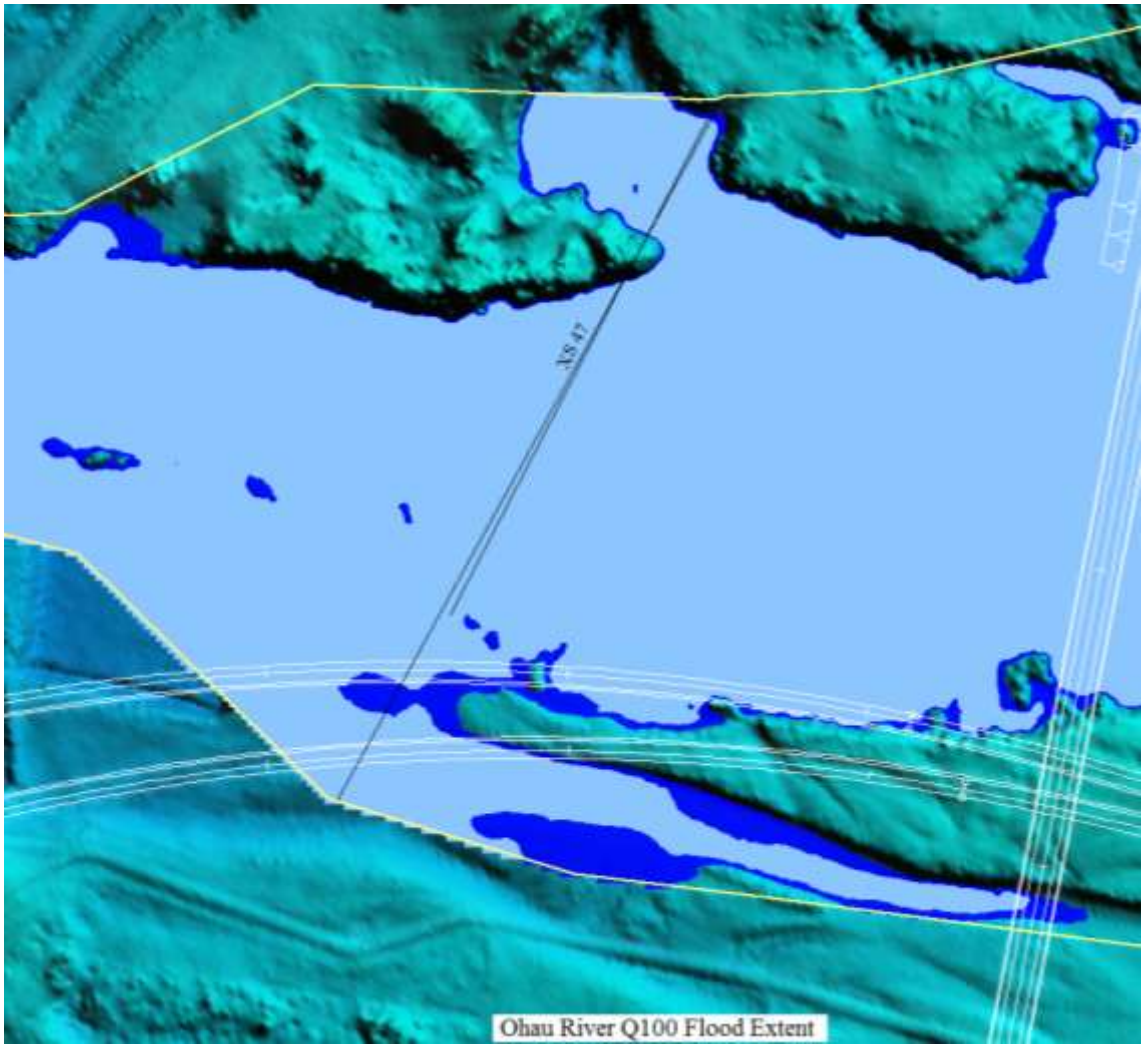


Figure 6-6: Flood extent at cross section 45 SH1 Bridge, 2011 extended survey

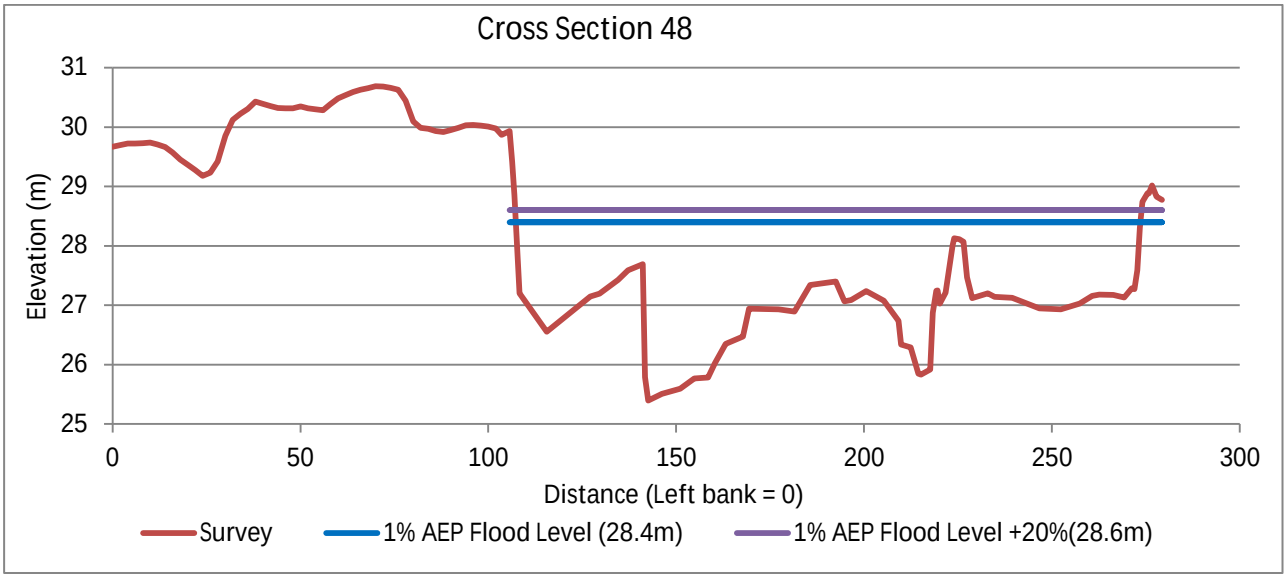


Figure 6-7: 1% AEP Water levels at cross section 48 SH1 Bridge, 2011 extended survey

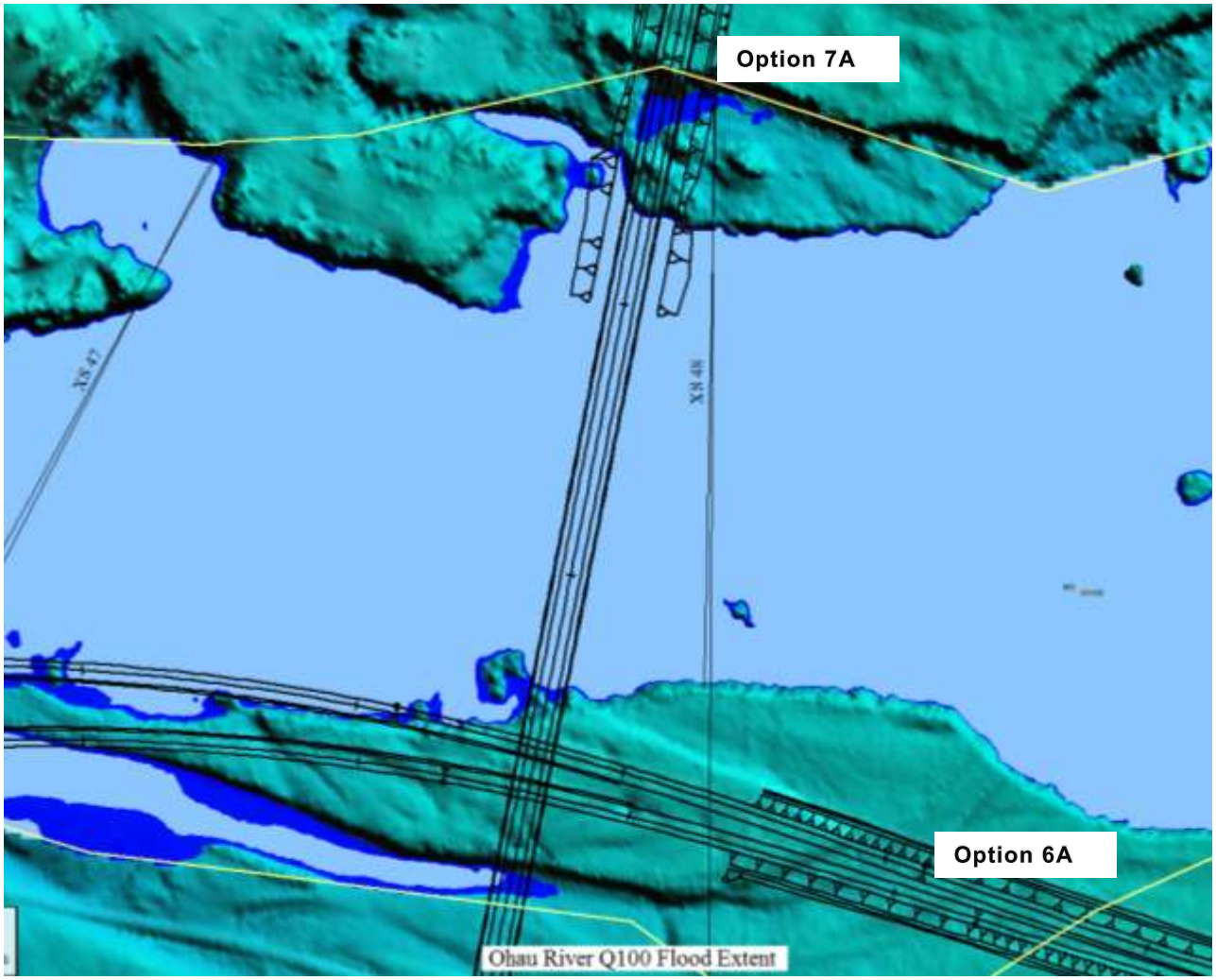


Figure 6-8: Flood extent at cross section 48 SH1 Bridge, 2011 extended survey

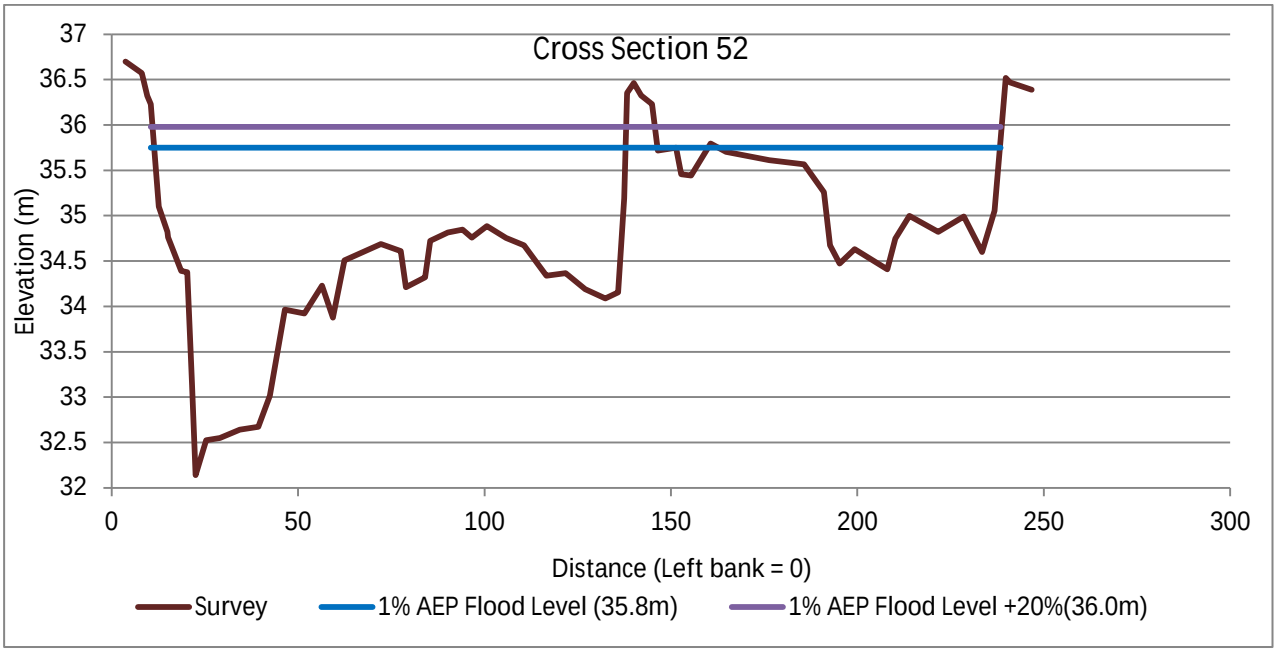


Figure 6-9: 1% AEP Water levels at cross section 52, 2011 extended survey

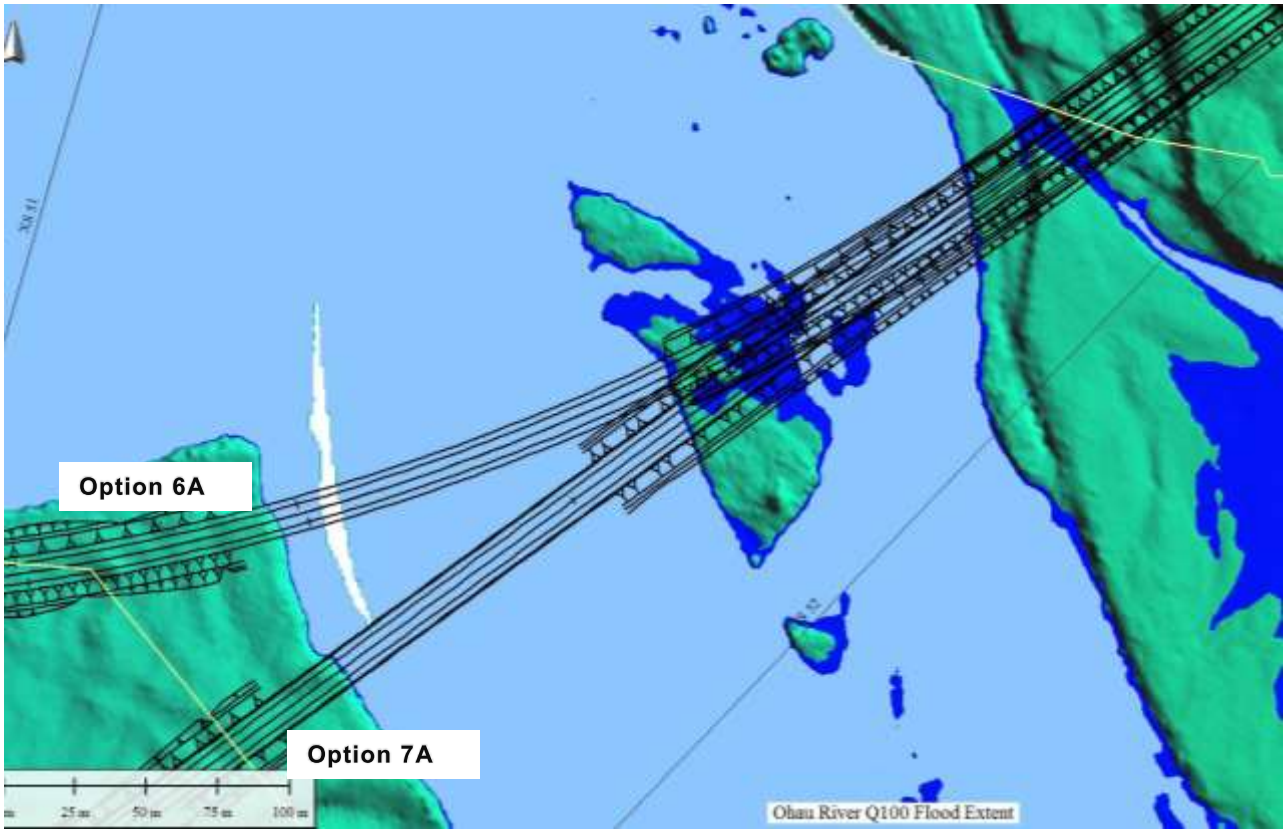


Figure 6-10: Flood extent at cross section 47, 2011 extended survey

7 Options Assessment

There are five options to be assessed; these are Option 3C, 4A, 5A, 6A and 7A (refer Figure 7-1 for option alignments).The purpose of this report is to consider the potential impacts of 1 % AEP flood event in the Ohau River for each option. Scores presented in this report are based on hydrological assessment prior to the MCA assessment workshop held to assess the options.

7.1 Crossings

Options 3C, 4A and 5A have one crossing of the Ohau River at a location just downstream of the existing State Highway One bridge.

Option 6A splits before the Ohau River and there are two bridges- one just downstream of the existing State Highway One bridge and another after the State Highway 57 alignment follows alongside the river for approximately 1 km, crossing the Ohau River 1.3 km upstream of the existing State Highway One bridge.

Option 7A also has two bridges, the SH57 bridge at the same location as Option 6A and the State Highway One bridge 500m upstream of the existing State Highway One bridge.

7.2 Scoring

The options were rated using scoring as described in Table 7-1. The scores given to each different option are shown in Table 7-2.

Table 7-1: Scoring Guide

Score	Description
++	The option presents few difficulties on the basis of the criterion being evaluated, taking into account reasonable mitigation proposals. There may be significant benefits in terms of the criterion.
+	The option presents only minor areas of difficulties on the basis of the criterion being evaluated, taking into account reasonable mitigation proposals. There may be some benefits in terms of the aspect.
0	The option presents some areas of reasonable difficulty in terms of the criterion being evaluated. Effects cannot be completely avoided. Mitigation is not readily achievable at reasonable cost, and there are few or no apparent benefits.
-	The option includes extensive areas of difficulty in terms of the criterion being evaluated, which outweigh perceived benefits. Mitigation is not readily achievable.
- -	The option includes extreme difficulties in terms of achieving the project on the basis of the criterion being evaluated.

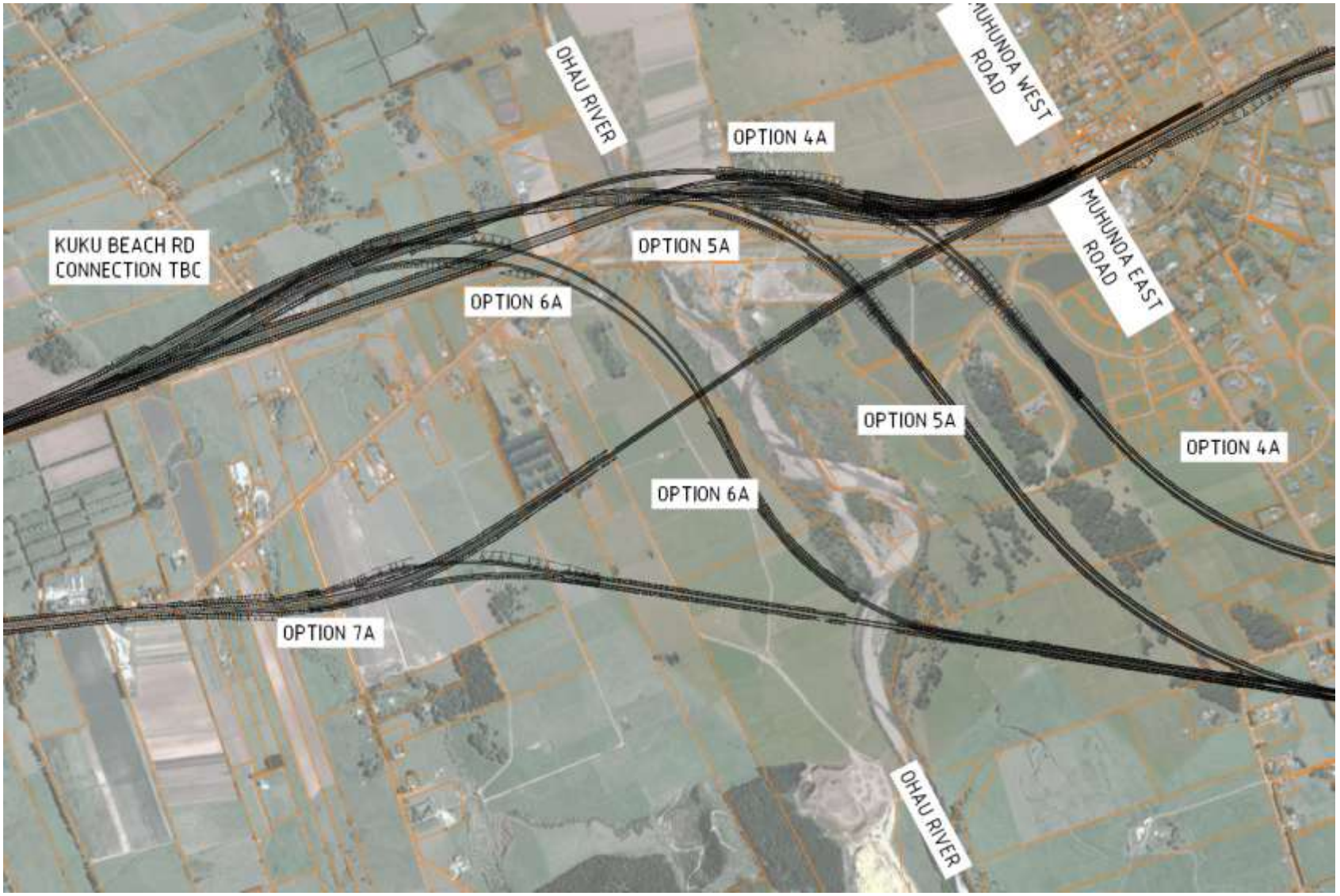


Figure 7-1: Alignments of the five Options around the Ohau River

Table 7-2: Option Scores

Score	Rating	Rationale
Option 3C	+	Proposed bridge location similar to existing State Highway One bridge Proposed bridge located at a natural constriction with high ground on either side
Option 4A	+	Proposed bridge location similar to existing State Highway One bridge Proposed bridge located at a natural constriction with high ground on either side
Option 5A	+	Bridge location similar to existing State Highway One bridge Proposed bridge located at a natural constriction with high ground on either side
Option 6A	-	Road runs alongside potential floodplain and existing ground levels do not have the required freeboard above the 1% AEP flood Proposed State Highway One bridge location 100m downstream of existing State Highway One bridge Proposed State Highway 57 bridge crosses the flood plain where it is wide and no natural constriction
Option 7A	-	Proposed State Highway One bridge location is located in an area with lower ground and crosses the flood plain where it is wide Proposed State Highway 57 bridge located in an area with lower ground and crosses the flood plain where it is wide

The higher rated options are those that cross at the existing State Highway One bridge location as the bank levels are higher compared to bed levels and the channel width is restricted.

Options 3C, 4A and 5A were all considered similar as the bridge locations were similar and so were given similar ratings.

Options 6A and 7A have a second bridge. In the case of Option 6A the first bridge has a location similar to those in Options 3C, 4A and 5A, the second bridge crosses the Ohau River in the wide floodplain upstream of the State Highway One bridge. The riverbed may change course here – there is evidence of recent flood channels adjacent to the main active river channel and historic aerial photos show the active channel was further to the north. Migration of the bends in the river in a downstream direction, which is evident from historic photos, may also threaten Options 6A and 7A.

Option 7A has both bridges located in the floodplain. Constricting the active floodplain in two locations may change the flow dynamics and the geomorphology of the river. Further investigations would be required if Option 7A was pursued.

7.3 Option 6A Road Alignment

Option 6A runs beside the river for approximately 1 km. Figure 7-2 shows the ground level of the Option 6A road alignment from LiDAR between cross sections 47 and 51 and also the estimated 1% AEP flood

level and the 0.5m freeboard level. The ground level of the Option 6 road alignment is below the projected 1% AEP flood levels and freeboard at the lower end of the profile, upstream of cross section 47. Protection from flooding would be necessary for the road at this location.

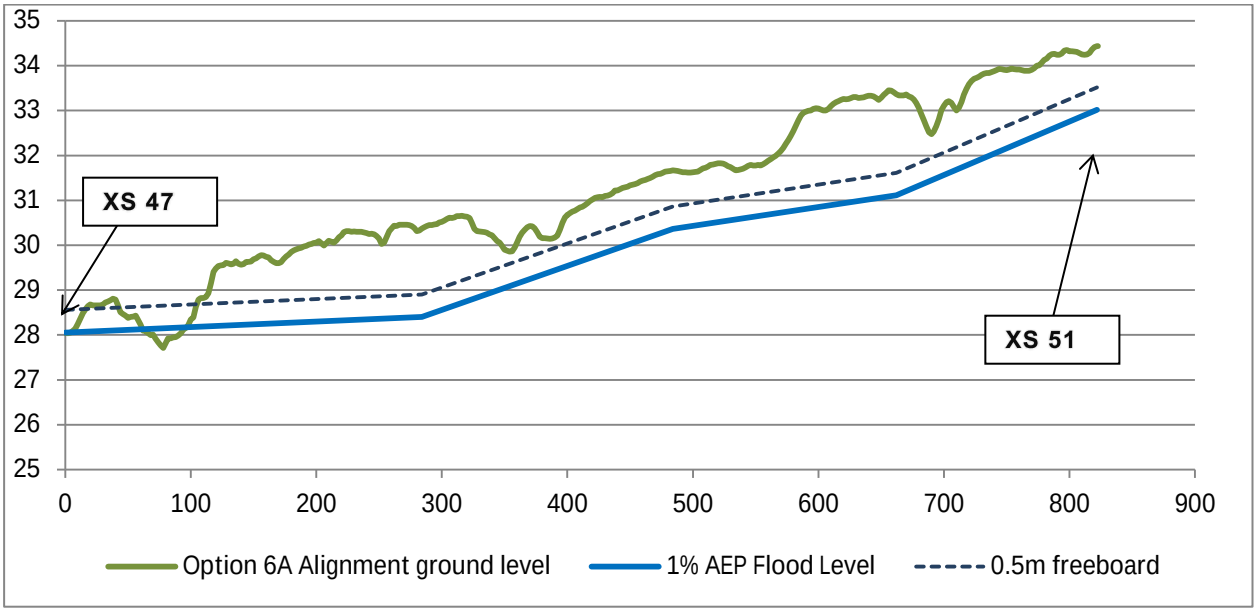


Figure 7-2: Flood Levels and Option 6A Alignment levels

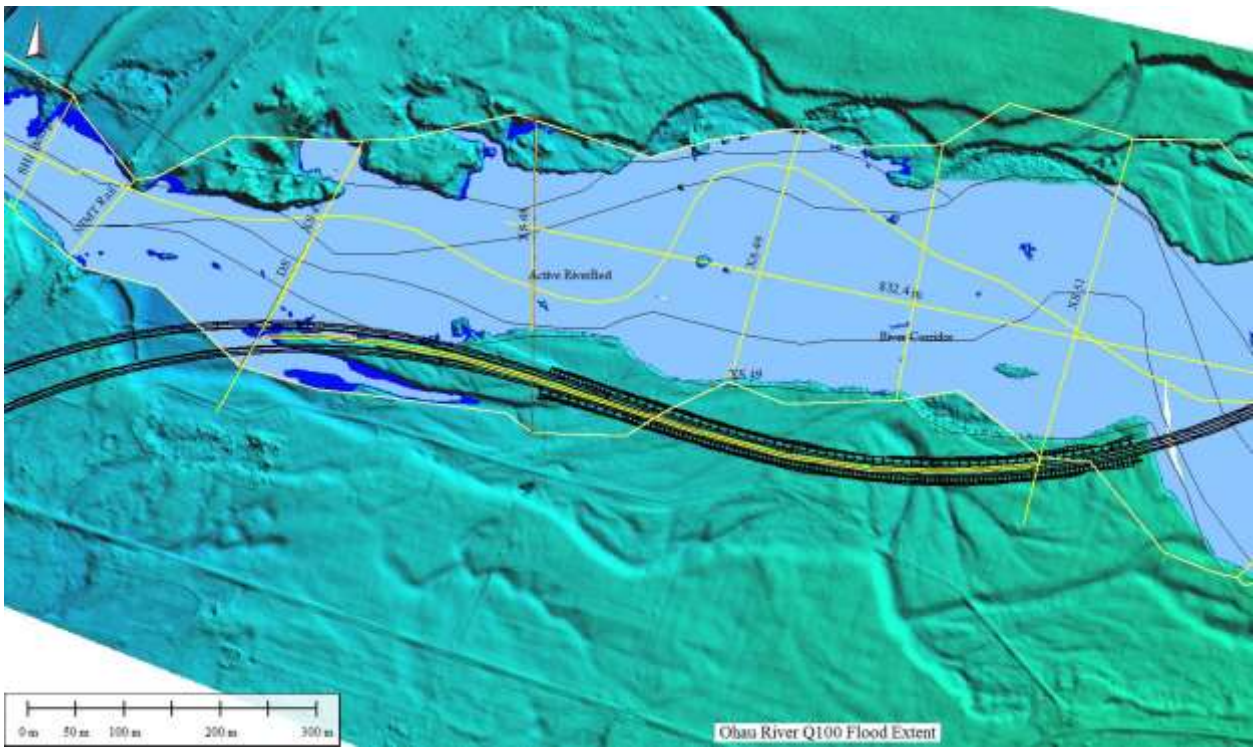


Figure 7-3: Path of Option 6A Alignment used for elevation (road alignment highlighted in yellow)

Appendix A Rainfall Distribution Map

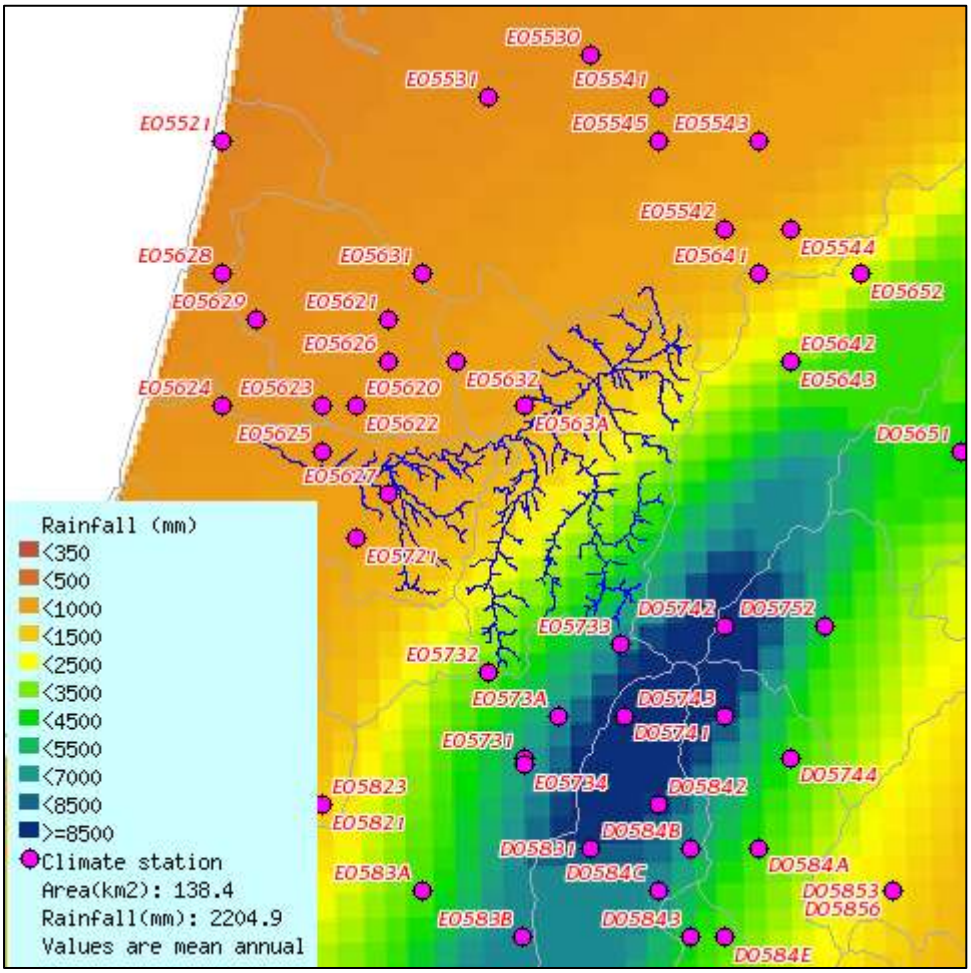


Figure A-1: Catchment Rainfall Map (Source: http://wrenz.niwa.co.nz/webmodel/)

Appendix B Runoff Distribution Map

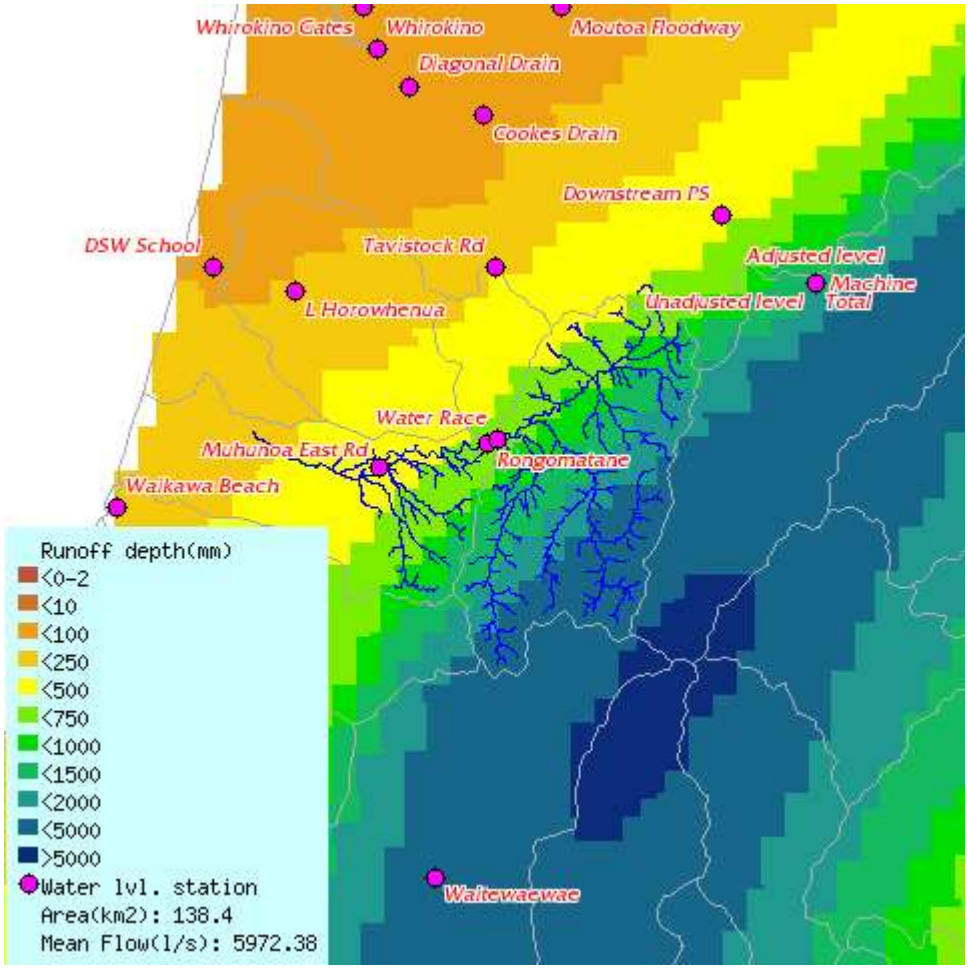


Figure B-1: Catchment Mean Annual Runoff Map (Source: http://wrenz.niwa.co.nz/webmodel/)

APPENDIX 9: SHORT REPORTS

ŌTAKI TO NORTH OF LEVIN – SH1-SH57 CONNECTION

MCA ANALYSIS

NOTES ON SOCIAL/COMMUNITY IMPACTS

Scope

applies to generic "community" effects, not individual effects
includes amenity effects – noise, odour, public safety
includes physical severance and access consideration
includes social severance – i.e. loss or gain in social cohesion.

Option Notes

3C:

reduced severance, improved amenity and public safety in Kuku community
increased severance, reduced amenity and public safety in Ohau
suggested rating " – – ".

4A, 5A:

reduced severance, improved amenity and public safety in Kuku
reduced severance, improved amenity and public safety in Ohau
note: vineyard area not regarded as a community because few houses as yet – little to distinguish these two options
suggested ratings " + ".

6A:

reduced severance, improved amenity and public safety at Kuku, but amenity for population cluster just south of northern bridge reduced, so not as good as three options above for this community
reduced severance, improved amenity and public safety in Ohau
suggested rating " 0 ".

7A:

reduced severance for part of Kuku, and partial improvement in amenity and public safety (northern end)
reduced severance, improved amenity and public safety in Ohau
suggested rating " – " or " 0 ".

T:

similar to Option 7A for part of Kuku
increased severance, reduced amenity and public safety in Ohau
suggested rating " – – ".

Sylvia Allan
16th October 2013

TO:	Sylvia Allan	DATE:	29 October 2013
CC:		REF:	80500902
FROM:	Steve Kerr, Principal Planner	MWH New Zealand Ltd	
SUBJECT:	October 2013 MCA Planning Input		

This memo outlines the analysis that was the basis of the input to the MCA Workshop on 17 October 2017. It has been updated to include the analysis of the new Option 'T'.

Option	MCA Criteria and Score		Comments
	District Plan	Land Use/ Ownership	
7A	**'-'**	**'--'**	No direct impact on items or ONA/ONL protected in the district plan Notable severances in the rural greenfield areas, particularly in the north Potentially impacts on residentially zoned land to the west of SH1 (Muhunoa West Rd). This land is to be subdivided in accordance with a structure plan in the district plan (08, Schedule 8). 3 river crossings Potential loss of café/store Move alignment closer to school and heritage church Change property access arrangements Avoids residential lifestyle/vineyard[17] area (area of investment and known contention) east of SH1 Ohau. This area is to be subdivided in accordance with a structure plan in the district plan (09, Schedule 8). Impacts on areas of bush and trees
6A	**'-'**	**'--'**	Notable severances in the rural greenfield areas, particularly in the north. Change property access arrangements 2 river crossings No direct impact on items or ONA/ONL protected in the district plan Avoids residential lifestyle/vineyard area (area of investment and known contention) east of SH1 Ohau. Minor impact on other residentially zoned land Passes through Tatum Park High risk to urupa at Kuku village

[17] This land is zoned "Greenbelt Residential'.

Option	MCA Criteria and Score		Comments
	District Plan	Land Use/ Ownership	
5A	'-'	'--'	No direct impact on items or ONA/ONL protected in the district plan Avoids residential lifestyle/vineyard area (area of investment and known contention) east of SH1 Ohau. Impacts on areas of bush and trees Change some property access arrangements Potentially affect access to the Allied concrete plant by Ohau River to extent it may require relocation. Impacts on residentially zoned land Notable severances though the rural greenfield areas, particularly in the north. Avoids the residential land to the west of SH1 at Ohau (Muhunoa West Rd). 2 river crossings
4A	'-'	'--'	No direct impact on items or ONA/ONL protected in the district plan Impacts on residentially zoned land Directly impacts on residential lifestyle/vineyard area (area of investment and known contention) east of SH1 Ohau. Change some property access arrangements Notable severances though the rural greenfield area, particularly in the north. Avoids the residential land to the west of SH1 at Ohau (Muhunoa West Rd). 2 river crossings
3C	'-'	'--'	No direct impact on items or ONA/ONL protected in the district plan Avoids residential lifestyle/vineyard area (area of investment and known contention) east of SH1 Ohau. 4 laning through Ohau, with limited access mitigation possible Potentially impacts on residentially zoned land in Ohau. Move alignment closer to school and heritage church Change some property access arrangements Potential loss of café/store Minimises potential severances in the rural greenfield areas. River crossing Passes through Tatum Park Avoids areas of notable bus and trees

Option	MCA Criteria and Score		Comments
	District Plan	Land Use/ Ownership	
T[18]	'-'	'--'	No direct impact on items or ONA/ONL protected in the district plan Impacts on residentially zoned land Avoids residential lifestyle/vineyard area (area of investment and known contention) east of SH1 Ohau 4 laning through Ohau, with limited access mitigation possible Potential loss of café/store Move alignment closer to school and heritage church Change some property access arrangements Minimises potential severances though the greenfield areas (rural and residential). 2 river crossings Keeps clear of local urupa near SH1 Avoids areas of notable bush and trees

18 New option variant. Dated Fri 25 October 2013.

	Option 3c		Option 4a		Option 5a		Option 6a		Option 7a		Option T	
To provide best value solutions which will progressively meet (via a staged approach) the long-term RoNS goal for this corridor of achieving a high quality four lane route to the bifurcation of SH1 and SH57, and high quality improved routes beyond that point	++	Significant improvement. Eliminates substandard structures and this option has only two major structures (bifurcation and crossing of the Ohau River). Construction and whole of life costs are relatively low, and better than the existing situation.	++	Significant improvement. Eliminates substandard structures and this option has only two major structures (bifurcation and crossing of the Ohau River). Construction and whole of life costs are relatively low, and better than the existing situation.	++	Significant improvement. Eliminates substandard structures and this option has only two major structures (bifurcation and crossing of the Ohau River). Construction and whole of life costs are relatively low, and better than the existing situation.	-	Negative. Although eliminating substandard existing structures, this option has three major structures (bifurcation and crossings of the Ohau River) which represent an additional construction and whole of life cost over and above options 3c, 4a and 5a.	- -	Significantly negative. Although eliminating substandard existing structures, this option has four major structures (Manakau Rail overbridge, bifurcation, and two Ohau River Crossings) which represent an additional construction and whole of life cost over and above options 3c, 4a, 5a and 6a.	-	Negative. Although eliminating substandard existing structures, this option has three major structures (Manakau Rail overbridge, bifurcation, and crossing of the Ohau River) which represent an additional construction and whole of life cost over and above options 3c, 4a and 5a.
To provide better Levels of Service, particularly for journey time and safety, between north of Otaki and north of Levin	+	Significant improvement, though the need for all through traffic to pass through Ohau for the foreseeable future represents a journey time and safety risk. Allows for new passing lane.	++	Significant improvement over existing. Taking road away from side friction on existing carriageway reduces journey time and safety level of service risks. Allows for new passing lane.	++	Significant improvement over existing. Taking road away from side friction on existing carriageway reduces journey time and safety level of service risks. Though the alignment of bifurcation is not as optimal as Option 4a, this is still significantly positive. Allows for new passing lane.	+	Improvement over existing. Taking road away from side friction on existing carriageway reduces journey time and safety level of service risks. However, this option reduces viability of new passing lane.	++	Significant improvement over existing. New alignment and service roads as appropriate reduces journey time and safety level of service risks.	+	Significant improvement over existing, with new alignment and service roads as appropriate south of Ohau reducing journey times and safety level of service risks, though the need for all through traffic to pass through Ohau for the foreseeable future represents a journey time and safety risk. Allows for new passing lane.

To remove or improve at-grade intersections between north of Otaki and north of Levin	+	Significant improvement to SH1/57 and Kimberley/Arapaepae intersections, but need to retain route through Ohau retains pressure on Muhunoa East Road. Good solution for Kuku Beach Road likely.	++	Significant improvement to SH1/57 and Kimberley/Arapaepae intersections, as well as alleviating pressure on Muhunoa East Road. Good solution for Kuku Beach Road likely.	++	Significant improvement to SH1/57 and Kimberley/Arapaepae intersections, as well as alleviating pressure on Muhunoa East Road. Good solution for Kuku Beach Road likely.	+	Improvement to SH1/57 and Kimberley/Arapaepae intersections, as well as alleviating pressure on Muhunoa East Road. Compromised solution for Kuku Beach Road likely.	++	Significant improvement to SH1/57 and Kimberley/Arapaepae intersections, as well as alleviating pressure on Muhunoa East Road. Good solution for Kuku Beach Road likely.	+	Significant improvement to SH1/57 and Kimberley/Arapaepae intersections, but need to retain route through Ohau retains pressure on Muhunoa East Road. Good solution for Kuku Beach Road likely.
To engage effectively with key stakeholders		This objective does not differ by option.		This objective does not differ by option.		This objective does not differ by option.		This objective does not differ by option.		This objective does not differ by option.		This objective does not differ by option.
To lodge Notices of Requirement and resource consents as appropriate with the relevant consent authorities for the first individual project by the 2013/14 financial year		This objective does not differ by option.		This objective does not differ by option.		This objective does not differ by option.		This objective does not differ by option.		This objective does not differ by option.		This objective does not differ by option.

Otaki to North of Levin: SH1-SH57 Connection

MCA Analysis – Engineering Degree of Difficulty

Rev. No.	Date	Description	Prepared By	Reviewed By	Approved By
-	25/10/13	Draft for Comment	P Peet	M Oppenhuis	P Peet

8 Introduction

As part of the Otaki to North of Levin Road of National Significance investigation, a scoping study is currently being prepared for the SH1 – SH57 Connection south of Levin. As part of this scoping study, a Multi Criteria Analysis (MCA) is being undertaken to help inform a decision on which option(s) to take forward into the Detailed Business Case.

This short report focuses on the Engineering Degree of Difficulty aspect for the MCA. The information below was initially compiled for Options 3C, 4A, 5A, 6A and 7A before the MCA workshop on 17 October. Subsequently, Option T has been added to the evaluation but this has been on the basis of little background information.

9 Engineering Degree of Difficulty Scores

The scores in the table below reflect the above. These are discussed briefly in the subsequent sections.

Option	Terrain	Structures	Railway Lines	Trunk Utilities	Rivers and Streams	Traffic Management
3C	+	- -	- -	0	0	- -
4A	++	-	0	0	0	-
5A	++	-	0	0	0	-
6A	+	- -	0	0	- -	- -
7A	++	-	0	0	-	- -
T	+	-	- -	0	0	- -

10 Engineering Degree of Difficulty Criteria

The criteria used are listed below along with a brief summary of issues which could create difficulties in constructing the option.

10.1 Terrain

3C, T issues through Ohau
5A, 6A, 7A minor issues near McLeavy
6A potential issues adjacent to river

10.2 Structures

Option	Waikawa Stream	Kuku Beach Rd Rail	Kuku Beach Road I/C	Ohau River	Muhunoa Road Underpass	SH57 NBD off ramp over SH1	Rail in arch culvert	Local road in arch culvert
3C	1	1	Future	1	Future	1 ½	1	
4A	1	1	Future	1		1	1	1
5A	1	1	Future	1		1	1	1
6A	1	1	Future	2		1	2	2
7A	1			2		1	2	
T	1			1	Future	1	2	1

10.3 Railway lines

3C requires relocation of railway lines
3C, 4A, 5A, 6A have issues with railway line near Kuku interchange
3C, 4A, 5A, 6A have issues with railway line near SH1 – 57 split
7A, T issues with rail at southern and northern end

10.4 Truck Utilities

Not investigated yet
All options avoid major gas pipelines and major transmission lines

10.5 Rivers and Streams

Options 3C, 4A, 5A have two river crossings
Options 6A and 7A have three river crossings
In addition option 6A runs parallel to the Ohau River

10.6 Likelihood of future structures

3C, 4A, 5A, 6A all would need interchange at Kuku
3C, T would also need underpass (or other solution) at Ohau
7A, T would need to tie into four laning past Manakau (unknown solution but maybe I/C near current tie in point)

10.7 Traffic Management

3C, 4A, 5A, 6A issues at Manakau Rail Overbridge
3C, T big problems through Ohau
3C, T problems on Kimberly Road
4A, 5A, 6A and 7A issues with local road connectivity during construction
6A issues at current Ohau railway overbridge vs new SH57 ramps
7A, T issues along current SH1 with property access
7A, T issues at northern SH1 tie in (due to road over rail at tie in).

APPENDIX 10: WORKSHOP BACKGROUND AND NOTES

DRAFT AGENDA

OTAKI TO LEVIN RoNS
SH1 + SH57 CONNECTION OPTIONS WORKSHOP

Thursday 17th October 2013, 1.30pm to 5.30pm
Venue: Matiu Room, Chapman Tripp, 10 Customhouse Quay, Wellington

Person	Item	Approx. Time
JD	Welcome and reason for Workshop	1.30 – 1.35pm
All	Introductions, housekeeping	1.35 – 1.45pm
SA	Purpose of afternoon (confirm agenda, background to MCA, discussion of criteria and scoring system)	1.45 – 1.55pm
PP	Description and explanation of options (how we got them and what they're like)	1.55 – 2.00pm
As listed	Presentations/discussions about criteria and scoring (order to be determined) landscape/visual implications (GL) ecological implications (AF) archaeology/heritage aspects (DP) tāngata whenua implications (ML) productive landuse aspects (LG) social/community impacts (SA) District Plan/consentability (CvH) transport effectiveness/fit with project transport objectives (JD/PP) specific land ownership effects (JD, CvH) engineering degree of difficulty/constructability (PP) cost (PP) Review of scores	2.00 – 5.00pm (includes 10min afternoon tea break at about 3.15pm)
SA/PP	Weighting of criteria and next steps	5.00 – 5.15pm
JD	Overall project update	5.15 – 5.30pm

NOTES TO ACCOMPANY DRAFT AGENDA

OTAKI TO LEVIN RoNS
SH1 + SH57 CONNECTION OPTIONS WORKSHOP

Thursday 17th October 2013, 1.30pm to 5.30pm
Venue: Matiu Room, Chapman Tripp, 10 Customhouse Quay, Wellington

1. These notes provide background for the workshop later this week. At the start of the workshop there will be a chance to talk through the purpose of the workshop and the process. It is important that we come with open minds and work collaboratively with questioning and testing of the values and issues around all the options we are looking at.

2. The workshop is intended to develop and apply a multi-criteria analysis (MCA) on the five options that have been developed earlier in this process, including the two options that went out for consultation in May this year. The project we are evaluating includes the concept of changes over time, so involves both the short-term improvements and the longer-term changes, including the 4-laning and the progressive improvements at Kuku Beach Road (short-term at- grade staggered intersection, and long-term grade-separation further to the south as shown on the schematics).

3. The attributes the workshop is looking at are the advantages and disadvantages, or positive and negative effects, for the criteria listed in the Agenda. We will discuss the list early in the workshop to decide whether all criteria are appropriate and meaningful for an assessment of alternatives; whether some should be split into more than one, or whether some should be combined.

   Note that it is ideal to have 10 to 12 criteria in an MCA, so we have about the right number. Also, we will be weighting the criteria later in the process, so if some seem less important, they can be given a lower weighting.

4. In terms of "scoping" the criteria and what needs to be taken into account under each heading, we are relying on the expert advisor to guide the workshop on that, and there will be an opportunity to discuss the scope of each criterion during the workshop (i.e. during the presentation session). We may want to break down and analyse a criterion under several headings (for example, using some secondary criteria) or by section of route, and recombine them with a single overall score per route alternative. We will document the scope of each criterion as part of the workshop record.

5. We are asking each expert (initials on the agenda) to come prepared to explain their aspect and discuss their preliminary scoring for each corridor. There will be a maximum of 5 to 10 minutes for each presentation, followed by discussion and scoring (or we can leave all

scoring until the end). Presentations (simple power-point) would be good, but there will be maps, aerials; etc available for people to refer/talk to for those who haven't organised that.

6. We will score each attribute as a group, on a 1 to 5 scale as set out below (note: cost is not amenable to this scale and will be scored on a relative basis). The preliminary (++ to - -) scoring that experts have done will be a guide, but the workshop (rather than the expert alone) should do the scoring. Ideally we will reach consensus on a score for each attribute, but if we can't, we will note the different views and use that for sensitivity analysis at a later stage. We will review the scores at the end of the session to make sure that we are all comfortable with them.

SCORE	DESCRIPTION
1	The option presents few difficulties on the basis of the criterion being evaluated, taking into account reasonable mitigation proposals. There may be significant benefits in terms of the criterion.
2	The option presents only minor areas of difficulties on the basis of the criterion being evaluated, taking into account reasonable mitigation proposals. There may be some benefits in terms of the aspect.
3	The option presents some areas of reasonable difficulty in terms of the criterion being evaluated. Effects cannot be completely avoided. Mitigation is not readily achievable at reasonable cost, and there are few or no apparent benefits.
4	The option includes extensive areas of difficulty in terms of the criterion being evaluated, which outweigh perceived benefits. Mitigation is not readily achievable.
5	The option includes extreme difficulties in terms of achieving the project on the basis of the criterion being evaluated.

7. We will be endeavouring to develop a "workshop-agreed" weighting system for the criteria towards the end of the workshop. This will be complemented in later analyses by other weighting systems to make sure we have a robust outcome.

Otaki to Levin RoNS
SH1 + SH57 Connection Options

MCA Workshop

17/10/2013

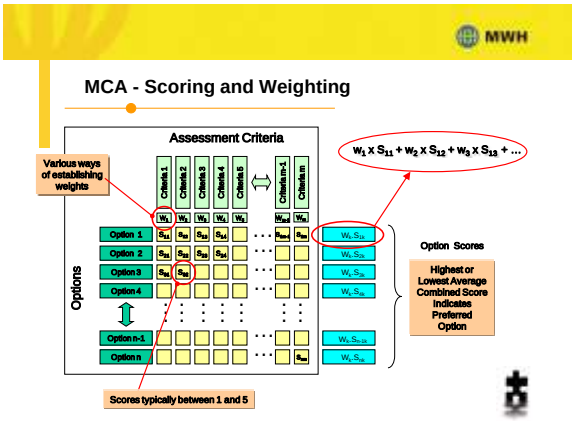
Allan Planning &Research Ltd

PURPOSE OF WORKSHOP

- Analyse five alternatives for SH1 + SH57 connection
- Carefully consider information presented by experts
- Apply MCA process in structured, defensible manner
- Keep notes of key points

Allan Planning &Research Ltd

MCA PROCESS



WORKSHOP PROCESS

- Model is:

Presentation by Nominated Person

⬇

Discussion/questions (general)

⬇

Discussion/scoring

- We will work towards consensus in scoring if possible
- Scores = raw data for further analysis
- If there are strongly-held different views, they will be recorded and used in sensitivity analysis
- Key points from Workshop, including scope of criteria and reasons for scores to be recorded

WORKSHOP PROCESS cont...

- Decisions to be made now:
  - All discussion now then scoring; group criteria and score; or one by one?
  - Any obvious issues with any attributes?
  - Order of attributes?
- Later:
  - Opportunity to quickly review scores
  - Develop workshop weighting of attributes

APPLYING SCORES

- Basically 1 = Good, 5 = Bad
- Each option must be scored for each attribute
- Can't use "0" or NA, as it would have a positive implication
- Don't need to use all scores in range for any (or all) attributes

PROCESS TO DATE

- Development of alternatives following initial consultation on two options
- Identified five "best" alternatives
- Preliminary technical investigations
- Specialist investigations and evaluations

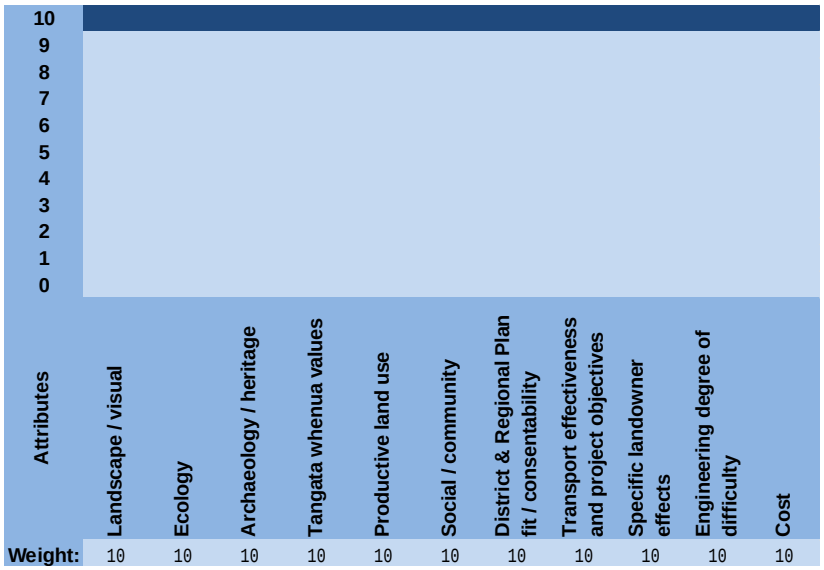
MEETING ATTENDEES

Meeting Name	SH1 + SH57 Connections Options MCA Workshop Meeting		
Meeting Venue	Conference Room, 10 Customhouse Quay, Wellington		
Date Of Meeting	17 October 2013	Time Of Meeting	1:30pm – 5:40pm
Facilitator	Sylvia Allan	Recorder	Jon England

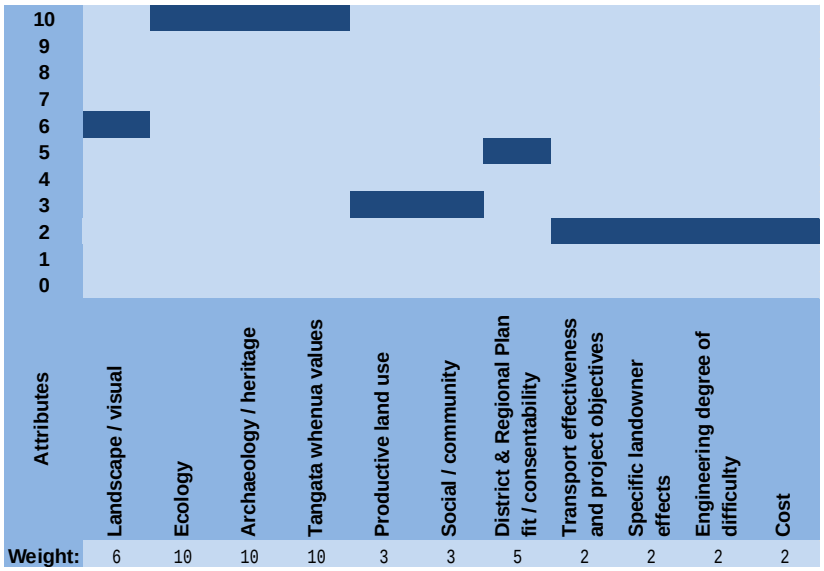
Attendees	Organisation
Jo Draper	NZTA
Phil Peet	MWH
Jon England	MWH
Sylvia Allan	Allan Planning and Research
Steve Kerr	MWH
Gavin Lister	Isthmus
Kristin Stokes	MWH
Daniel Parker	InSite Archaeology
Jamie Mitchington	Beca (representing HDC)
Lachie Grant	LandVision
Morrie Love	Raukura Consultants
Adam Forbes	Forbes Ecology

APPENDIX 11: WEIGHTING SYSTEMS APPLIED IN ANALYSIS

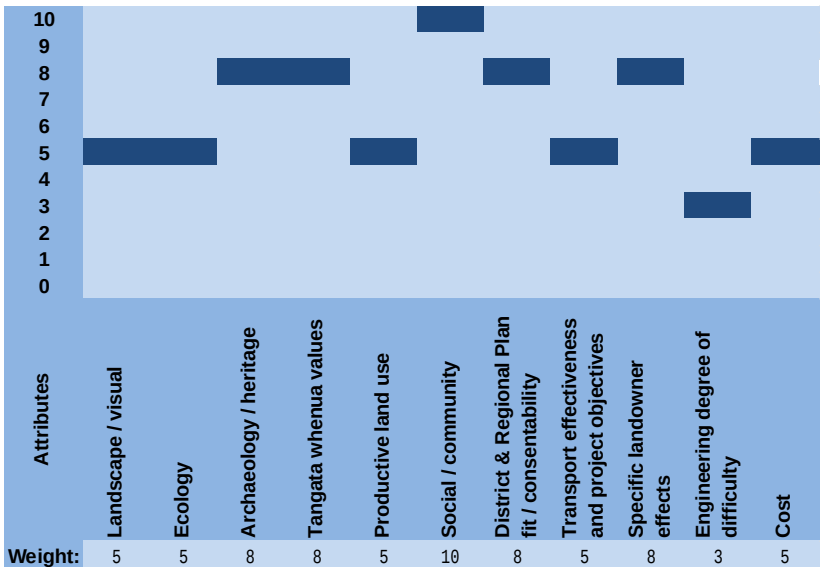
Workshop Participant Weighting



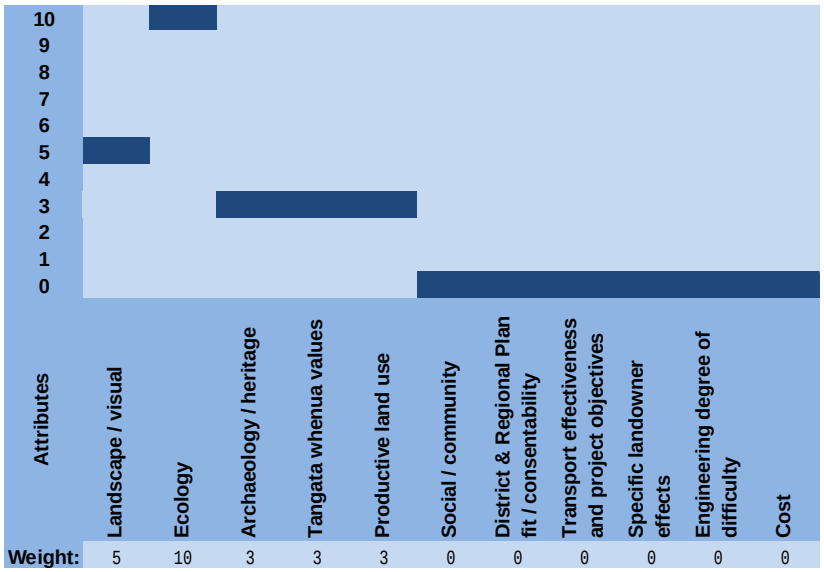
RMA S6 Weighting



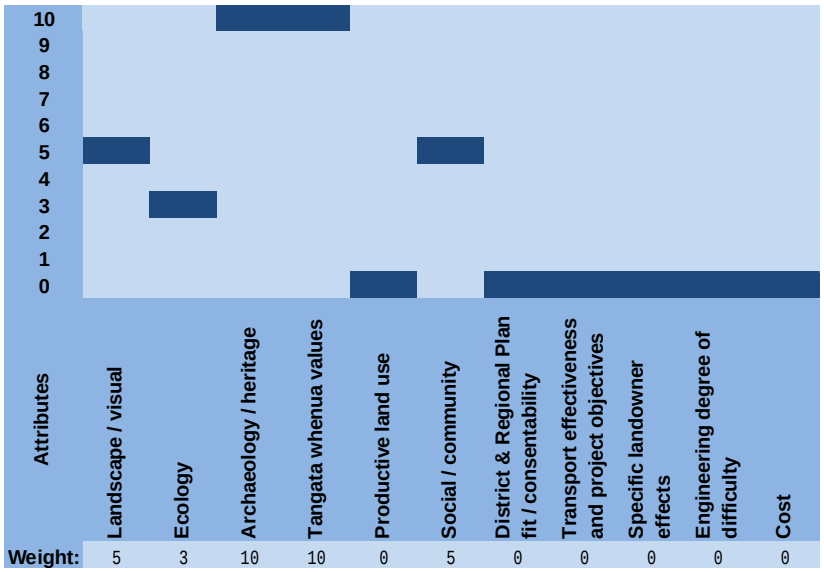
Social Weighting



Environmental Weighting



Cultural Weighting



Economic Weighting