MELLING INTERSECTION IMPROVEMENTS MCA WORKSHOP (JUNE 2018) REPORT

PREPARED FOR NZ TRANSPORT AGENCY

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Stantec

Melling Intersection Improvements MCA Workshop (June 2018) Report

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Executive Summary

Introduction

The third Multi-Criteria Analysis (MCA) workshop for the NZ Transport Agency's (the Transport Agency's) Melling Intersection Improvements project was held in June 2018. Two previous MCA processes were conducted for the project to help narrow down the options for the layout and design of the State Highway 2 (SH2) intersection and surrounds. The third MCA workshop was conducted on three remaining options that connect to the eastern side of the Hutt River, as follows (images of each option in main report):

- Melling Link – a bridge connecting to the existing Melling Link roundabout.
- Queens Direct – a bridge connecting to the Queens Drive roundabout.
- Queens Indirect - a dog-leg approach between the interchange and the bridge connecting to the Queens Drive roundabout.

Prior to MCA Workshop 3, technical specialists were identified to undertake preliminary investigations and to lead discussion on each criterion at the workshop. An agenda was also circulated to attendees that provided background of the work to date, information of the assessment criteria and how to scoring and weighting would be performed.

MCA Criteria

Initially ten criteria were proposed, however, during the workshop, the criterion of 'Urban Design and Recreational Opportunities' was modified to extract recreational considerations into a new category labelled as 'Recreational Functional Amenity'. The eleven criteria evaluated were as follows:

- **Transport benefits**
- **Fit with local road system**
- **Visual and landscape impacts**
- **Natural hazards management fit**
- **Landuse effects**
- **Urban design opportunities**
- **Consentability**
- **Engineering degree of difficulty**
- **Ability to be Staged**
- **Cost**
- **Recreational Functional Amenity**

MCA Scoring

The scoring outcomes of the three options are set out in the table below (a low number is a good score, a high number is a bad score). While there was general agreement at the workshop, some of the scores differed from those initially proposed by the technical specialist in their presentation. Changes in score were robustly discussed amongst the workshop attendees, who sometimes would offer a point of consideration from their field of expertise that may not have been considered by the technical specialist. All scoring achieved consensus.

Option	Transport benefits	Fit with local road system	Visual and landscape impacts	Recreational Functional Amenity	Natural hazards management fit	Landuse effects and opportunities	Urban design opportunities	Consentability	Engineering Degree of Difficulty	Ability to be staged	Cost
Melling Link	2	3	3	2	5	3	2	4	5	5	3
Queens Direct	2	1	3	3	2	2	1	3	3	4	3
Queens Indirect	1	2	5	4	3	3	3	3	5	4	4

NB: dark green means a positive outcome (best) and dark red means a negative outcome (poor).

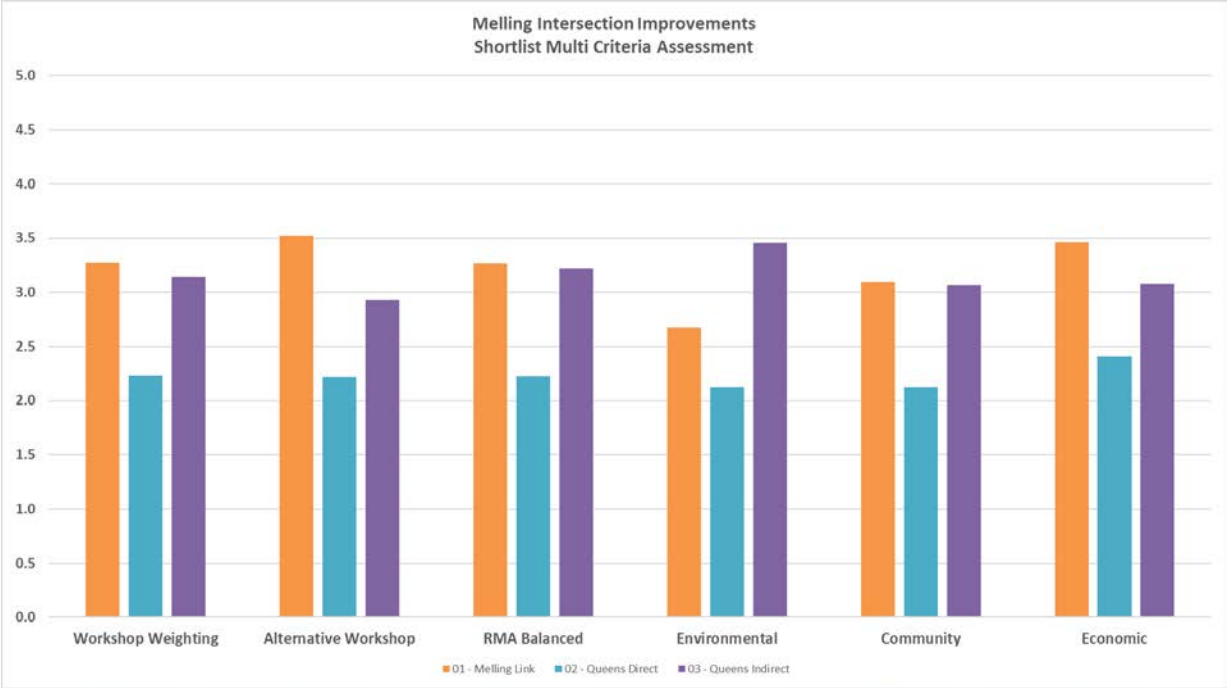
MCA Weighting System

There were six weighting systems applied to the MCA scores. None of the weighting systems are constrained in terms of an overall weighting, so no 'trade-offs' were made. The systems used were as follows;

- **Workshop** - based on values of the attendees.
- **Alternative Workshop Weighting** –Visual and Landscape, Recreational Functional Amenity and Urban Design Opportunities reduced to 1/3 of their weighting as could otherwise dominate scoring.
- **RMA Balanced** – This reflects the aspects that contribute to the overall evaluation of the project under the RMA.
- **Environment** – This weighting system emphasised the physical environment.
- **Community** – This weighting system emphasised the aspects likely to be most important to the community and was informed, in part, by consultation comments.
- **Economic** – This weighting system placed full weight on the criteria with a significant economic component.

MCA Result

A clear order of preference emerged from the overall analysis across the various weighting systems. Based on the Workshop Weighting, Queens Direct was the most-favoured option with the lowest aggregated score. The subsequent additional weighting systems also all identified Queens Direct as the most favoured. In all but the Environmental Weighting, the Queens Indirect option was second favoured and Melling Link least favoured. The figure below graphically represents the outcome of the weighting process, with the shortest bar indicating the most favoured for each weighting scenario.



The analysis was also run with costs excluded and similar results were obtained.

As the scoring process had achieved consensus across the board, there were no alternative scorings that needed to be considered as part of a sensitivity test.

NZ Transport Agency

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Appendix B Background Paper – Transport Benefits
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1. Introduction

1.1 Previous Analyses

This report covers the parameters for, and outcomes of, the third Multi-Criteria Analysis (MCA) workshop for the NZ Transport Agency's (the Transport Agency's) Melling Intersection Improvements project. MCA processes have been used throughout the project to help narrow down the options for the layout and design of the intersection. The previous workshops proceeded as follows:

1. **WORKSHOP 1:** A comprehensive all-day workshop (December 2016), which included a fatal flaw exercise that removed two of the 13 options. This was followed by a full MCA process, which applied and scored each option based on 12 criteria[1]. Following this workshop, the project team determined to proceed to further investigations on four options.

   A subsequent concept design safety audit of the four options led to the development of three additional sub-options. Traffic modelling[2] was then conducted on the seven options which primarily focused on capacity issues.

2. **WORKSHOP 2:** An all-day workshop (February 2018) focussed on options for the four key attributes of the interchange, rather than on the specifics of the seven options. The attributes were; the interchange form, the Tirohanga Link connection, the location of the bridge connection into the Lower Hutt CBD and the connection between the SH2 interchange and the new bridge. This Workshop applied an MCA process, but did not numerically score the criteria. Rather, scoring was undertaken based on positives and negatives, on a scale of + +, +, 0, -, - -[3]. This process resulted in the seven options being narrowed down to three options, all of which were based on a diamond interchange on SH2, and a similar form of connection between Tirohanga and Harbour View on the west side of SH2.

1.2 Public Consultation

Prior to the third MCA workshop, public consultation on the three options occurred as part of the RiverLink Project consultation. The public were asked to turn their minds to, and give feedback on, the following two questions; "where to locate a new bridge?" and "should there be a direct or indirect approach to the bridge?". The public were also asked to identify the top three factors they believed were important when identifying a preferred option, why they were important, and whether anything else should be considered.

For more information on the outcomes of the consultation process for the three options, refer to the RiverLink Community Engagement Report May – June 2018[4].

Broad information on the findings of the public consultation helped inform the analysis at the MCA workshop.

1.3 Iwi involvement

In developing the scope of the workshop, the interests of local mana whenua in the process were considered, and the project team met with representatives of the Port Nicholson Trust (Taranaki Whanui) and Ngāti Toa Iwi. With a narrowed range of options, the representatives chose not to be directly involved in the MCA process but sought that the Transport Agency provide a debrief following the workshop. The criteria did not include cultural values[5].

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[1] Melling Intersection Improvements Indicative Business Case DRAFT Version 1.1 NZ Transport Agency July 2017

[2] The seven options were not modelled rather modelling was conducted to help understand the relative performance of the seven options

[3] Melling Link Further Options Report Stantec March 2018

[4] NZ Transport Agency June 2018

[5] A Tangata Whenua values criterion had been applied with the assistance of the project's Maori advisor in the first MCA analysis but even with the wider range of options evaluated in that process the scoring of all options was the same indicating that such values were not a distinguishing consideration. This was agreed in discussion with tangata whenua representatives in relation to the present process.

2. The Three Options

Workshop 2 effectively narrowed the seven options down to three, based on the various project components. Subsequently it was agreed with the Transport Agency that the three options should all be based on a diamond interchange on State Highway 2 (SH2) and a Tirohanga Road connection into Harbour View Road on the west side of SH2. What was not confirmed was where the bridge should connect on the eastern side of the Hutt River and whether the Queens Drive connection should be on a straight or "dog-leg" approach from SH2. These elements are, necessarily, interconnected and led to the configurations described below.

The differences between the three shortlisted options were quite subtle in terms of safety and efficiency, but appeared to vary in terms of urban form and fit with the proposed flood works, as well as other aspects relevant to a decision on preference. A third MCA evaluation was necessary to help the project team identify a recommended option. The options were as follows;

- Melling Link – a bridge that connects into the existing Melling Link roundabout on the eastern side of the Hutt River as per Figure 2-1.
- Queens Direct – a bridge that connects into the Queens Drive roundabout on the eastern side of the Hutt River as per Figure 2-2.
- Queens Indirect - a dog-leg approach between the interchange and the bridge which connects into the Queens Drive roundabout on the eastern side of the Hutt River as per Figure 2-3.

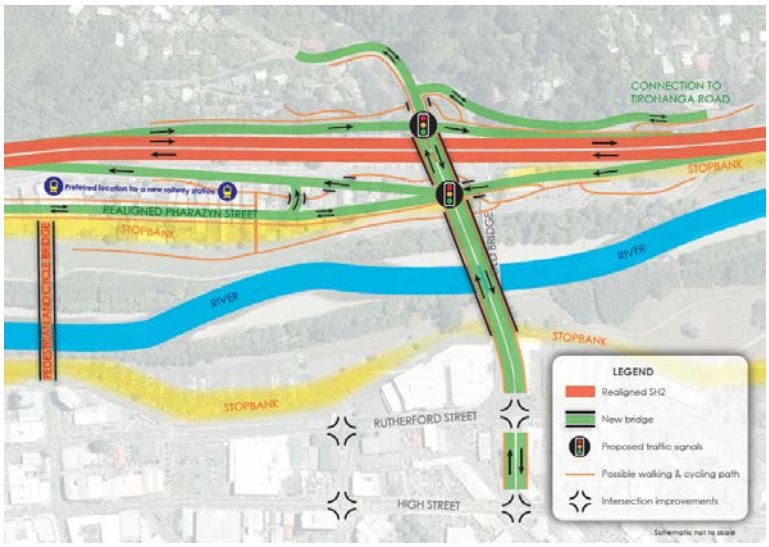

Figure 2-1: Diamond Interchange with direct connection to Melling Link (Melling Link Option)

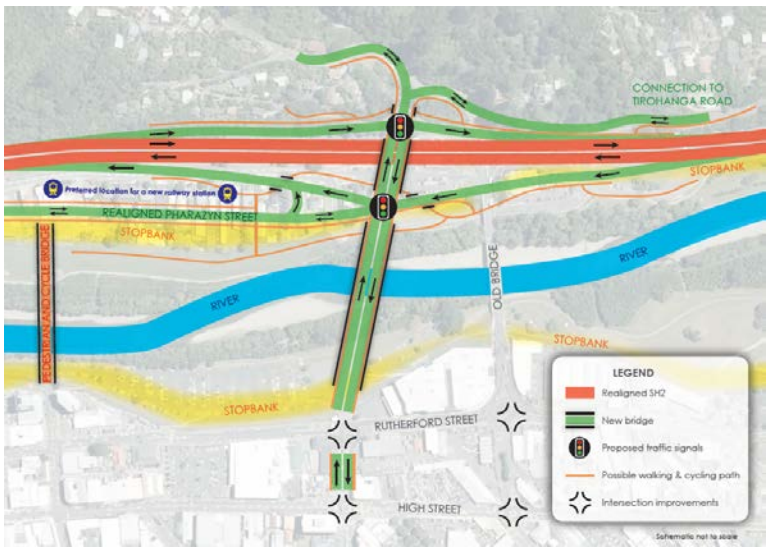

Figure 2-2: Diamond Interchange with direct connection to Queens Drive (Queens Direct Option)

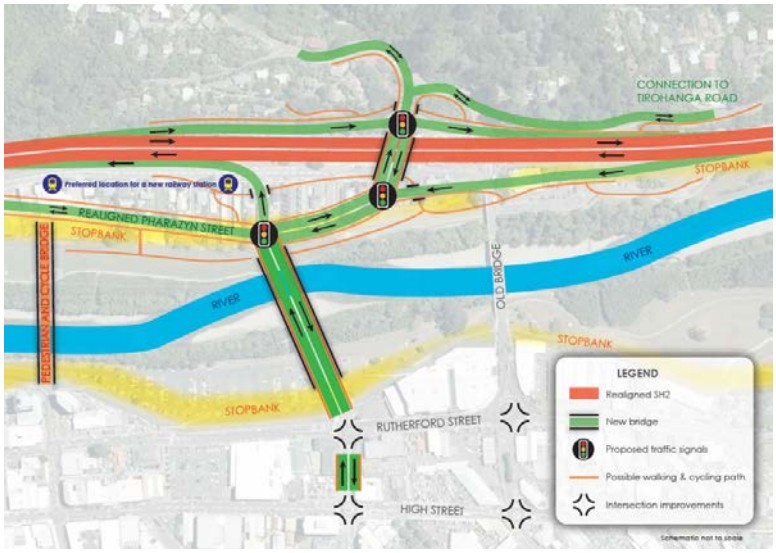

Figure 2-3: Diamond Interchange with indirect connection to Queens Drive (Queens Indirect Option)

3. MCA Workshop 3 and Subsequent Analyses

3.1. Overview

As with earlier analyses, it was necessary to identify relevant criteria. Ten potential criteria were selected and modified to suit the reduced diversity of options. The criteria were discussed in detail with the technical specialists involved in MCA Workshop 3, to ensure the scope of each criterion was sufficient and appropriate to identify the characteristics of the options and any differences between them.

Prior to MCA Workshop 3, technical specialists had been identified to undertake preliminary investigations and to lead discussion on each criterion at the workshop. Each technical lead was requested to provide a short background report and provide a short evaluative presentation on how each of the three options performed for that criterion. Each then presented their overall assessment and an indicative score for that criterion for each option, which was then discussed and challenged by the wider workshop group[6]. A final score was then agreed.

The agenda for MCA Workshop 3 was:

- Description and discussion of options and how we got to them
- Confirmation of the criteria
- Confirmation of the scoring method
- Discussion, definition and scoring of options by the 10 criteria
- A discussion on the weighting to be applied to each criterion in the analysis of the scoring.

An early briefing note had been pre-circulated to attendees along with the draft agenda prior to the workshop. The process and agenda were confirmed at the start of the workshop. Appendix A includes the briefing note, agenda, updated criteria descriptions and the meeting notes of MCA Workshop 3.

3.2. Fatal Flaws

It was agreed at the start of the Workshop that none of the three options had a 'fatal flaw', as the previous two MCA workshops would have already identified any fatal flaws present.

[6] This follows the methodology of "Decision Conferencing" and seeks to reach consensus scores. Where a consensus is not reached alternative scores are recorded and uses as part of the sensitivity analysis.

3.3. MCA criteria

Ten criteria were initially decided upon and scoped with the assistance of the technical experts. The progression of the MCA criteria used through the three workshops for this project is shown in Table 3-1.

Prior to the workshop it was decided not to include a criterion relating to "Utility for non-motorised travel modes" (consideration of how well the project can provide for walking, cycling, and any other modes) and "Railway/bus system Utility" (consideration of opportunities for rail and bus system integration and facilities such as park and ride, and potential for their future expansion or extension). Such criteria had been included in earlier assessments. These criteria were excluded, as there was unlikely to be any significant difference between options at this level of assessment.

The 'Additional Safety Benefits' criterion was specifically created for Workshop 2 to differentiate between the (further) options in response to the safety audit undertaken at this time. Any project traffic safety benefits were incorporated into the 'Transport Benefits' criterion for Workshop 3, whereas for Workshop 2 'Transport Benefits' was limited to the traffic efficiency of modelling outputs.

Table 3-1: Progression of MCA Criteria used through the project lifecycle

Criteria used in Workshop 1 and/or 2	Workshop 3 Criteria	Why Different
Transport benefits	Transport benefits	
Fit with local road system	Fit with local road system	
Visual and landscape impacts	Visual and landscape impacts	
Railway/bus system utility		No difference between shortlisted options
Utility for non-motorised travel modes		No difference between shortlisted options
Natural hazards management	Natural hazards management fit	
Impact on adjacent landuses	Landuse effects	
Urban design opportunities	Urban design opportunities	
	Recreational functional amenity	Additional level of detail enabled this to be split from Urban design.
Engineering degree of difficulty	Engineering degree of difficulty	
Ability to be staged	Ability to be staged	
Consentability	Consentability	
Additional safety benefits		Criteria was included for Workshop 2 only to respond to safety audit questions
Impacts on tangata whenua values		No difference between shortlisted options
Cost	Cost	

The criteria are outlined further below (with the nominated technical specialist leading the discussion for each). Note that these were scoped slightly differently from the pre-circulated background notes (first document in Appendix A) because of subsequent discussions with the technical leads.

- **Transport benefits** s 9(2)(a)): An overall assessment of the option covering state highway and local road efficiency and any benefits to regional road transport, and the adequacy and quality of cycling, walking and bus system provision (compared against the current situation). This criterion will also include any safety benefits.
- **Fit with local road system** s 9(2)(a) **):** A criterion that covers the contribution of the option to the management of the local road network, including the opportunities to integrate effectively with the roading hierarchy (present and as could effectively be modified) in the CBD and vicinity. This criterion differs from the transport benefits criteria, as it focuses on the local network as a system in its own right, i.e. receiving and dispatching traffic in the wider Hutt valley.
- **Visual and landscape impacts** s 9(2)(a)): This criterion covers the visual amenity impacts on the locality in terms of the river and fault scarp environment, to a range of viewers. It also includes RMA natural character considerations, and biophysical impacts and opportunities.
- **Natural hazards management fit** (s 9(2)(a)): This criterion considers the ability to integrate with Greater Wellington Regional Council's flood hazard management, and to address the other natural hazards found in the area. Natural hazards are an RMA management issue for territorial and regional councils, and significant risks from natural hazards are an RMA section 6 matter.
- **Landuse effects** s 9(2)(a) This is a broad criterion which addresses potential changes in use of land across the project area. It accounted for adverse effects such as loss of access and reduced exposure to passing traffic in some areas, but also opportunities created by release and re-parcelling of residual land. It also covered construction impacts on the project's immediate neighbours.
- **Urban design and recreational opportunities** (s 9(2)(a)): This criterion was based on the opportunities that the option creates to strengthen the CBD form and function (gateway, identity and wayfinding opportunities) and/or other valued Hutt Valley spaces and places, and to contribute to the CBD's recreational amenity.
- **Consentability** s 9(2)(a) This criterion involves a high-level judgement of the issues and the anticipated ease of obtaining the necessary approvals, given the need to integrate a range of projects and designations and other consents in the three options.
- **Engineering degree of difficulty** s 9(2)(a)): This criterion covers physical components such as volume and balance of earthworks; structures; complexity of programming and temporary works, traffic and access management during construction; risks around "unknowns"; any necessary additional provisions to address natural hazards, and general degree of difficulty in construction.
- **Ability to be Staged** s 9(2)(a) This criterion involves consideration of how the project's separate elements (as part of the Riverlink Project, and as subsidiary components of the transport interchange project) could be programmed and the implications of proceeding with separate elements if necessary.
- **Cost** s 9(2)(a)): Scoring this criterion is based on an indicative high-level analysis only (note that MCA analysis will be done both with and without costs)[7].

During the workshop, the criterion of **Urban Design and Recreational Opportunities** was separated into two criteria of **Urban Design Opportunities** and **Recreational Functional Amenity**. Recreational attributes of each option had been intended to be included within the Urban Design opportunities criterion, but the attendees decided that it was worth considering separately as they include significantly different characteristics. The following revised description was used for **Urban Design Opportunities**:

> "This criterion is based on the opportunities that the option creates to strengthen the CBD form and functioning (gateway or identity opportunities) and/or other valued Hutt Valley spaces and places."

s 9(2)(a) Boffa Miskell led the discussion on **Recreational Functional Amenity**, which had the following description applied:

> "A criterion that considers the recreational use, function of the bridge and overall amenity of the option. This considers how the public currently use the existing riverside space and how it would be used under the RiverLink project".

[7] No background paper was produced on this aspect – rather it was verbally reported on at the meeting on a comparative basis.

3.4. Multi-Criteria Analysis of Options

3.4.1. Scoring System

The proposed scoring system had been pre-circulated as part of the Agenda. The general approach to scoring used at Workshop 3 is set out in Table 3-2 below. In assigning scores, it was recognised that the interchange project would not proceed unless there were benefits, however it is more likely the options would be distinguished by their adverse effects and difficulties within the criteria. Therefore, the scoring was focussed with this in mind, whilst also capturing where significant benefits were present.

Table 3-2: Basis for Scoring used in the MCA

Score	Description
1	The option presents few difficulties based on the criterion being evaluated and/or may provide significant benefits in terms of the attribute.
2	The option presents only minor aspects of difficulty based on the criterion being evaluated and/or may provide some benefits in terms of the criterion.
3	The option presents some aspects of reasonable difficulty in terms of the criterion being evaluated and/or problems cannot be completely avoided. There are few apparent benefits in terms of the criterion.
4	The option includes clear aspects of difficulty in terms of the criterion being evaluated, and/or very limited perceived benefits.
5	The option includes significant difficulties or problems in terms of the criterion being evaluated and/or no apparent benefits.

3.4.2. Scoring Process

The overall MCA process was facilitated by s 9(2)(a) Allan Planning and Research. Most attendees at Workshop 3 had also been present at previous workshops, so were familiar with both the processes and the history of the project.

Criteria technical leads led the scoring process, conducting a short discussion/presentation on their assessment of the criterion and identifying issues relevant to each option. Following this, the workshop attendees raised any questions or matters relating to the implications of a particular option, or the score proposed by a specialist for each route option. The background notes and assessments of the three options for each criterion are presented in B to H[8].

3.4.3. Scoring of Criteria

The scoring outcomes of the three options are set out in Table 3-3 (a low number is a good score, a high number is a bad score). While there was general agreement at the workshop, some of the scores differed from those initially proposed by the technical specialist[9]. These were robustly discussed amongst the workshop attendees, who sometimes would offer a point of consideration from their field of expertise that may not have been considered by the technical specialist. All scoring achieved consensus.

Key points made in the discussion that led to the scores are set out in bullet-point form following on from Table 3-3.

[8] Note that these are presented in different styles and levels of detail depending on the approach of the technical specialist. Substantive discussion was held on all of the criteria at the workshop.

[9] Note that in some cases the workshop process resulted in scores which were different from those proposed by the technical specialist who provided the base case information. The technical specialists were asked to indicate (as part of the relevant Appendix) where they had any disagreement with the workshop score. This ensures their professional independence while not affecting the MCA outcome process.

Table 3-3: Scoring of the Three Options

Option	Transport benefits	Fit with local road system	Visual and landscape impacts	Recreational Functional Amenity	Natural hazards management fit	Landuse effects and opportunities	Urban design opportunities	Consentability	Engineering Degree of Difficulty	Ability to be staged	Cost
Melling Link	2	3	3	2	5	3	2	4	5	5	3
Queens Direct	2	1	3	3	2	2	1	3	3	4	3
Queens Indirect	1	2	5	4	3	3	3	3	5	4	4

NB: dark green means a positive outcome (best) and dark red means a negative outcome (poor).

- **Transport benefits**: The 2031 modelled overall travel time through the interchange for each option was similar (for all modes), the same applied to the SH2 through traffic. The options would all provide a significant travel time improvement when compared to the existing road layout.

  All options were expected to significantly improve safety on SH2, by separating the local and state highway traffic streams. There were concerns held about the safe operation of the five-leg intersection in the Queens Direct option, as well as reservations from the technical lead that the operation of the five-leg intersection could fail in practice, despite modelling not showing much of a problem. These two points (safety and operating effectiveness) were the biggest concerns from a transport perspective.

  The Queens Indirect option had a better bus route alignment for Melling train station, as it takes buses nearer to the station. Queens Indirect would also provide a more direct connection (than the other two options) for walking /cycling to the train station.

  During the public consultation the general feedback was that three sets of traffic lights were less desirable than two, and the Queens Indirect option would feel as though you were heading in the wrong direction and then coming back on yourself when travelling from SH2 to the CBD.

  HCC noted there was currently a suppressed travel demand (due to existing travel time delays), and that this is greater than what is shown by the transport modelling. However, the estimated volume from the unconfirmed Petone to Grenada project was included in the modelling, which increased the traffic volumes and could compensate for the suppressed demand.

  MOST FAVOURED OPTION: Queens Indirect

- **Fit with local road system**: The technical specialist leading the discussion highlighted the future importance of connectivity to HCC's Eastern Access Route, because the Western Access Route via Daly Street would be closed by the construction of the eastern stopbank for RiverLink. HCC is keen for the Eastern Access to provide a better defined through route, and for it to define the desired CBD boundary in conjunction with land use planning. It was also noted (at the workshop) there was increasing demand to access SH2 from the industrial suburb of Gracefield, via the Eastern Access Route. Therefore, the two options that connect to Queens Drive are preferred in order to help meet these objectives.

  The two options which connect directly to Queens Drive also work better from a public transport point of view, as they would provide a more direct connection to the CBD than the Melling Link option.

  Queens Direct was preferred over Queens Indirect as it was considered to provide a more legible connection to the local road network, particularly Pharazyn Street.

  MOST FAVOURED OPTION: Queens Direct

- **Visual and landscape impacts**: The Queens Indirect option was considered the worst option because it requires the road to run along the top of/above the western stopbank which would have significant visual impacts particularly from the river corridor. The Melling Link connection was slightly favoured over the Queens Drive options, as there was already a bridge which would be familiar to residents and provide less of an adverse visual effect than a new bridge nearer to the CBD. The need to lift Rutherford Street for the two options which connect to Queens Drive would also present an

unappealing visual aspect for adjoining commercial businesses. Overall these differences were considered to be minor in comparison to the effect of the road on the stop banks in the Queens Indirect option.

MOST FAVOURED OPTION: Melling Link or Queens Direct

- **Recreational functional amenity:** The recreation area currently used as an off-street carpark and where the weekend market is held, is very important to local residents. There were concerns about shading and noise from a new bridge above the vicinity of this popular public area. As both options which connect to Queens Drive would only be 260m from the proposed new pedestrian bridge, it was thought that it would negatively impact on the recreational use of this popular stretch of the river corridor without providing significant additional benefits. By connecting at Melling Link, these concerns were averted.

MOST FAVOURED OPTION: Melling Link

- **Natural hazards management fit:** The main natural hazard concern is the waterway and river constrictions. If Melling Link was chosen, it would lock in the existing river channel constraint for the next 100 years. This would greatly restrict any chance of future flood protection improvements at this highly constrained location. By relocating the bridge to connect to Queens Drive, the opportunity is created to provide additional flood protection in the future. Of the two options which connect to Queens Drive, the Queens Indirect option was less desirable if constructed as currently presented. The bridge location would fix in place an undesirable berm fill obstruction for the lifespan of the bridge.

  The seismic, landslide and tsunami hazards were predicted to be similar for all three options, with no distinguishing differences. All tsunami effects were expected to be accommodated in the waterway and were estimated to cease any potential impact at approximately the location of the current Melling Link Bridge. It was considered unlikely that the volume of water generated by a tsunami would be greater than the 2,800 m^3 which the Hutt River floodway is designed to accommodate. The Queens Direct option did not preclude opportunities for future upstream channel improvement.

MOST FAVOURED OPTION: Queens Direct

- **Landuse effects:** All three options have impacts on land parcels on the CBD side of the river, as either Queens Drive needs widening or Melling Link needs realignment.

  The possible 5.0 m lift of Rutherford Street required for the Queens Indirect option would have major adverse effects for existing adjacent land uses, particularly close to the intersection where the height differential is greatest. The Queens Direct option also lifts Rutherford Street up, but only by an estimated 2.0 – 3.0 m.

  The Queens Indirect option potentially leaves a surplus 'island' land parcel in between the SH2 interchange and the southbound on-ramp. However, it was also identified that the southbound on-ramps for the other two options may go through this parcel and leave no surplus land all. Any surplus parcel(s) could be used as a skate park or other civic space, so could be of benefit to the community.

  There was discussion and agreement that all temporary adverse effects should be discounted in the time scale of a 100-year project, and not have any effect on the overall score.

  A potential opportunity was identified that if a Queens Drive option was progressed, the current Melling Link could be used as a new informal connection to the river.

  There was less confidence in scoring this criterion, with attendees finding it hard to balance the adverse effects vs the opportunities. It was proposed that this criterion may justify only a low weigh because of the uncertainty.

MOST FAVOURED OPTION: Queens Direct (by a narrow margin)

- **Urban design opportunities:** It was assumed that a high-quality replacement bridge would be designed and the existing bridge removed. It was very important that there was excellent integration between the CBD and the Hutt River. The Melling Link option did not create the gateway effect into the CBD desired by HCC, whereas the two options that connect to Queens Drive do. The Queens Indirect option was, however, less desirable due to the dog-leg approach from SH2, which was thought to create some negative urban design features with the additional road link required along the top of the western stopbank. The Queens Direct option was most preferred but would need more urban design development around how the new Rutherford Street level would work with the existing CBD blocks.

The opportunity for a pedestrian bridge over SH2 to provide access between the CBD, station and western communities was discussed and it was agreed this would be investigated.

MOST FAVOURED OPTION: Queens Direct

- **Consentability:** This criterion involved high-level judgements around the issues and consentability of each option given the need to integrate a range of projects, designations and other consents in the three options. The key consideration was section 6 Matters of National Importance – in this case section 6(h): the management of significant risks from natural hazards[10]. Melling Link did not perform well against his criterion as it did not improve the existing river constraint at this location created by the width of the river channel at this point. It could make matters worse as the new piers would need to be located within the existing constrained waterway. It would therefore have the highest risk in terms of consentability. This was the one main distinguishing factor for the three options, otherwise all other matters were considered similar in nature.

MOST FAVOURED OPTION: Queens Indirect or Queens Direct

- **Engineering degree of difficulty:** The term 'ease of design' was defined by the criterion owner as how straight forward the design is to implement, one that does not require a lot of design exceptions / compromises to provide the necessary road layout e.g. smaller radii curves than desired, undesirable intersection layouts or signal phasing. It was not just concerned with the design itself, but also the legacy of design decisions/compromises and how they affect the users for over the life of the structures/roads.

  The Melling Link option provides the largest engineering challenge to overcome, as a segment of the existing bridge needs to be removed to enable completion of construction of the new bridge. This makes the task of keeping the existing traffic flowing through Lower Hutt more challenging. The bridge abutment on the western side would need to form part of the stopbank or be piled through the stopbank. Both the permanent and temporary works for this option make it complex to design.

  The Queens Indirect option has a significant interaction with the eastern stopbank, as the road would need to be constructed on top for the dog-leg. This also increases the earthquake risk to the road in this option as it runs along the fault line. It also requires an approximately 5.0 m lift to Rutherford Street if interaction with the western stopbank is to be avoided. Construction of the new river crossing predominantly avoids the existing traffic, but the stopbank interactions make this complex to design.

  The Queens Direct has the least impact on the stopbanks and may be progressed with only minimal interaction with the stopbanks. The necessary lift of Rutherford Street is lower for this option, as it crosses the stopbank at a location where there is more horizontal distance before dropping down to Rutherford Street (allows for a shallower road grade between the top of the stopbank and Rutherford Street). Construction of the new river crossing predominantly avoids the existing traffic and the abutment location can be progressed without any interaction with the stopbanks. This option is the least complex to design overall.

MOST FAVOURED OPTION: Queens Direct

- **Ability to be Staged:** With all options, the bridge and SH2 interchange would need to be built after the stopbanks. Because the stopbanks consist of earth-fill material, they need to be properly compacted with heavy plant. It would not be possible to compact the material directly under the bridge if it was built first, as the heavy plant would not be able to pass under the bridge, as the bridge will be directly on top of the stopbank.

  It is not possible to build the interchange before the bridge for any option, as the interchange would be too high to connect to the existing Melling Bridge. However, constructing the bridge before the interchange is feasible, as the rearrangement of the road connections between the new bridge, SH2 and local roads can be made.

  Therefore, if the interchange is not built by NZTA within the first phase of works, it does not preclude it from being constructed in the future. However, building the bridge before the interchange would result in increased travel time delays and poor access to the Lower Hutt CBD. Overall, staging would provide disbenefits against some of the project objectives.

MOST FAVOURED OPTIONS: Queens Indirect or Queens Direct

[10] While other RMA section 6 matters of natural character of the river environment (section 6(a)) and public access to the river corridor (section 6(d)) were also potentially relevant the options were not distinguishable on the basis of those considerations.

- **Cost**: All options currently have similar cost estimates which are likely to be within 20% of each other. Queens Indirect is expected to be the most expensive of the three options due to it having the longest bridge and the likely additional cost of construction associated with the stopbanks. The Melling Direct option, whilst having the shortest bridge, will also have significant additional costs associated with traffic management and temporary diversions due to building a bridge alongside, and tying into the same location as the existing bridge.

MOST FAVOURED OPTIONS: Melling Direct or Queens Direct

3.5. Weighting Systems

3.5.1. Workshop Weighting

It was recognised by the workshop attendees that not all criteria are of equal importance and that different stakeholders may accord them different importance. There was acceptance that the criteria did not represent a "base case" and there was no benefit in an analysis with all criteria accorded equal weight. This approach is consistent with earlier MCA undertaken in relation to the project[11].

A "Workshop" weighting was sought and led to some debate. The weights for the various criteria arrived at are presented in Table 3-4. This can be regarded as the workshop weighting, based on values of the technical experts[12], as it was performed as part of the workshop process and in the context of the comprehensive scoring exercise which had just been undertaken. Participants were not constrained in terms of an overall weighting, so no 'trade-offs' were made.

Table 3-4: Workshop Weighting

Weighting of Criteria (out of 10)	Transport benefits	Fit with local road system	Visual and landscape impacts	Recreational Functional Amenity	Natural hazards management fit	Landuse effects and opportunities	Urban design opportunities	Consentability	Engineering Degree of Difficulty	Ability to be staged	Cost
Workshop	10	8	7	7	10	4	8	6	7	2	1

The workshop participants determined that the most important aspects were Transport Benefits and Natural Hazards Management Fit. It was important that the preferred option improved the existing safety and efficiency problems for the road network, as well as not undermining the overall purpose of the RiverLink project and its objectives of improving the flood resilience of the Lower Hutt valley.

The next most important criteria were identified as Fit with Local Road System and Urban Design Opportunities. Any changes to the road network layout and local connectivity could not be detrimental to the local road users who would be using it most often. Equally the option also had to fit well with the central city regeneration that was promoted as part of the RiverLink project. Therefore, the similar categories of Recreational Functional Amenity and Visual and Landscape Aspects were weighted closely behind at 7. Engineering Degree of Difficulty was also weighted a 7, noting the difficulty of some elements within the options.

Consentability and 'Landuse Effects and Opportunities' were rated 6 and 4 respectively. Whilst both criteria were recognised by participants as important, it was considered that risks and potential adverse effects could be mitigated (although at additional cost). The two criteria identified as being of lowest importance were Ability to be Staged and Cost. Ability to be Staged had a low weighting as there was no guarantee that it would be necessary, whilst Cost was considered not to be important and should not have much weight in terms of choosing the best option to resolve the identified problems.

[11] 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.

[12] Informed by a high-level understanding of community values.

The workshop attendees were made aware that additional weighting systems would also be developed after the workshop to ensure robustness of outcome, and as a form of sensitivity analysis. The next section explains the basis for these additional weighting approaches.

3.5.2. Additional Weighting Systems

A range of additional weighting systems were developed by Allan Planning and Research Ltd and applied to the workshop scorings. These are based on "quadruple bottom line" considerations[13] but excluded a cultural evaluation (for reasons noted in section 1.3 of this report). An RMA evaluation was also included to reflect the fact that statutory approvals will need to be obtained for the project. These are shown alongside the workshop weighting in Table 3-5 and are further described below.

Alternative Workshop Weighting – A question was raised at the workshop as to the overall justification of having three separate criteria which potentially overlap; Visual and Landscape, Recreational Functional Amenity and Urban Design Opportunities. These three criteria are of importance to major stakeholders, but cover similar aspects and there is a risk that they skew the overall results. It was agreed that the implications of bringing these criteria together as one should be considered. To investigate this concern, an alternative workshop weighting was developed which allocated only one-third of the weight for each of these criteria to the assessment.

RMA Balanced – This reflects the aspects that contribute to the overall evaluation of the project under the RMA. There is just one aspect that was a Section 6 matter reflected in the analysis (Matters of National Importance [h]: The management of significant risks from natural hazards), which was given a weighting 10. Most of the other matters are relevant to RMA considerations and have been weighted at 5, as they were difficult to distinguish between in the current highly modified urban environment where considerable change can be expected. Consentability as a criterion was given no weight (as it is internalised within this weighting system). Engineering Degree of Difficulty and Staging are given less weight as they are effectively transient aspects in RMA terms.

Environment – This weighting system emphasised the physical environment. In this respect, there are no "outstanding" components reflected in any of the criteria, so no high weightings were allocated. The three criteria which most closely reflect environmental outcomes are Visual and Landscape, Urban Design Opportunities and Recreational Functional Amenity, with each given a weighting of 7. The other criteria which have some bearing on the physical environment were included with a weight of 2 or 3 (to distinguish their relative contribution).

Community – This weighting system emphasised the aspects likely to be most important to the community and was informed, in part, by consultation comments. This places most emphasis on Transport Benefits (including non-motorised modes), Natural Hazards Management Fit and Urban Design Opportunities. Other items which are likely to be important to the community have been allocated either a weighting of 6 or 4, with those criteria likely to have the broadest constituency (related to Local Roading Fit, Recreational Functional Amenity and Visual and Landscape Impact) allocated a weighting of 6. Engineering aspects (including Construction Management) drew a significant number of comments although from a relatively small number of people, and both Cost and Consenting were matters of general community interest.

Economic – This weighting system placed full weight on the criteria with a significant economic component e.g. Transport Benefits, Natural Hazards Management Fit and Cost. Given the well-developed surrounding urban area, all other criteria have some economic aspects, so were given some recognition in the weighting. Consentability, Engineering Degree of Difficulty and Fit with Local Roading System were allocated a greater weighting than the other items because of their more direct economic implications.

[13] Environmental, Social, Economic and Cultural.

Table 3-5: Weighting Systems Applied (Includes Workshop Weighting)

Weighting of Criteria (out of 10)	Transport benefits	Fit with local road system	Visual and landscape impacts	Recreational Functional Amenity	Natural hazards management fit	Landuse effects and opportunities	Urban design opportunities	Consentability	Engineering Degree of Difficulty	Ability to be staged	Cost
Workshop	10	8	7	7	10	4	8	6	7	2	1
Alternative Workshop Weighting	10	8	2.3	2.3	10	4	2.6	6	6	6	6
RMA Balanced	5	5	5	5	10	5	5	0	2	2	5
Environment	2	3	7	7	3	2	7	0	0	0	0
Community	10	6	6	6	10	4	10	4	4	0	4
Economic	10	4	2	2	10	2	2	5	5	2	10

3.6. Results of MCA Process

A clear order of preference emerged from the overall analysis using alternative weighting systems. Based on the Workshop Weighting, Queens Direct was the most-favoured option, having the lowest aggregated score. The subsequent additional weighting systems also all identified Queens Direct as the most favoured. In all but the Environmental Weighting, the Queens Indirect option was second favoured and Melling Link least favoured. Figure 3-1 graphically represents the outcome of this process, with the shortest bar indicating the most favoured option.

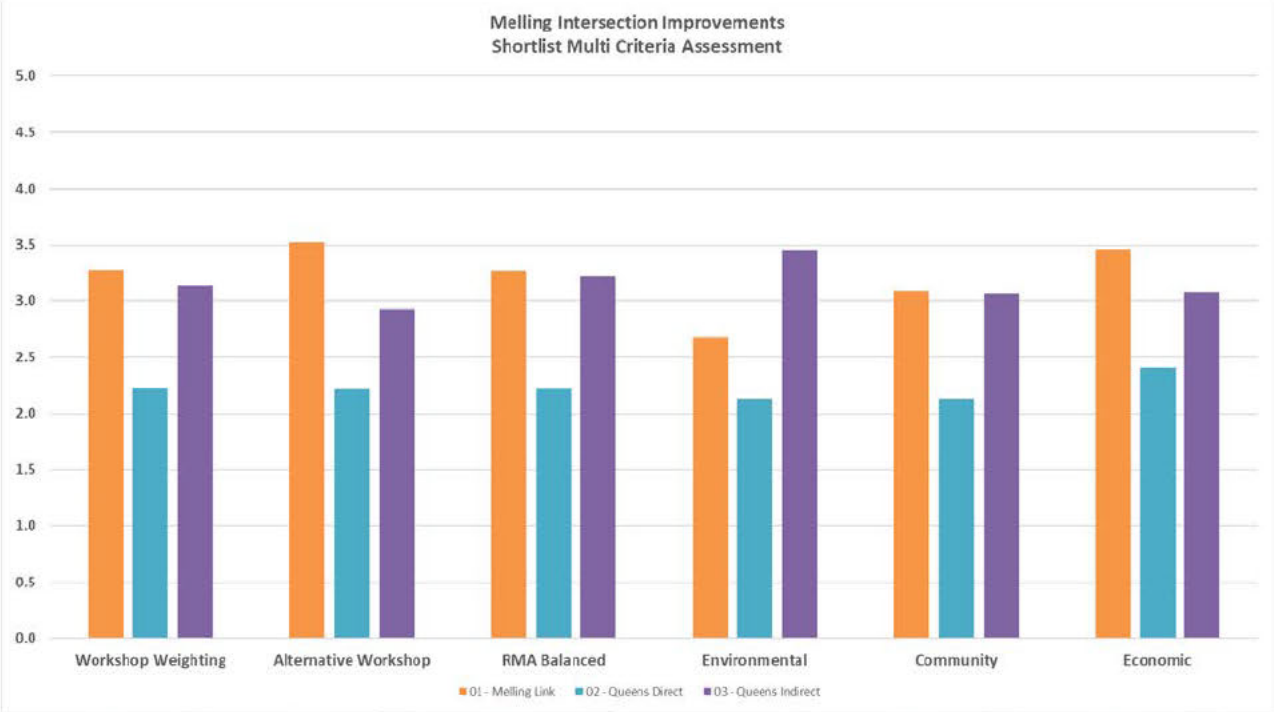

Figure 3-1: Resulting scores from the all weighting systems applied

The analysis was also run with costs excluded and similar results were obtained.

As the scoring process had achieved consensus across the board, there were no alternative scorings that needed to be considered as part of a sensitivity test.

4. Conclusion

This report has set out the multi-criteria analysis process for the Melling Intersection Improvements short list options.

It is clear from the analysis that the Queens Direct option performs the best when considering the wide range of criteria through a comprehensive MCA process.

This option will be presented to the NZ Transport Agency for their consideration alongside other aspects when deciding on a recommended option to present to the Board.

Appendices

Appendix A Pre-circulated Briefing Note, Agenda, Updated Criteria Descriptions and Meeting Notes

Briefing Note – Melling Intersection

MCA Criteria – 3rd Workshop

Introduction

This note covers the preparation for the third workshop for the Melling options. The previous workshops have proceeded as follows:

1. Comprehensive all-day workshop (December 2016). Undertook a fatal flaw exercise (removed two of the 13 options), and then a full MCA, applying and scoring each option on the basis of 12 criteria. Following this workshop, the project team determined to proceed to further investigations on four options.
2. Following a safety audit of the four options, their further development led to seven options (including a sub-option for all but one) and modeling (particularly focused on capacity issues), a review was undertaken on the basis of the key components of the options (February 2018). These components were evaluated on the basis of considerations which were felt to be relevant to distinguishing between the current set of options. While this comprised a multi-criteria assessment, criteria were not numerically scored.

The February 2018 review enabled the seven options to be narrowed down to three – all based on a diamond interchange on SH2 and a similar form of connection between Tirohanga and Harbour View on the west side of SH2.

The differences between the three shortlisted options are quite subtle, but a further MCA exercise is needed to help NZTA identify the preferred option. This is set down for mid-June 2018.

By that stage there will have been public consultation as part of the RiverLink Project. The public are being asked to turn their minds to, and give feedback on, "Where to locate a new bridge?" and "Direct or indirect approach to the bridge". The public are also asked to identify the top three factors they believe are important when identifying a preferred option, why they are important and whether there is anything else that should be considered.

Legal Review of Options Evaluation Completed to Date

s 9(2)(h)

Possible Criteria

The possible criteria (with nominated leaders for each) are listed below. Please note that at this stage we have not included the criteria of Utility for non-motorised travel modes (a criterion which requires consideration of how well the project is able to provide for walking, cycling, and any other modes) and

Railway/bus system utility (a criterion which addressed opportunities for rail and bus system integration and facilities such as park and ride, and potential for their future expansion or extension). Our thinking on these is that there is unlikely to be any significant difference between the options but we would like to discuss these in detail at the start of the workshop and make a decision on whether they should be included as separate criteria, or possibly as a single criterion.

Transport benefits s 9(2)(a) Flow): An overall assessment of the option covering state highway and local road efficiency and ability to modify it in the future (future-proofing), and any benefits to regional road transport. This criterion will also include any safety benefits which can be identified separately amongst the options.

Fit with local road system (s 9(2)(a) - GHD): A criterion that covers the contribution of the option to the management of the local road network, including the opportunities to integrate effectively with the roading hierarchy (present and as could effectively be modified) in the CBD and vicinity.

Visual and landscape impacts s 9(2)(a) Boffa Miskell): This criterion covers the visual impacts on the locality in terms of the river and fault scarp environment. It needs to take into account RMA natural character and amenity considerations from the perspective of both users of public spaces and any nearby residents. As the options to the west of the SH are all the same, the focus will be on how the road/bridge systems will affect the character of the river itself, and effects on views from the city centre and hill suburbs.

Natural hazards management fit (TBC): This criterion takes into account the ability to integrate with GW's flood hazard management, and to address the other natural hazards found in the area. Natural hazards are an RMA management issue for territorial and regional councils, and significant risks form natural hazards are an RMA section 6 matter.

Landuse effects (s 9(2)(a) - Stantec): This is a broad criterion which addresses potential changes in use of land across the project area. It will take into account adverse effects such as loss of access and reduced exposure to passing traffic in some areas, but also opportunities created by release and reparcelling of residual land. It also covers construction impacts on the project's immediate neighbours.

Urban design opportunities s 9(2)(a) Boffa Miskell): This criterion is based on the opportunities that the option creates to strengthen the CBD form and functioning (gateway or identity opportunities) and/or other valued Hutt Valley spaces and places.

Consentability s 9(2)(a) Stantec): This criterion involves a high-level judgement of the issues and consentability given the need to integrate a range of projects and designations and other consents in the three options. (Note – it was found from the first MCA that there was little to distinguish any options in terms of plan provisions and requirements, so this criterion would be scoped slightly differently as the project has moved on).

Engineering degree of difficulty (s 9(2)(a) - Stantec): This criterion covers physical components such as volume and balance of earthworks, structures, complexity of programming and temporary works, access management, risks around "unknowns", any necessary additional provisions to address natural hazards, and general degree of difficulty in construction.

Ability to be Staged (s 9(2)(a) Stantec): This criterion involves consideration of how the separate elements could be programmed and separate elements proceeded with if necessary.

Cost s 9(2)(a) Scoring this criterion is based on an indicative high-level analysis only (note that MCA analysis will be done both with and without costs).

The above descriptions outline a high level explanation of each criterion. However, there will be a need to better define the elements to the criteria and exactly how each specialist will be approaching it. This will be done in advance of the workshop through discussions between the specialist, s 9(2)(a) Each specialist will be asked to prepare their assessment prior to the workshop and present their approach and assessment to the participants for discussion and agreement for scoring. s 9(2)(a) will be responsible for managing the interfaces between criteria. The workshop will need to consider any overlaps, and the extent to which this can be justified.

For earlier MCA workshops, the evaluation concluded that in terms of Tangata Whenua values, there was little to differentiate between the options. On this basis it is not currently proposed that this criterion will be used. However, NZTA is consulting with tangata whenua, and discussing how they could be involved in decision making.

Involving Community Feedback

This is a separate exercise from the MCA, but some of the criteria may be informed by the feedback. It is proposed that the specialists receive early advice of the information from the public consultation process to enable them to include any matters of specific relevance to their topic in their consideration prior to the MCA workshop. The workshop participants will also receive a short briefing on the consultation feedback analysis to date.

Community feedback may also assist in developing the weightings to be used.

Scoring

It is proposed that we apply a 5-scale numeric score as in the first MCA. This will enable numeric evaluation and the application of different weighting systems.

Conclusion

As with previous MCAs, it is proposed to pre-circulate a briefing note and agenda, and each of the specialists will lead the discussion for their criterion so that people can come prepared for an intensive working day. With only three options with many similarities to evaluate, in-depth discussion can be anticipated.

s 9(2)(a)
8rd May 2018

SH2 MELLING INTERSECTION IMPROVEMENTS

Draft Agenda for MCA Workshop on Three Options

Tuesday 19th June 2018, 9:30am-4:30pm
Stantec, Level 13, 80 The Terrace, Wellington

9-9:30am: coffee available – prompt start at 9.30am
12:30-1pm: lunch will be provided

1. Introduction

- Introductions
- Background, update on project progress, consultation preliminary outcomes (Roger Burra, Eddie Anand)
- Confirm agenda (all)

2. Options

- Description and discussion of options and how we got to them ([redacted] s 9(2)(a)

3. MCA Preparation

- Confirm criteria (see Briefing Note dated 8th May – attached)
- Confirm scoring method (see end of Agenda).

4. Discussion, Definition and Scoring of Options by Criteria (see Briefing Note – order to be determined)

- Transport benefits ([redacted] s 9(2)(a)
- Fit with local road system [redacted] s 9(2)(a))
- Consentability [redacted] s 9(2)(a))
- Visual and landscape impacts [redacted] s 9(2)(a)
- Natural hazards management fit [redacted] s 9(2)(a)
- Landuse effects and opportunities ([redacted] s 9(2)(a)
- Urban design opportunities [redacted] s 9(2)(a)
- Engineering degree of difficulty [redacted] s 9(2)(a)
- Ability to be staged [redacted] s 9(2)(a)
- Cost [redacted] s 9(2)(a)

5. Review of Scoring

6. **Weightings Discussion**

7. **General Discussion and Next Steps**

- Report preparation
- Next Steps
- Other matters?

SCORING

We propose to apply the 5-step numerical scale to scoring, as applied in the first Workshop. The preliminary descriptions of the scores are set out below. Because of the similarities of the options, it may be that the full range of scores is not applied for all criteria.

Score	Description
1	The option presents few difficulties on the basis of the criterion being evaluated and may provide significant benefits in terms of the attribute.
2	The option presents only minor aspects of difficulty on the basis of the criterion being evaluated, and may provide some benefits in terms of the criterion.
3	The option presents some aspects of reasonable difficulty in terms of the criterion being evaluated and problems cannot be completely avoided. There are few apparent benefits in terms of the criterion.
4	The option includes clear aspects of difficulty in terms of the criterion being evaluated, and very limited perceived benefits.
5	The option includes significant difficulties or problems in terms of the criterion being evaluated and no apparent benefits.

UPDATED CRITERIA 18.06.18

(FOLLOWING DISCUSSIONS WITH TECHNICAL LEADS)

Transport benefits - An overall assessment of the option covering state highway and local road efficiency and any benefits to regional road transport, and the adequacy and quality of cycling, walking and bus system provision (compared against the current situation). This criterion will also include any safety benefits which can be identified separately amongst the options.

Fit with local road system - A criterion that covers the contribution of the option to the management of the local road network, including the opportunities to integrate effectively with the roading hierarchy (present and as could effectively be modified) in the CBD and vicinity. This criterion differs from the transport benefits criteria, as it focuses on the local network as a system in its own right (ie, receiving and dispatching traffic in the wider Hutt valley).

Visual and landscape impacts - This criterion covers the visual amenity impacts on the locality in terms of the river and fault scarp environment to a range of viewers. It also includes RMA natural character considerations, and biophysical impacts and opportunities.

Natural hazards management fit - This criterion takes into account the ability to integrate with GW's flood hazard management, and to address the other natural hazards found in the area. Natural hazards are an RMA management issue for territorial and regional councils, and significant risks from natural hazards are an RMA section 6 matter.

Landuse effects - This is a broad criterion which addresses potential changes in use of land across the project area. It takes into account adverse effects such as loss of access and reduced exposure to passing traffic in some areas, but also opportunities created by release and reparcelling of residual land. It also covers construction impacts on the project's immediate neighbours.

Urban design and recreational opportunities - This criterion is based on the opportunities that the option creates to strengthen the CBD form and functioning (gateway, identity and wayfinding opportunities) and/or other valued Hutt Valley spaces and places, and to contribute to the CBD's recreational amenity.

Consentability - This criterion involves a high-level judgement of the issues and consentability given the need to integrate a range of projects and designations and other consents in the three options.

Engineering degree of difficulty s 9(2)(a) - Stantec): This criterion covers physical components such as volume and balance of earthworks, structures; complexity of programming and temporary works, traffic and access management during construction; risks around "unknowns"; any necessary additional provisions to address natural hazards, and general degree of difficulty in construction.

Ability to be Staged (s 9(2)(a) Stantec): This criterion involves consideration of how the project's separate elements (as part of the Riverlink Project, and as subsidiary components of the transport interchange project) could be programmed and the implications of proceeding with separate elements if necessary.

Cost s 9(2)(a)): Scoring this criterion is based on an indicative high-level analysis only (note that MCA analysis will be done both with and without costs).

Minutes of Melling Intersection Improvements Project: Workshop 3

Held on 19 June 2018 at the Stantec Office, 80 The Terrace, Wellington.

List of Attendees:

Attendee	Organisation
Roger Burra	NZ Transport Agency
Eddie Anand	NZ Transport Agency
Coral Aldridge	NZ Transport Agency
John Gloag	Hutt City Council
Paki Maaka	Hutt City Council
Alistair Allan	Greater Wellington Regional Council
s 9(2)(a)	Flow
	Boffa Miskell
	Boffa Miskell
	Damwatch
	GHD
	Allan Planning and Research Ltd
	Stantec
	Stantec
	Stantec
	Stantec
	Stantec
	Stantec
	Stantec

The notes below provide a brief summary of the main points of the discussion held at the workshop, under the Agenda headings.

Introduction

The following background information on parallel project work was relayed to the attendees.

Consultation

Eddie Anand briefly summarised the recent Riverlink consultation that ran for five weeks in May, based on the three options.

Hutt City community very well engaged and wanted to be involved. They knew the problems. 350+ submissions. The main concerns which related to MCA criteria were:

1. Transport benefits
    a. Congestion, cyclists connections
    b. Didn't think Tirohanga Road was connected in
2. Engineering degree of difficulty
    a. Don't want much disruption during construction
3. Natural environment fit
    a. How does traffic integrate into local traffic?
    b. Connect to train station

Paki Maaka noted younger people are looking to the future about living in Hutt City and want a connected transport network.

Questions raised about the Queens Drive connection – noted potential height of road over stopbank that may require a substantial lift of Rutherford Street.

- Direct +2.5m lift
- Indirect +5.0m lift

Flood Bank Protection Phasing

Current thinking in regards to Riverlink constructing phasing involves starting on city side from north to south then back up the western side, to give more time to acquire land/buildings in Pharazyn Street vicinity and NZTA more time to decide on interchange form/design.

Criteria

It was suggested that a new criterion be included to allow consideration of Recreation aspects. Originally, this was considered to be included in Urban Design but the group agreed it is appropriate to have this as a separate criterion. How this is weighted would be discussed later in the workshop.

MCA Discussion Summary

The following notes cover each of the criteria covered in the agenda.

1. Transport Benefits

- Overall travel time: all options similar for all modes, state highway similar benefit for all options too.
- Local travel effects: all similar; however,
    - concerns around the five-leg intersection in Queens Direct option, modelling doesn't show too much of a problem but concerns from technical point of view that it could fall over. Therefore, it scored lower.
    - Also safety concerns of five leg intersection
    - The above two points were the biggest concerns from a transport perspective.
- Walking / cycling is similar for all options. Queens Indirect option has better route to train station, so is slightly preferred.
- Public transport: Queens Indirect option has better bus options for Melling, as takes buses nearer station

Eddie Anand: Public thought three traffic lights was less desirable than two, as well as the fact that it feels like you would be driving back on yourself if travelling from Wellington direction.

2031 modelled with Petone to Grenada included, which increases volume. Hutt City Council noted there is currently suppressed demand at Melling (due to rat running to avoid current delays), which could be as high as 40%.

2. Fit with Local Road System

Sub criteria:

1. Pharazyn St and Block Road connectivity
2. Eastern access route connectivity
3. Local network connectivity
4. Legibility / directness

- Riverlink takes out the western access link (Daly Street)
- Demand from SH2 to Gracefield – keen for an Eastern Access Route to better define the through route and define the CBD boundary (alongside the land use planning).
- Eastern Access has higher importance now with the pending loss of the western access
- The more direct the PT network, the better for HCC

3. Urban Design and Recreational Opportunities

Assumes a high quality bridge and existing bridge removed.

Integration with the river was important.

The existing roundabouts are not very intuitive from legibility perspective.

Opportunity to put pedestrian bridge over SH2 should be investigated.

4. Visual and Landscape Impacts

The Melling Link location is the best, by a small margin, as there is already a bridge there.

The Queens Indirect is a lot worse than Queens Direct option due to the road running above the stopbank.

If the Queens Indirect link was able to be constructed as part of the stopbank then the impacts may be slightly better.

5. Recreation

This is a very popular stretch of river corridor and new bridges will impact on this.

The recreation area where carpark / market is held, has high importance for locals. Concerns about shading and noise from bridge above this public area.

6. Natural Hazards

Moving the bridge south, splits the traffic problem location from the flood problem location, rather than being in the same space.

Waterway

- Melling link connection locks in the existing river channel constriction for another 100 years approximately. Ideally would like flexibility to widen this at a later date.
- Melling Link would also introduce an additional set of piers into the waterway due to the construction phasing
- Queens Drive allows for future opportunities to move stop banks into Harvey Norman site etc.

Melling Link nearly a fatal flaw with respect to flood risk, as it leaves the major flood constriction in the Hutt River that currently exists.

Seismic Hazard

No issue for MCA – same hazard for all three options

Tsunami Hazard

No issue for MCA – same hazard for all three options

All tsunami effects were captured in the waterway and stopped by about Melling Link. Unlikely to be greater than 2,800m3 which floodway is designed for.

7. Consentability

RMA Section 6 – Management of a significant risk from a natural hazard. Melling Link would be the worst performing for that regard, as the new bridge location was not significantly improving a significant risk from a natural hazard compared to the other options. The other two options allow for improvements at that constricted location.

Apart from Section 6, each of the options were similar.

2,800m3 floodway area capacity generally provides a higher standard than elsewhere in New Zealand, when designing for flood mitigation, but noted the consequence of overtopping here was high.

8. Landuse Effects and Opportunities

The possible 5.0m lift at the Rutherford roundabout (for the Queens Indirect Option) has major adverse effects for existing land use adjacent to the road, particularly the closer you are to the intersection.

The Queens Indirect Option leaves a land parcel between interchange and on-ramp southbound. Southbound on-ramps for the other two options, goes through this parcel and leaves no surplus land. Parcel could be used as a skate park or something, so not completely wasteful.

With Queens Drive options, the old bridge location gives an opportunity for a new connection to the river.

There was less confidence in this scoring, with attendees finding it hard to score – having to balance the adverse effects vs the opportunities.

Discussion that temporary affects should all be considered as neutral in the time scale of a 100 year project.

A question was raised about a bridge extension to flyover Rutherford roundabout into High Street. Local traffic could then travel on Rutherford, but that was discarded previously by the project team due to the impacts on the CBD.

9. Engineering Degree of Difficulty

Ease of design was defined as trying to avoid a lot of design compromises that might be necessary for certain design layouts. Not just the short-term period of creating the design, it was the legacy of design decisions that everyone must use/cater for over the life of the structures/roads.

Noted light rail not really an option across the bridge into Lower Hutt. It is more likely in the future that an extension of the rail continues to the north and connects back to Wairarapa Line.

Melling Link option poses the biggest challenge, as need to remove segments of the existing bridge to enable construction to continue.

Walking and cycling was similar for all options.

10. Staging

All three options are judged as equal.

Bridge and interchange needs to be built after stopbank, so that the stopbank is compacted properly, hard to compact material with heavy plant under a new bridge when at the same height as top of stopbank.

Transport Improvements

Constructing a new interchange ahead of a bridge is not feasible due to height differences of the interchange and the existing Melling Link Bridge.

Staging of bridge first so that flood protection can be achieved is technically feasible. However, that type of staging would be very bad for efficiency of the SH2 intersection, worse than it is now. Harbour View Road could be seagull or a signalised T-junction onto existing SH2, in that scenario.

11. Cost

Comes mainly down to bridge length as the main differentiator, with all other costs being similar between options.

Appendix B Background Paper – Transport Benefits

flow
TRANSPORTATION SPECIALISTS

SH2 Melling Interchange

Transport Assessment of Options

June 2018

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EXECUTIVE SUMMARY

Flow Transportation Specialists Ltd, as sub consultants to Stantec, have been commissioned by the New Zealand Transport Agency (Transport Agency), to prepare a Transport Assessment of options under consideration for the SH2 Melling Interchange.

The assessment has been informed by a series of traffic models, including the North Wellington SATURN model for the area wide effects, and a small PARAMICS model to assess the local, detailed operational effects.

The SATURN model has been run with the Petone to Grenada project assumed to be in place before 2031. The PARAMICS models will need to be rerun without the changes in demands due to that project, at some time, but it was considered sensible to test the options with higher rather than lower flows, at this stage.

The following three options have been shortlisted for assessment:

- Option 9 (also termed "the Queens Direct option"): this would include a diamond interchange at Melling (i.e. two signalised intersections, which will operate under one controller), to the west of the existing SH2 intersections, with a new four lane bridge passing over the Hutt River to tie into the intersection of Rutherford Street/Queens Drive. Tirohanga Road would tie into Harbour View Road, to the east of the motorway, with Harbour View Road forming the northern leg at the diamond interchange. On the south western side, Block Road would tie into the southern intersection as a fifth arm
- Option 9A (also termed "the Melling option"): this would be very similar to Option 9 in most respects, with a diamond interchange at Melling. However, the new four lane bridge over the Hutt River would tie into the Rutherford Street/Melling Link intersection, as is the case with the existing bridge
- Option 9B (also termed "the Queens Indirect option"): this would also be similar to Option 9, in most respects, with a diamond interchange at Melling. However, the southern link from the interchange would veer round to the west, to an additional signalised intersection with Block Road, the westbound on ramp to SH2, and the new bridge. The bridge itself would tie into Rutherford Street/Queens Drive just to the west of the existing intersection. Therefore the main differences (between Option 9 and 9B) are that Option 9 would have two signalised intersections, with the southern one having five arms, while Option 9B would have three signalised intersections, none with five arms.

Overall Travel Times

The outputs from the traffic models indicate that all three options will lead to significant overall travel time savings. If Option 9A is assumed to be the "central" option, then Option 9 is predicted to lead to slightly greater overall travel time benefits, while Option 9B is predicted to lead to slightly less travel time benefits. However, the differences are predicted to be quite modest (with both Options 9 and 9B within 5% of Option 9A), meaning that the three options have been scored equally on this category.

Operation of State Highway

Significant congestion is predicted on the State Highway in the weekday morning and evening peaks, with the Do Minimum scenario for the year 2031. Therefore all three options are predicted to provide significant travel time savings for through traffic along SH2.

Local Traffic Effects

The SATURN model indicates that the options will attract some additional traffic onto the State Highway, with corresponding reductions in flows on the local road network. The local effects of the three options are predicted to be as follows:

- Options 9 and 9A are predicted to lead to quicker travel times on a number of routes than Option 9B, although Option 9B is predicted to offer quicker times for traffic between Lower Hutt and SH2 south
- However, the five leg intersection on the southern side of the interchange, with Options 9 and 9A, is of some concern as it will be operationally complex, and Option 9B will separate some of the traffic movements away from the main interchange
- The local effects of the options within the Lower Hutt centre are clearly different, with Options 9 and 9B tieing into Queens Drive/Rutherford Street, while Option 9A will tie into Melling Link/Rutherford Street.

Of the above issues, we consider that Option 9B is preferable in terms of the efficiency of local traffic, due to the greater complexity of the signal phasing at the five leg signalised intersection that would form part of Options 9 and 9A.

Safety Issues

It is expected that all three options will significantly improve the safety performance of both the State highway and the local traffic network, by reducing the significant traffic flow breakdown predicted in the Do Minimum, and by separating through traffic from local traffic at the interchange. However, at a more local level:

- It is considered that Option 9 and 9A will offer similar crash reduction benefits as they will have similar layouts at the main interchange. However, the five leg intersection on the southern side of the interchange with these options may represent a safety issue, as such layouts are quite complex, and may not be comprehensible for all users
- Option 9B will avoid the provision of a five leg intersection. However, it will instead lead to an additional signalised intersection (i.e. three closely spaced signalised intersections) on the connection between Lower Hutt and the SH2 interchange.

Of the above issues, we consider that the provision of a five leg intersection with Options 9 and 9A means that Option 9B is preferable from a safety point of view.

Provision for Walking and Cycling

The benefits of the options for walking and cycling will generally be similar for all three options. However, at a local level, there are the following differences for pedestrians/cyclists:

- Options 9 and 9A will offer more direct connections for pedestrians and cyclists travelling between Lower Hutt and either Harbour View Road or Tirohanga Road
- However, Option 9B will provide a more direct connection between Lower Hutt and the rail station, for those pedestrians/cyclists using the main bridge which is to be used by general traffic
- The spacing between the general traffic bridge and the pedestrian/cycle bridge will be greater with Option 9A, indicating a slight preference in terms of connectivity for pedestrians and cyclists, across the river.

Based on the above points, we consider that the overall performance of the options for pedestrians and cyclists is similar.

Provision for Public Transport

The following comments are provided on the effects of the options on public transport:

- The relocation of the rail station, to the west, will be required for all three options, to a location which is consistent across the options. The new rail station will be served by a pedestrian/cycle bridge across the river, with all options
- Option 9B will offer a more direct connection for buses from Lower Hutt to the rail station
- However, Options 9 and 9A will offer a more direction connection between the rail station and bus services to/from SH2 North.

Based on the above points, we consider that the overall performance of the options for users of public transport is very similar.

Overall Assessment

A summary of the transport effects of the short listed options is provided in Table ES1.

It should be noted that the relative effects of the different connections on circulation within the Lower Hutt centre along with urban design issues, are being considered by other participants to the multi criteria analysis.

Table ES1: Summary of Transport Effects

Benefit	Option 9	Option 9A	Option 9B
Overall Travel Times	1	1	1
State Highway	1	1	1
Local Traffic	3	3	2
Safety	3	3	2
Walking/cycling	2	2	2
Public Transport	2	2	2
Overall	**2**	**2**	**1**

The scores are based on a ranking of 1 to 5, with 1 being a very good outcome, and 5 being very poor. It is not desirable to simply add up the scores to derive a mathematical average score for each option.

It is considered that Option 9B is preferable from an overall transportation perspective, primarily on the basis that it would avoid the potential operational inefficiencies and potential safety issues associated with the five leg signalised intersection that would form part of Options 9 and 9A.

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1 INTRODUCTION

Flow Transportation Specialists Ltd, as sub consultants to Stantec (formerly MWH), have been commissioned by the New Zealand Transport Agency (Transport Agency), to prepare a Transport Assessment of options under consideration for the SH2 Melling Interchange.

2 EXISTING SITUATION

Details regarding the existing situation were set out in the MWH Report "Melling Interchange IBC: Problems, Opportunities and Constraints" (October 2016).

That report set out the existing problems as:

- Safety, and the report provided details of the crash records for the period 2011-2015
- Reliability, and the report provided details of existing daily flows, travel speeds and queues
- Modal choice/accessibility, and the report provided details of the multi modal connections for the area
- Availability, and the report provided details of the number of unplanned events between 2011 and 2015, including crashes and floods.

3 TRANSPORT MODELLING

This assessment has made use of two tiers of traffic modelling: the North Wellington SATURN model and a PARAMICS microsimulation model of Melling.

3.1 North Wellington SATURN Model

The North Wellington SATURN model (NWSM) was developed by Jacobs and it has been used for the assessment of several transport projects, including the Transmission Gully and Petone to Grenada projects.

The model was satisfactorily validated to a base year of 2011.

This study has used forecasts for 2031. Details of the network assumptions are included at Section 4 below.

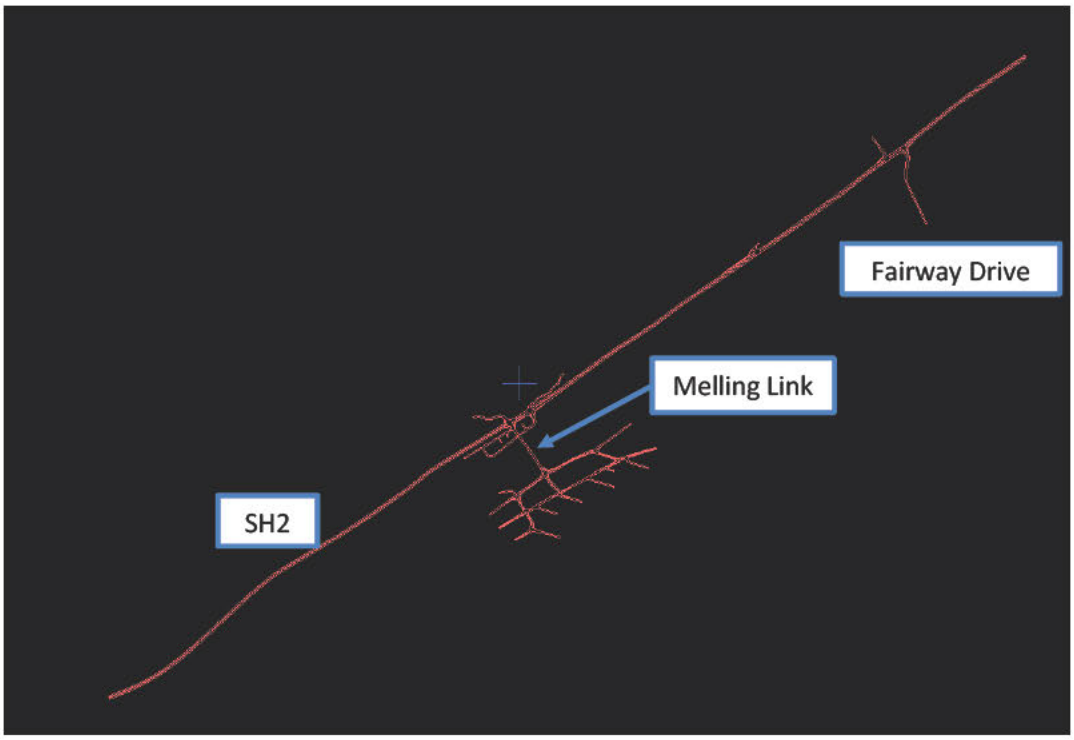
The changes in forecast demands (between the base and forecast models) in the NWSM are derived from the Wellington Transport Strategic Model (WTSM).

3.2 PARAMICS Model

The Melling PARAMICS model was originally developed by GHD. It originally included a fairly limited length of SH2, so it was extended in 2017 for this study, to ensure that the effects of options for the Melling interchange on upstream and downstream bottlenecks could be taken into account.

The area of the extended model is shown in Figure 1.

Figure 1: PARAMICS Model Extent



The extended model was revalidated to a base year of 2012 (with some data from 2013). Details regarding the validation were provided within a previous report by Flow.

4 DO MINIMUM SCENARIO

4.1 Network Changes

Away from the Melling Interchange, the SATURN model includes the assumed completion of the Transmission Gully project (assumed to be complete by 2021) and the Petone to Grenada project (assumed to be complete by 2031).

At the Melling interchange itself, the Do Minimum scenario assumed within the SATURN model is the existing layout. (This is different from the 2017 assessment, which included the short term improvements previously recommended by GHD).

In the PARAMICS models, the various roundabouts within the Lower Hutt City Centre are assumed to change to signal control, based on layout plans provided by Stantec.

4.2 Forecast Demands

The forecast growth in the PARAMICS models has been derived from the NWSM, which in turn gets inputs from the WTSM (see Section 3.1 above).

5 OPTION ASSESSMENT

5.1 Options

The following three options were shortlisted for further assessment:

- Option 9, also referred to as "the Queens Direct option": this would include a diamond interchange at Melling (i.e. two signalised intersections, which will operate under one controller), to the west of the existing SH2 intersections, with a new four lane bridge passing over the Hutt River to tie into the intersection of Rutherford Street/Queens Drive. Tirohanga Road would tie into Harbour View Road, to the east of the motorway, with Harbour View Road forming the northern leg at the diamond interchange. On the south western side, Block Road would tie into the southern intersection as a fifth arm
- Option 9A, also referred to as "the Melling option": this would be very similar to Option 9 in most respects, with a diamond interchange at Melling. However, the new four lane bridge over the Hutt River would tie into the Rutherford Street/Melling Link intersection, as is the case with the existing bridge
- Option 9B, also referred to as "the Queens Indirect option": this would also be similar to Option 9, in most respects, with a diamond interchange at Melling. However, the southern link from the interchange would veer round to the west, to an additional signalised intersection with Block Road, the westbound on ramp to SH2, and the new bridge. The bridge itself would tie into Rutherford Street/Queens Drive just to the west of the existing intersection. Therefore the main differences (between Option 9 and 9B) are that Option 9 would have two signalised intersections, with the southern one having five arms, while Option 9B would have three signalised intersections, none with five arms.

Plans of the options are provided at Appendix A.

5.2 Modelling of Options

The Do Minimum scenario and one of the options (Option 9) have been assessed in the SATURN model. It is assumed that the area wide traffic effects will be similar for Options 9, 9A and 9B, as these will all provide a grade separated interchange at Melling. However, all three short listed options (plus the Do Minimum scenario) have been assessed in more detail in PARAMICS.

5.3 Transport Assessment Criteria

The transport assessment criteria to be used for the multi criteria analysis, are as follows:

- Overall travel times
- Operation of State Highway
- Operation of local road network
- Safety benefits
- Provision for walking and cycling
- Provision for bus and rail integration

6 TRAFFIC MODELLING RESULTS

This section of the report sets out the results of the traffic modelling, considering the area wide (SATURN) results first, then focussing on the more detailed (PARAMICS) results in the vicinity of the Melling Interchange itself.

6.1 SATURN Results

6.1.1 Network Wide Outputs

Statistics indicating the network wide performance of the Do Minimum and Option 9 are outlined in Table 1.

Table 1: Network Summary Statistics: Morning Peak

Period	Model	Total Travel Time (hr)	Total Travel Distance (km)	Average Speeds (kph)
Morning Peak	**Do Minimum**	11,800	556,400	47.1
	Option	11,500	556,900	48.4
Inter Peak	**Do Minimum**	6,100	353,600	57.9
	Option	6,050	353,800	58.4
Evening Peak	**Do Minimum**	13,150	610,100	46.4
	Option	12,650	608,000	48.0

The above table indicates that the Option will lead to significant overall travel time savings. These are predicted to be quite modest during the weekday interpeak, more significant during the morning peak, and greater still during the evening peak. This reflects the fact that significant congestion is predicted in the Do Minimum scenario in the 2031 evening peak.

6.1.2 Traffic Flow Differences

Figure 2 below provides a comparison of the two-way average daily flow (AADT) between the Do Minimum and the Option. The blue bands indicate the road sections with reduced traffic flows in the option while the green bands indicate increased traffic demands. Only the changes greater than 500 vehicles per day have been shown in this figure.

Figure 2: Predicted AADT Differences between Do Minimum and Option (vehicles per day, sum of both directions)

The above plot shows green lines where increases in flows are forecast as a result of the Project, with blue lines shown where decreases are forecast. It should be noted that the model networks are different in and around the Melling Interchange itself, and given the resulting inconsistencies in the networks, the local differences are not shown in this plot. However, the plot indicates that increased flows are predicted on the State Highway, with decreases on several of the local roads. Local to the project, the model shows the expected changes in routing within the Lower Hutt centre, due to the provision of a new bridge connecting with Queens Drive with Option 9, replacing the existing bridge to Melling Link.

6.2 PARAMICS Results

6.2.1 Network Wide Outputs

Statistics indicating the performance of each of the options are outlined in Tables 2-4, along with comparison against the Do Minimum.

Table 2: Network Wide Outputs: Morning Peak

Metric	Do Min	Option 9	Option 9A	Option 9B
Mean Delay	490	340	330	300
Total Distance (m)	65,100	82,650	83,100	83,500
Total Number Vehicles	24,800	28,050	28,100	28,350
Mean Speed (kph)	19	32	32	35
Total network travel time (hrs)	3,380	2,620	2,600	2,370

Table 3: Network Wide Outputs: Inter Peak

Metric	Do Min	Option 9	Option 9A	Option 9B
Mean Delay	200	180	190	200
Total Distance (m)	46,150	51,000	51,350	51,100
Total Number Vehicles	19,000	20,350	20,300	20,300
Mean Speed (kph)	44	51	47	44
Total network travel time (hrs)	1,050	1,010	1,090	1,150

Table 4: Network Wide Outputs: Evening Peak

Metric	Do Min	Option 9	Option 9A	Option 9B
Mean Delay	820	380	370	380
Total Distance (m)	60,200	89,000	89,650	89,650
Total Number Vehicles	25,050	32,000	32,200	32,200
Mean Speed (kph)	11	26	27	26
Total network travel time (hrs)	5,690	3,420	3,340	3,430

The above outputs could be misleading, and it needs to be noted that they only relate to the area of the PARAMICS model, and the SATURN model indicates that the project will lead to traffic being attracted into the Melling area. This is reflected in the increases in the total numbers of vehicles in the above tables, for the three options. Thus the apparent increases in total travel times and distances indicates for the options are not necessarily indicating disbenefits, and in fact the tables indicate that the three options will lead to increases in average speeds, and the following points are noted:

- Option 9B is predicted to lead to the highest average speeds in the morning peak
- Option 9 is predicted to lead to the highest average speeds in the inter peak
- All three options are predicted to operate similarly in the evening peak.

6.2.2 Travel Time Outputs

Predicted travel times for routes through the Melling Interchange are presented in Tables 5 to 7.

Table 5: Predicted Travel Times: Morning Peak

Route	Do Min	Option 9	Option 9A	Option 9B
1: SH2 North to South	09:50	02:30	02:30	02:30
2: SH2 South to North	03:30	02:30	02:30	02:30
3: Lower Hutt to SH2 South	02:50	02:15	02:15	02:30
4: SH2 South to Lower Hutt	14:45	03:10	04:10	03:50
5: Lower Hutt to SH2 North	03:50	02:50	03:00	02:50
6: SH2 North to Lower Hutt	10:40	02:50	03:15	04:00

Table 6: Predicted Travel Times: Inter Peak

Route	Do Min	Option 9	Option 9A	Option 9B
1: SH2 North to South	03:20	02:25	02:25	02:25
2: SH2 South to North	03:10	02:30	02:30	02:30
3: Lower Hutt to SH2 South	02:05	02:35	02:20	02:00
4: SH2 South to Lower Hutt	02:40	03:10	03:45	03:05
5: Lower Hutt to SH2 North	02:50	02:15	02:00	02:30
6: SH2 North to Lower Hutt	02:35	02:15	02:55	02:50

Table 7: Predicted Travel Times: Evening Peak

Route	Do Min	Option 9	Option 9A	Option 9B
1: SH2 North to South	13:10	02:25	02:25	02:25
2: SH2 South to North	07:15	02:40	02:40	02:40
3: Lower Hutt to SH2 South	02:45	02:55	02:55	02:20
4: SH2 South to Lower Hutt	07:40	03:45	03:55	04:50
5: Lower Hutt to SH2 North	05:40	03:15	03:15	03:05
6: SH2 North to Lower Hutt	11:15	02:50	02:50	04:00

Analysis of the results indicates the following:

- Severe congestion is predicted in the Do Minimum scenario in the morning and evening peaks
- The Do Minimum scenario is predicted to operate reasonably well during the inter peak
- All options are predicted to result in similar travel time savings on SH2 between north and south, as expected
- For travel times between Lower Hutt to SH2 South, similar travel times are predicted for all options in the morning peak. However the quickest travel times in both the inter peak and evening peak are predicted with Option 9B. This is a result of the direct connection from the new Melling Bridge to the SH2 southbound on ramp

- For journeys from SH2 south to Lower Hutt, Option 9 is predicted to offer the quickest travel times in the morning peak, with similar times for Options 9 and 9A in the evening peak. Option 9B is predicted to have the longest travel times in the evening peak, due to the additional distance and the proposed additional signals between the SH2 interchange and Lower Hutt area
- Similar travel times are predicted from Lower Hutt to SH2 North for all three options, in all three time periods
- The quickest travel times from SH2 North to Lower Hutt are predicted with Option 9, in the morning and inter peak period. Similar times are predicted for Options 9 and 9A in the evening peak.

6.2.3 Queues

Queue plots are provided at Appendix B. These need to be viewed with a degree of caution, as even though we have sought to provide comparable plots, they represent only a snapshot for each model, at a particular point in time. The plots indicate the following:

- No or very little congestion is predicted during the Interpeak for all options, and although queues are observed in the inter peak in the Do Minimum, the extent of the queues is mostly local and they do not extend to adjacent intersections
- Significant queuing on SH2 can be observed in the Do Minimum model in both the morning and evening peaks. It is predicted that the northbound queues extending back from the SH2/Melling Link intersection will reach Rutherford Street in the evening peak, result in a gridlock situation in the Lower Hutt area
- Queues on the motorway ramps are predicted to remain within the length of ramps i.e. not extending back on the motorway mainline. It is also observed in all three options that queues are predicted on Rutherford Street and Queens Drive east and south of the interchange respectively, due to the increased demands predicted with the option layout. However, these queues are not to the extent to create gridlock within the CBD.
- Queues in Option 9 are predominately observed on the new Melling Bridge in the northbound direction in the evening peak. These may sometimes extend back to the Rutherford Street intersection, however queues will not extend to adjacent intersections in most cases. In the morning peak, queues are mostly observed on the southbound off ramp due to the high number of trips heading towards Pharazyn Street (realigned).
- Queues observed in Option 9A models are similar to those observed in Option 9. It is noticed however the southbound queues on the Melling Bridge are predicted to be slightly longer as vehicles heading towards Queens Drive will have to turn right at the intersection, as opposed to going straight through using the layouts proposed in Option 9 and 9B
- Option 9B is predicted to lead to greater northbound queues on the new Melling bridge during the evening peak periods, compared to the above two options. This is due to a slightly shorter bridge between Rutherford Street and the proposed SH2 Southbound On Ramp/Pharazyn Street intersection, and therefore queues are more likely to extend back to Rutherford Street during the evening peak hour.

7 OPTION EVALUATION

The options have been assessed in accordance with the criteria identified at Section 5.3.

7.1 Overall Travel Times

Table 1, within Section 6.1, indicated that grade separation at Melling will offer significant area wide travel time savings, while Tables 2 to 4, within Section 6.2, indicated that the three short listed options will offer significant travel time savings within the area of the PARAMICS model. Given that this assessment is primarily being prepared in order to enable a comparative assessment of the three options, the more detailed information within Tables 2 to 4 is useful.

The total travel times over the three modelled time periods have been used to derive total daily travel times, for weekdays, using the simple "rule of thumb" that total daily travel times can be derived from the following formula:

- Total daily travel times = (2 x morning peak hour) + (11 x inter peak hour) + (2 x evening peak hour).

On this basis, if Option 9A is assumed to be the "central" option, then Option 9 will lead to 3% less overall travel time on a weekday (ie 3% greater travel time benefits) while Option 9B will lead to 2% more travel time (i.e. 2% less travel time benefits).

The above is simplistic in that it assumes that travel times across the day can be valued equally, and it only includes weekdays. The analysis has been rerun to derive a total value of travel times in 2031. M This has used the annualisation factors (i.e. hours per year) that were used in the previous economic analysis, and the monetary values of time for each time period (i.e. dollars per hour, including those for weekdays and weekends) that are set out in the Economic Evaluation Manual (incorporating the latest updated factors from late 2017). . This method leads to quite similar values to those presented above: if Option 9A is assumed to be the "central" option, then Option 9 will lead to 4.5% less travel time (ie 4.5% greater travel time benefits) while Option 9B will lead to 3.5% more travel time (i.e. 3.5% less travel time benefits). The slightly greater differences between the options results from the use of the weekday inter peak models to derive estimates of weekend benefits, and also from the greater values of time (according to the EEM) for travel in the weekday inter peak.

Nevertheless, it can be concluded that the overall travel time benefits of the three options are very similar.

7.2 Operation of State Highway

Significant congestion is predicted on the State Highway in the weekday morning and evening peaks, with the Do Minimum scenario for the year 2031. Therefore all three options are predicted to provide significant travel time savings for through traffic along SH2.

7.3 Local Traffic Effects

The local effects of the three options are predicted to be as follows:

- The SATURN model indicates that the options will attract some additional traffic onto the State Highway, with corresponding reductions in flows on the local road network
- Options 9 and 9A are predicted to lead to quicker travel times on a number of routes than Option 9B, although Option 9B is predicted to offer quicker times for traffic between Lower Hutt and SH2 south
- However, the five leg intersection on the southern side of the interchange, with Options 9 and 9A, is of some concern as it will be operationally complex, and Option 9B will separate some of the traffic movements away from the main interchange
- The local effects of the options within the Lower Hutt centre are clearly different, with Options 9 and 9B tieing into Queens Drive/Rutherford Street, while Option 9A will tie into Melling Link/Rutherford Street. The relative merits of these connections is being considered by other participants to the multi criteria analysis.

Of the above issues, we consider that the provision of a five leg intersection with Options 9 and 9A means that Option 9B is preferable in terms of the efficiency of local traffic, due to the greater complexity of the signal phasing at a five leg signalised intersection.

7.4 Safety Issues

It is expected that all three options will significantly improve the safety performance of both the State highway and the local traffic network, by reducing the significant traffic flow breakdown predicted in the Do Minimum, and by separating through traffic from local traffic at the interchange. However, at a more local level:

- It is considered that Option 9 and 9A will offer similar crash reduction benefits as they will have similar layouts at the main interchange. However, the five leg intersection on the southern side of the interchange with these options may represent a safety issue, as such layouts are quite complex, and may not be comprehensible for all users
- Option 9B will avoid the provision of a five leg intersection. However, it will instead lead to an additional signalised intersection (i.e. three closely spaced signalised intersections) on the connection between Lower Hutt and the SH2 interchange.

Of the above issues, we consider that the provision of a five leg intersection with Options 9 and 9A means that Option 9B is preferable from a safety point of view.

7.5 Provision for Walking and Cycling

The benefits of the options for walking and cycling will generally be similar for all three options, on the northern side of the bridge. Mitigation measures that could be applied to one option (such as provision for cyclists within the State highway corridor) could also be applied to the other options.

We understand that the relocation of the rail station, to the west, will be required for all three options, to a location which is consistent across the options. Also we understand that a pedestrian/cycle bridge is proposed across the river, with all options, from a point on Rutherford Street, west of Queens Drive, to the new rail station.

However, at a local level, there are the following differences for pedestrians/cyclists:

- Options 9 and 9A will offer more direct connections for pedestrians and cyclists travelling between Lower Hutt and either Harbour View Road or Tirohanga Road
- However, Option 9B will provide a more direct connection between Lower Hutt and the rail station, for those pedestrians/cyclists using the main bridge which is to be used by general traffic
- The spacing between the general traffic bridge and the pedestrian/cycle bridge will be greater with Option 9A, indicating a slight preference in terms of connectivity for pedestrians and cyclists, across the river.

Based on the above points, we consider that the overall performance of the options for pedestrians and cyclists is similar.

It is assumed that the relative merits of the different connections to the Lower Hutt centre, along with urban design issues, are being considered by other participants to the multi criteria analysis.

7.6 Provision for Public Transport

The following brief comments are provided on the effects of the options on public transport:

- As noted above, we understand that the relocation of the rail station, to the west, will be required for all three options, to a location which is consistent across the options
- Also we understand that a pedestrian/cycle bridge is proposed across the river, with all options, from a point on Rutherford Street, west of Queens Drive, to the new rail station
- Option 9B will offer a more direct connection for buses from Lower Hutt to the rail station
- However, Options 9 and 9A will offer a more direction connection between the rail station and bus services to/from SH2 North.

Based on the above points, we consider that the overall performance of the options for users of public transport is very similar.

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APPENDIX A Option Plans

APPENDIX B PARAMICS Model Queue Plots

Figure B1: Typical Queues Predicted by PARAMICS – Do Minimum: Morning Peak

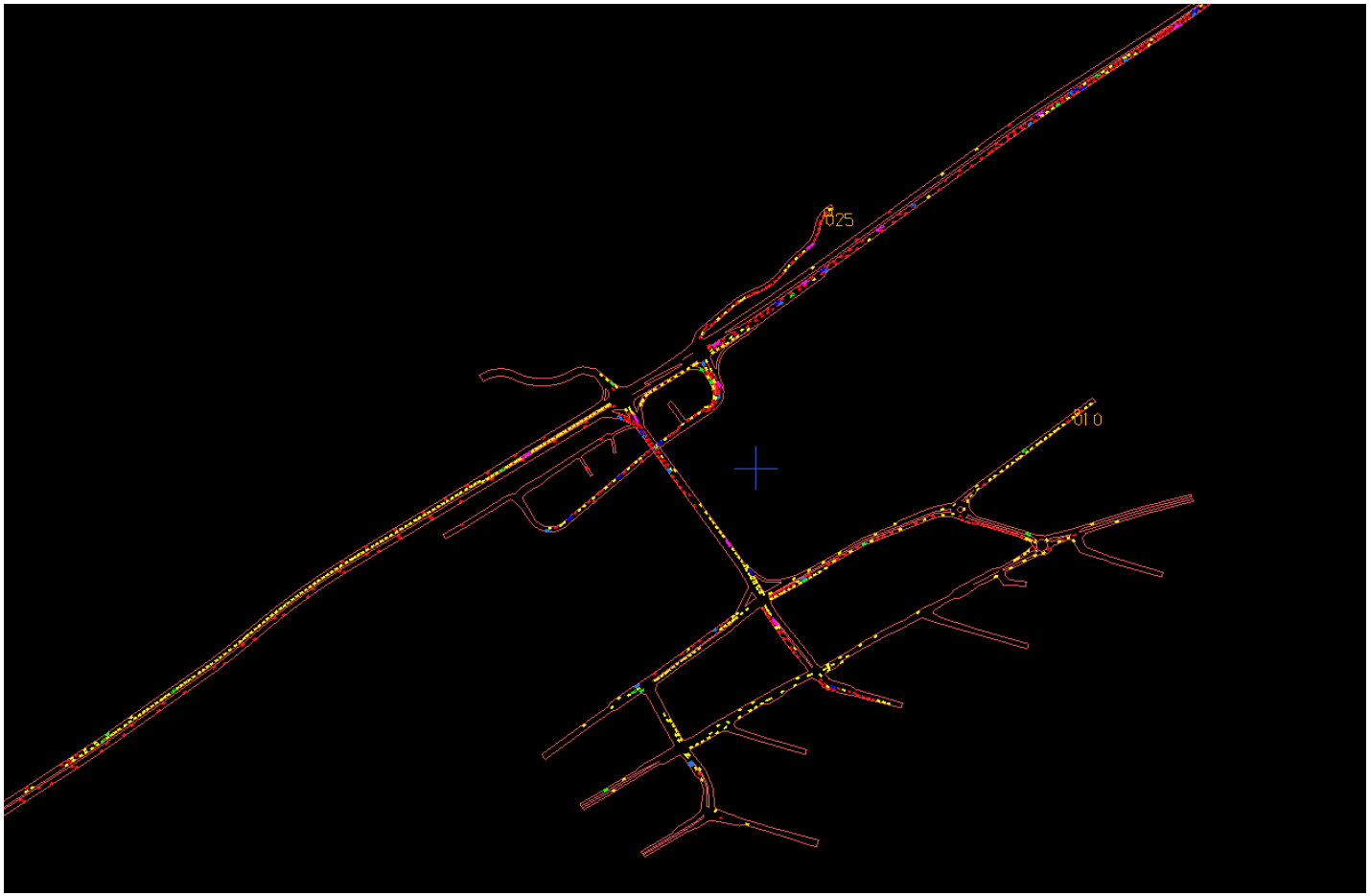


Figure B2: Typical Queues Predicted by PARAMICS – Do Minimum Inter Peak

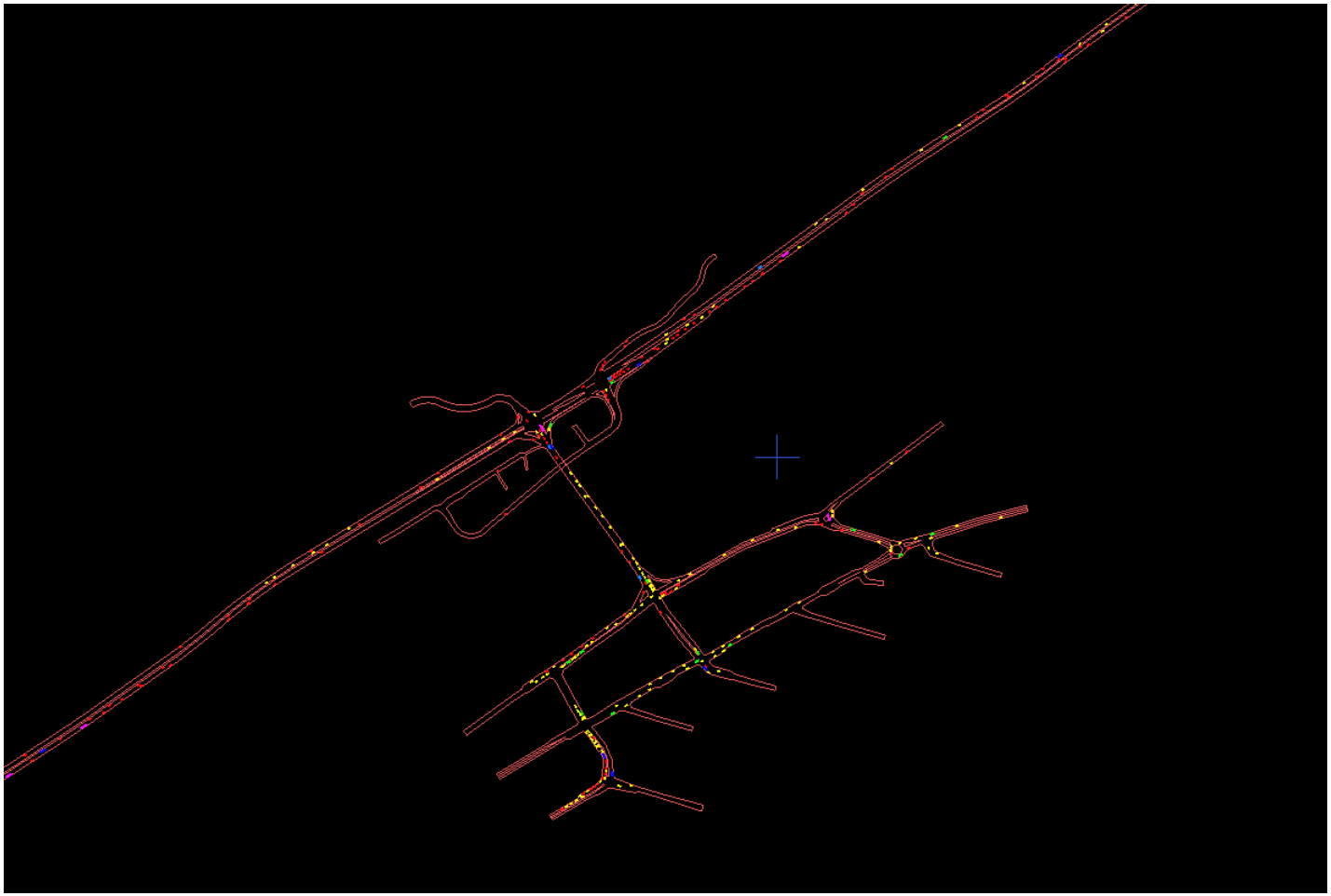


Figure B3: Typical Queues Predicted by PARAMICS– Do Minimum: Evening Peak

Figure B4: Typical Queues Predicted by PARAMICS– Option 9: Morning Peak

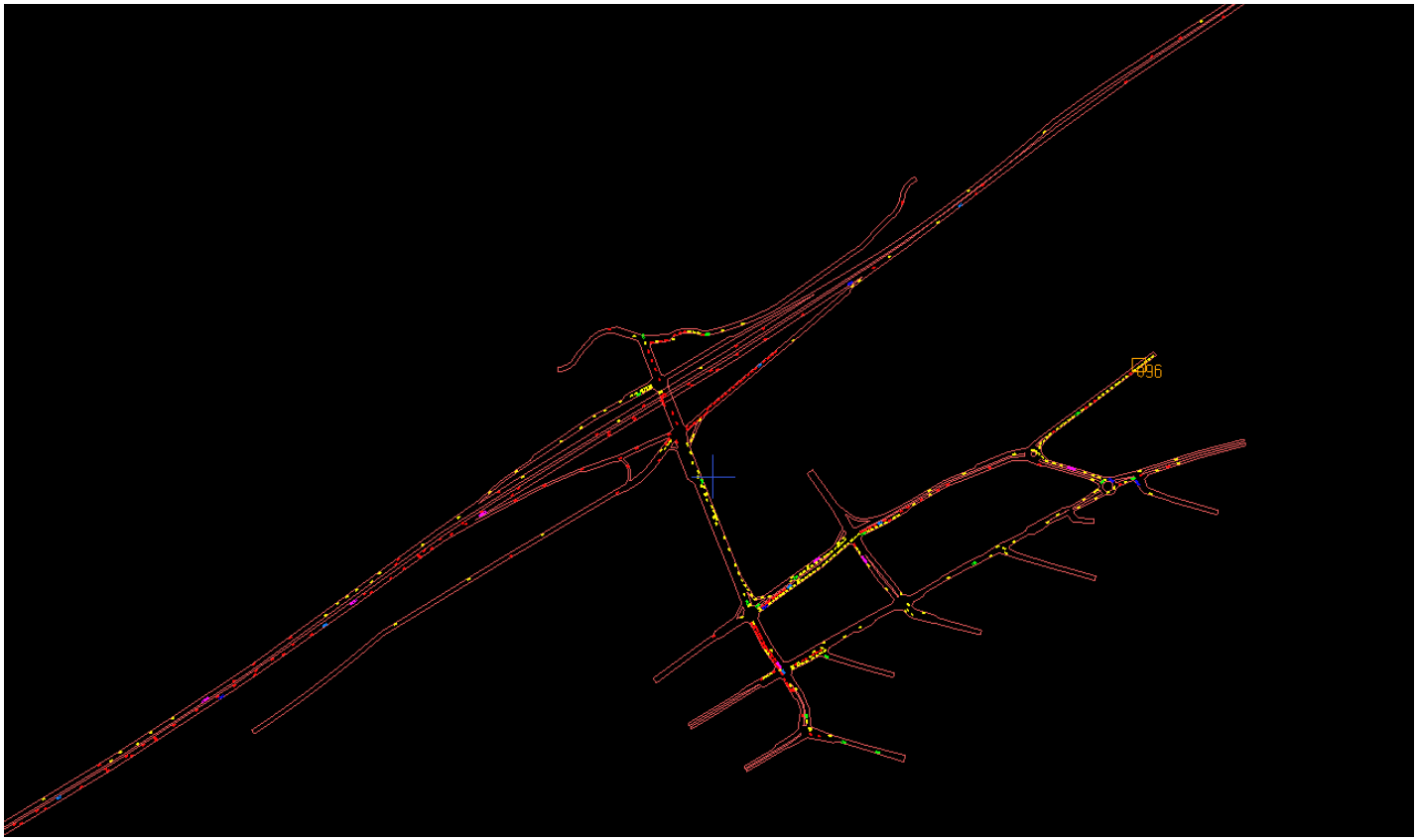


Figure B5: Typical Queues Predicted by PARAMICS – Option 9 Inter Peak

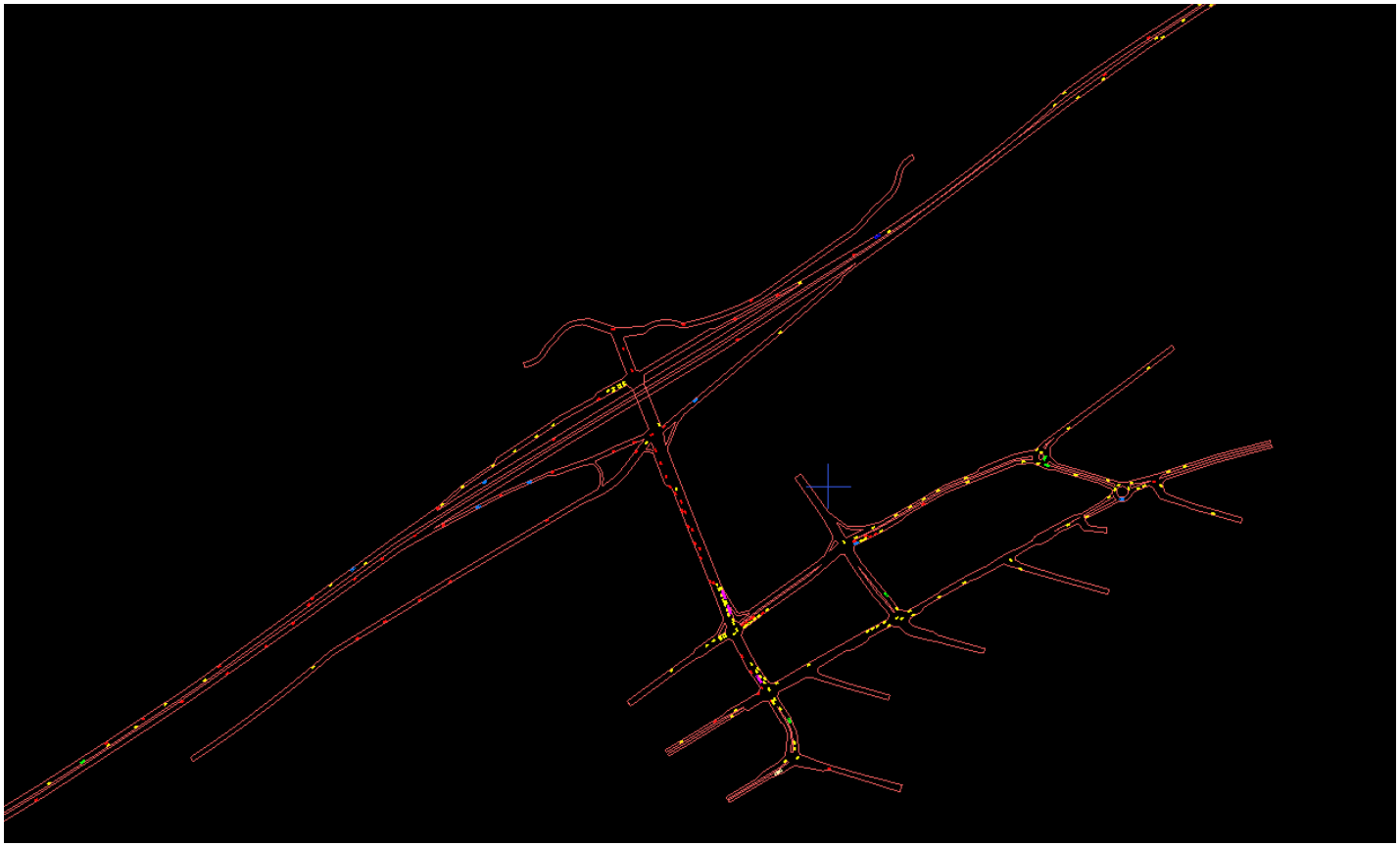


Figure B6: Typical Queues Predicted by PARAMICS– Option 9 Evening Peak

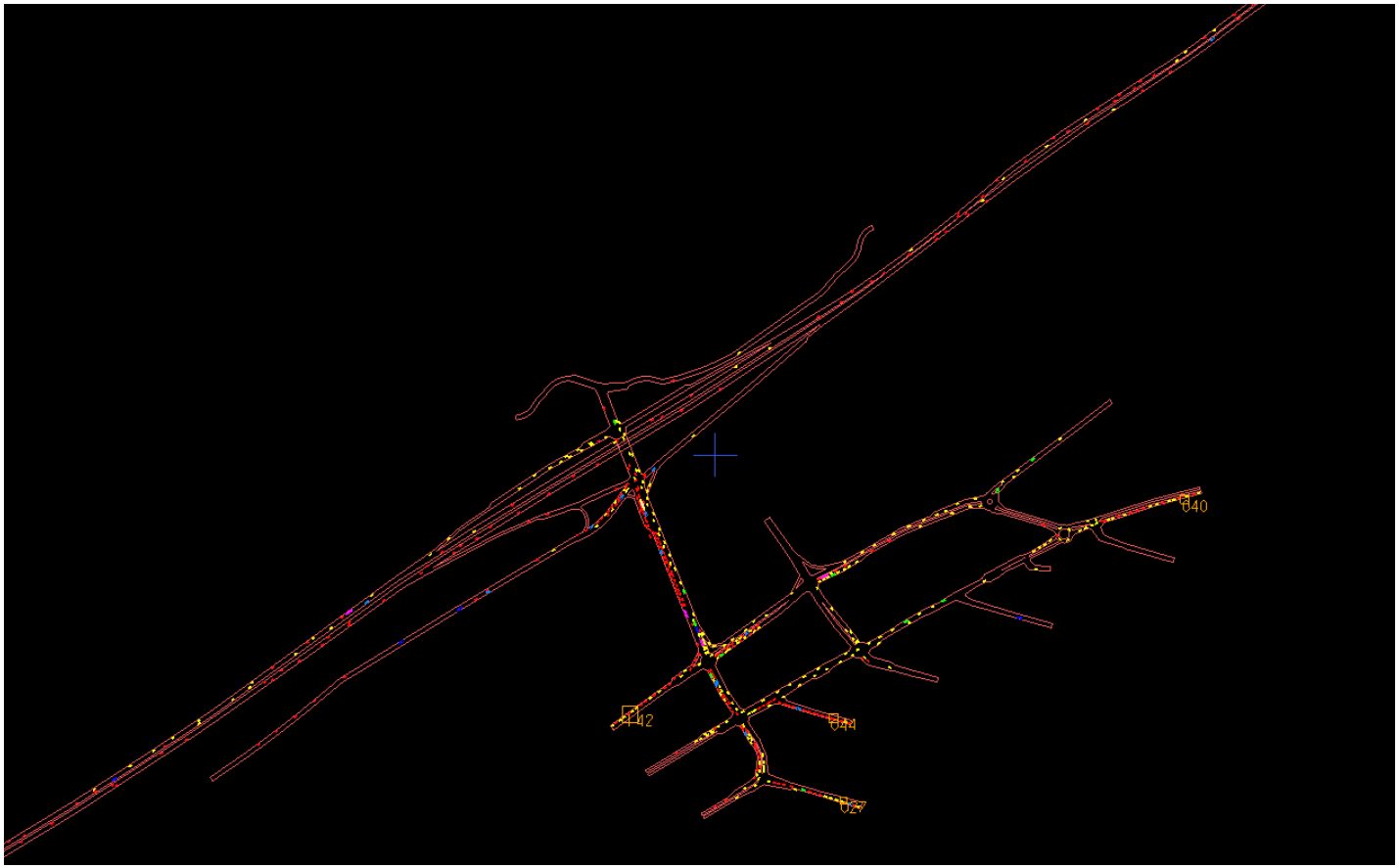


Figure B7: Typical Queues Predicted by PARAMICS – Option 9A Morning Peak

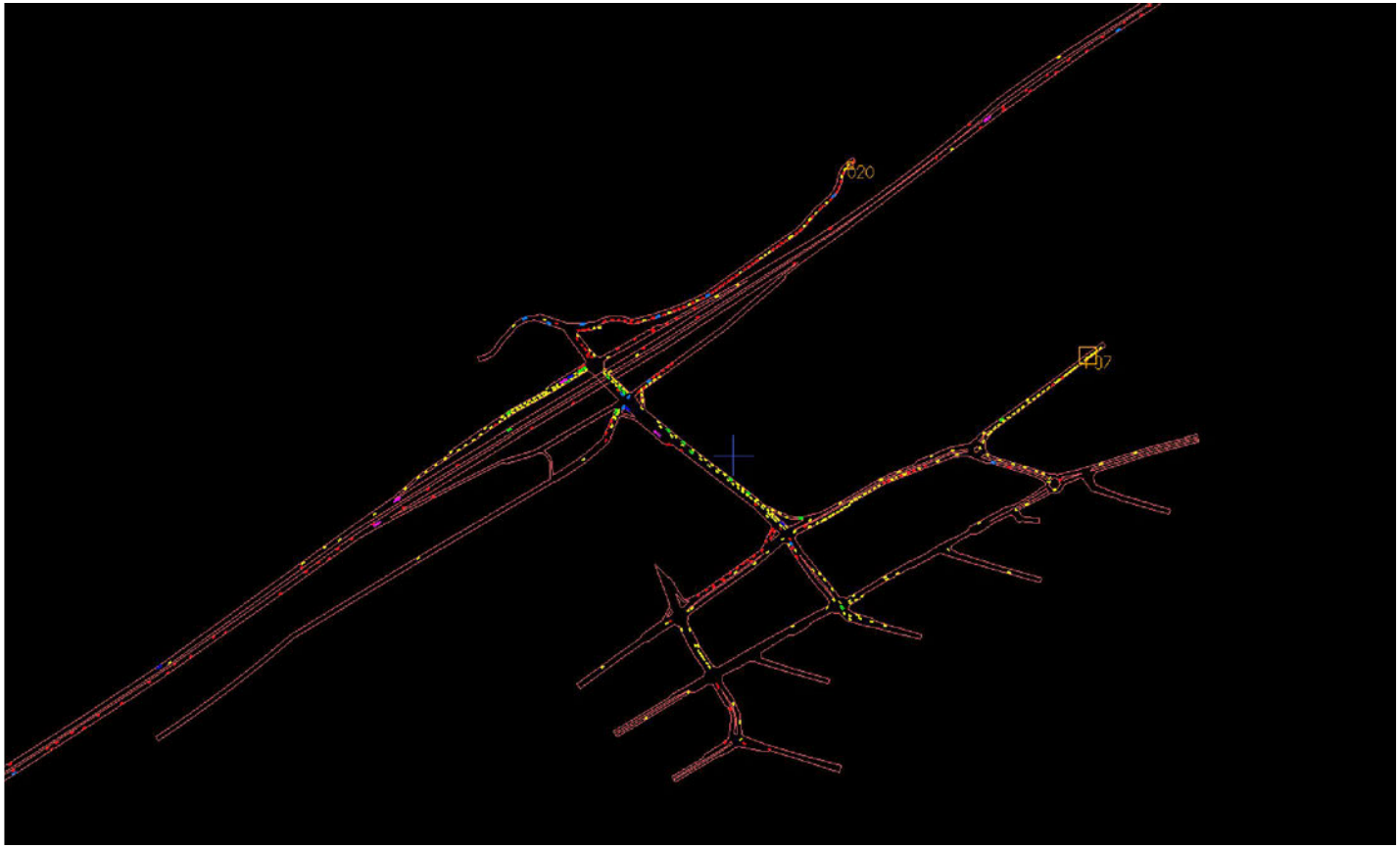


Figure B8: Typical Queues Predicted by PARAMICS – Option 9A Inter Peak

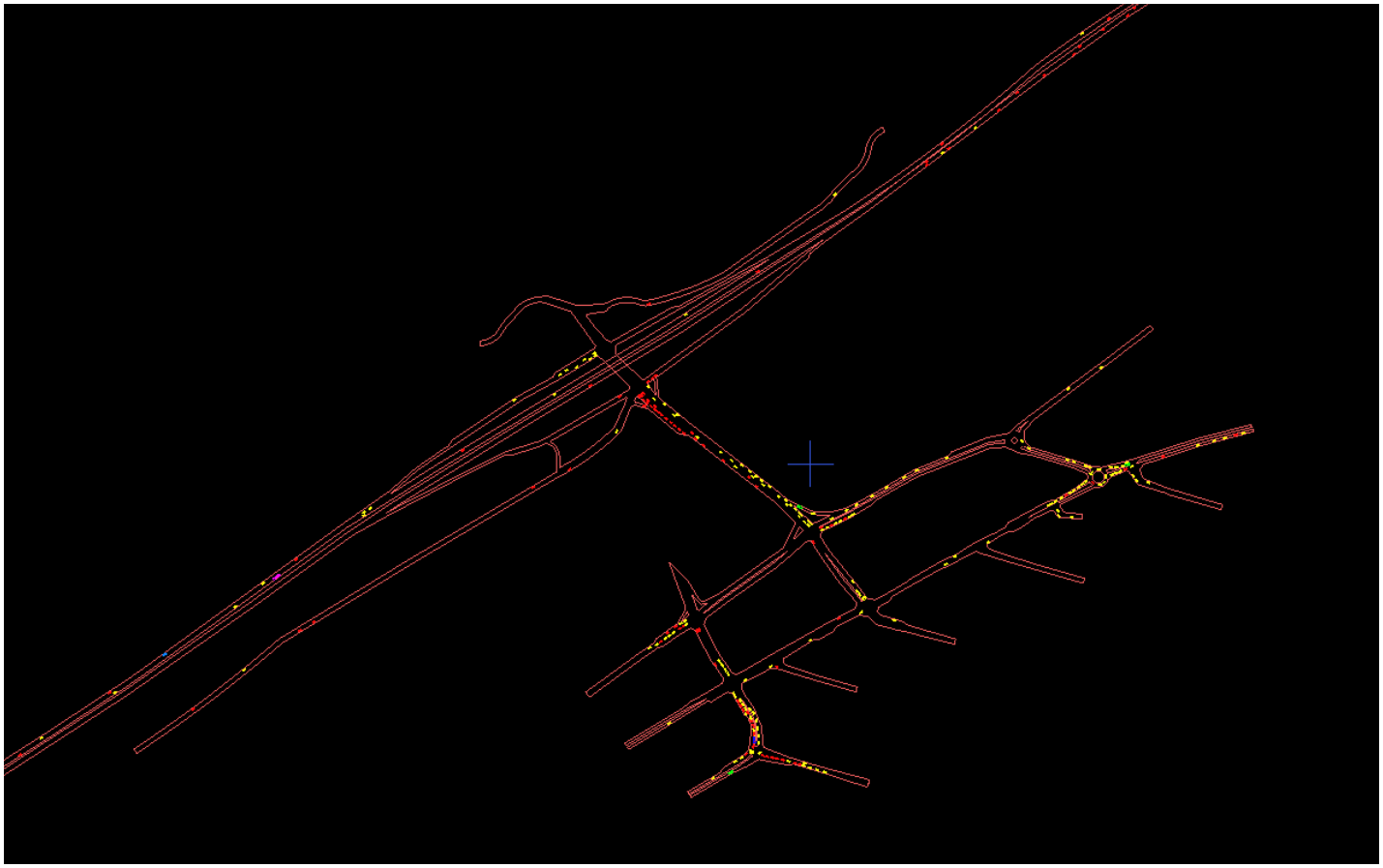


Figure B9: Typical Queues Predicted by PARAMICS – Option 9A Evening Peak

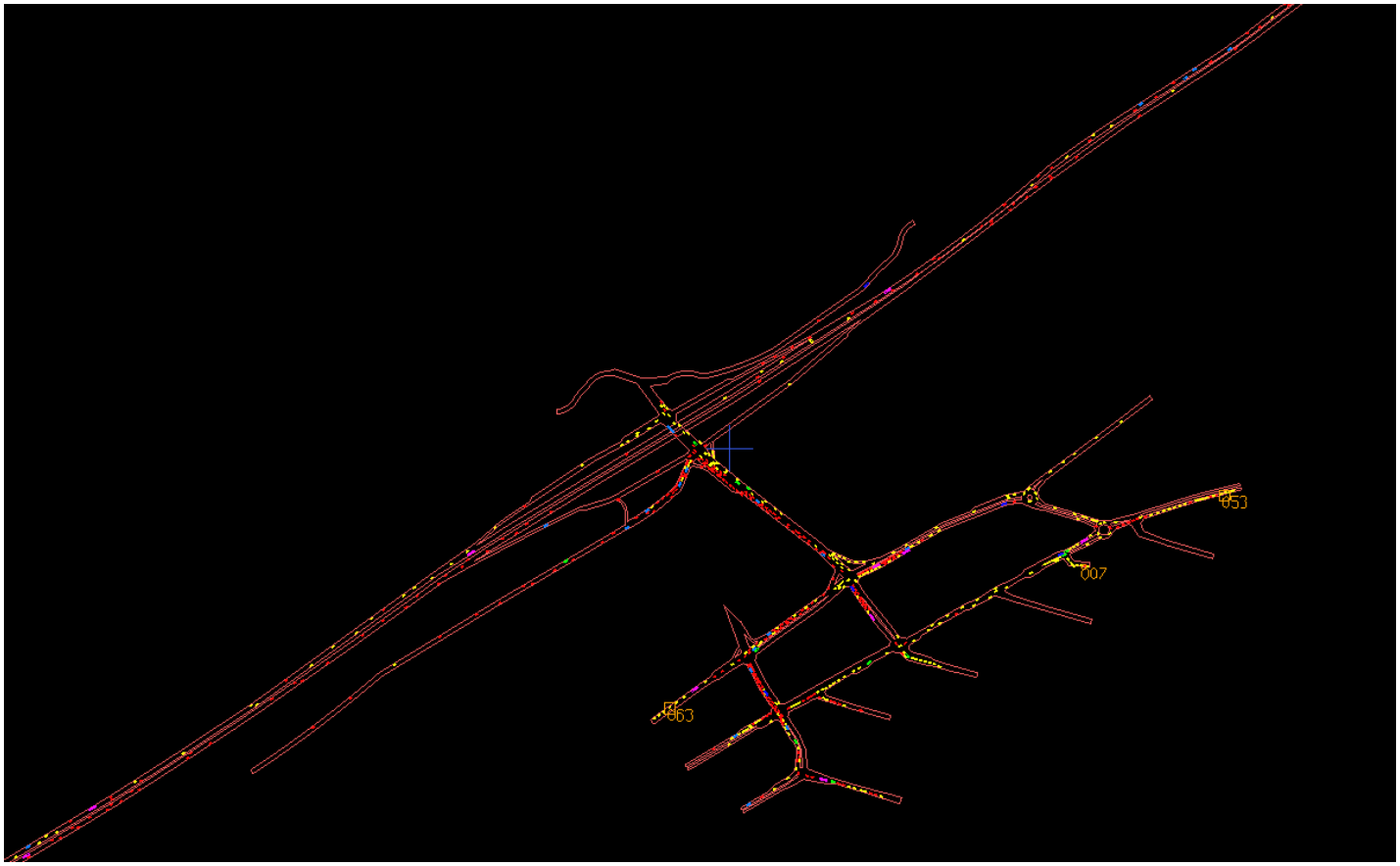


Figure B10: Typical Queues Predicted by PARAMICS – Option 9B Morning Peak

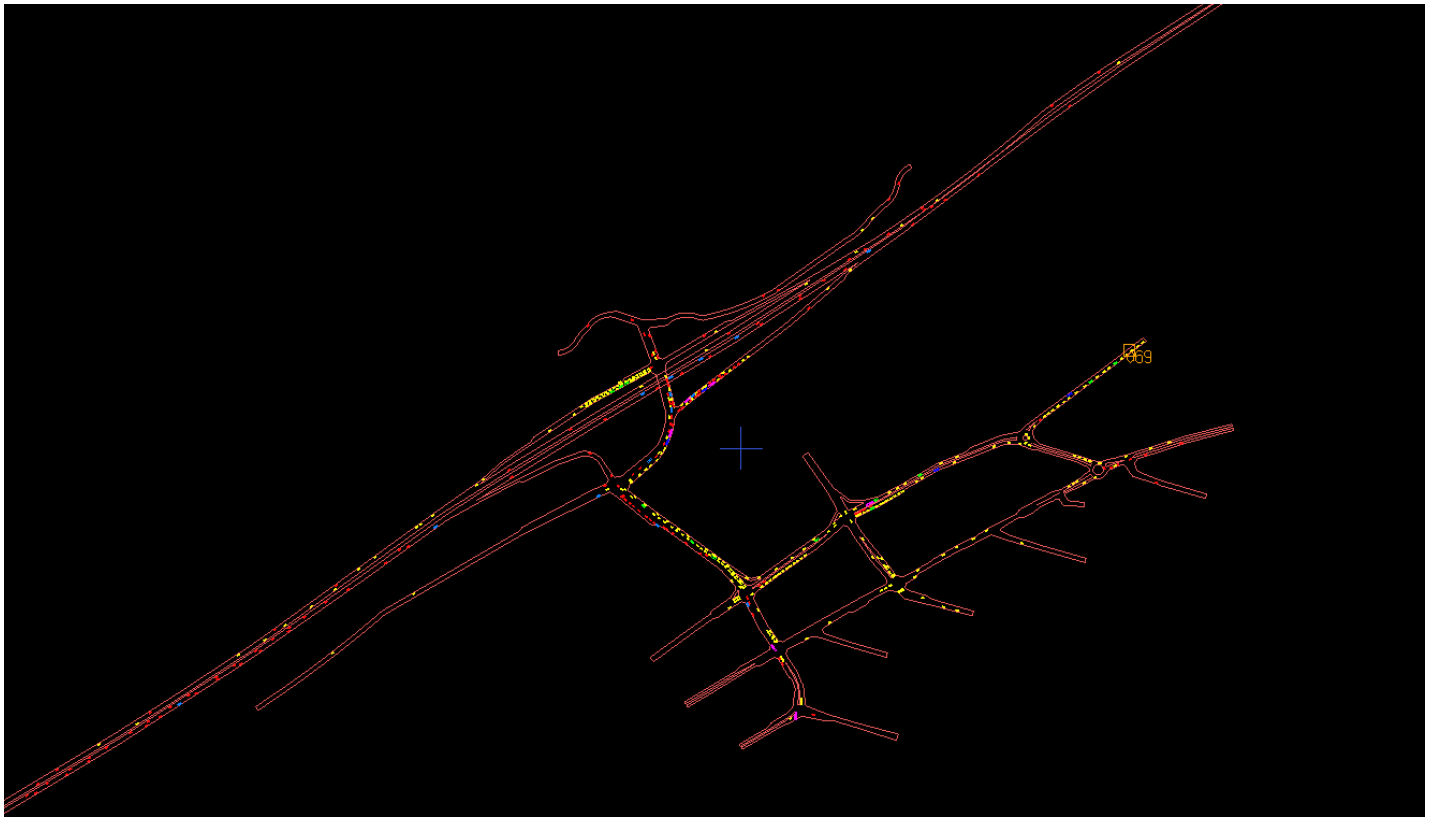


Figure B11: Typical Queues Predicted by PARAMICS – Option 9B Inter Peak

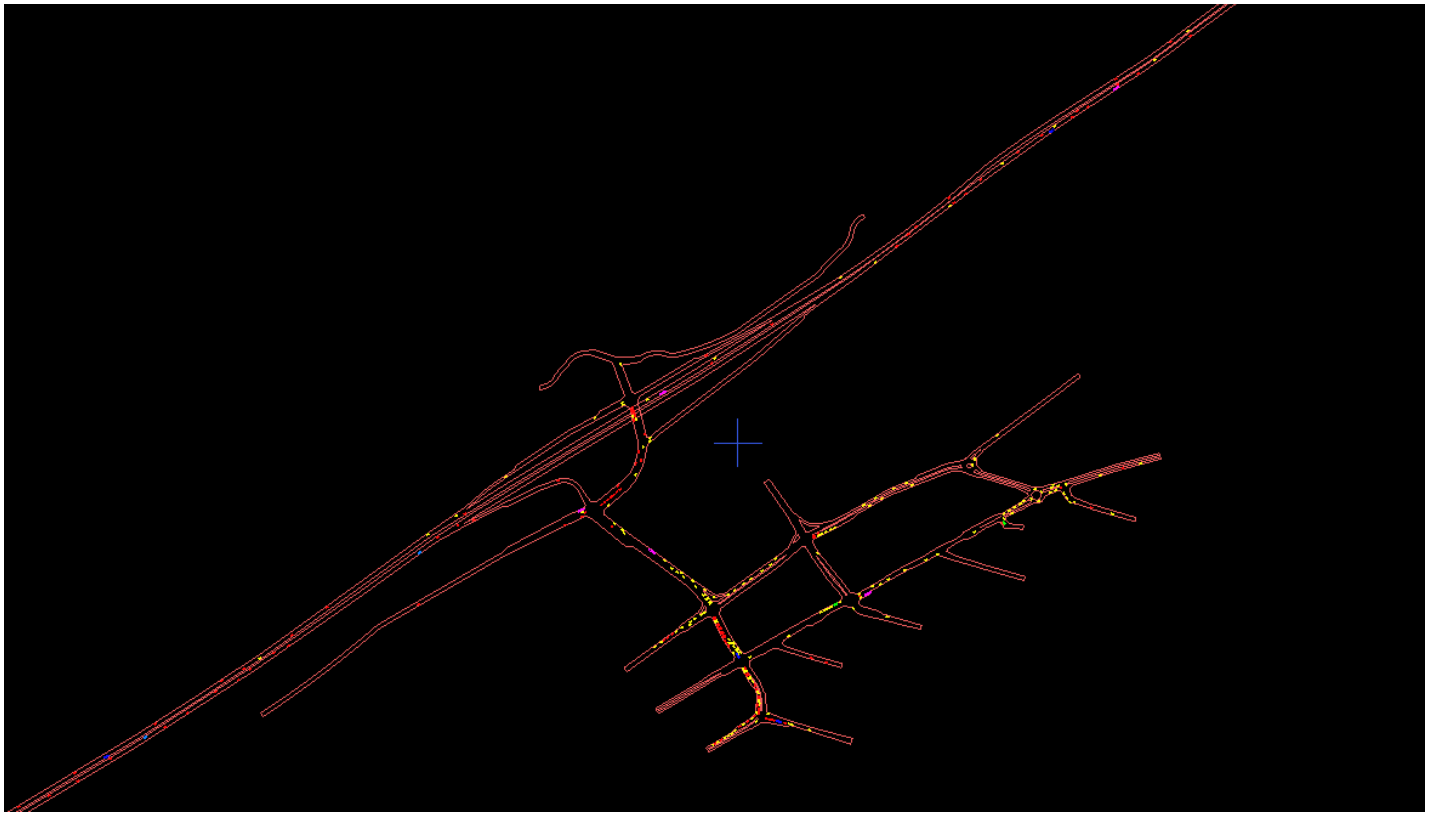
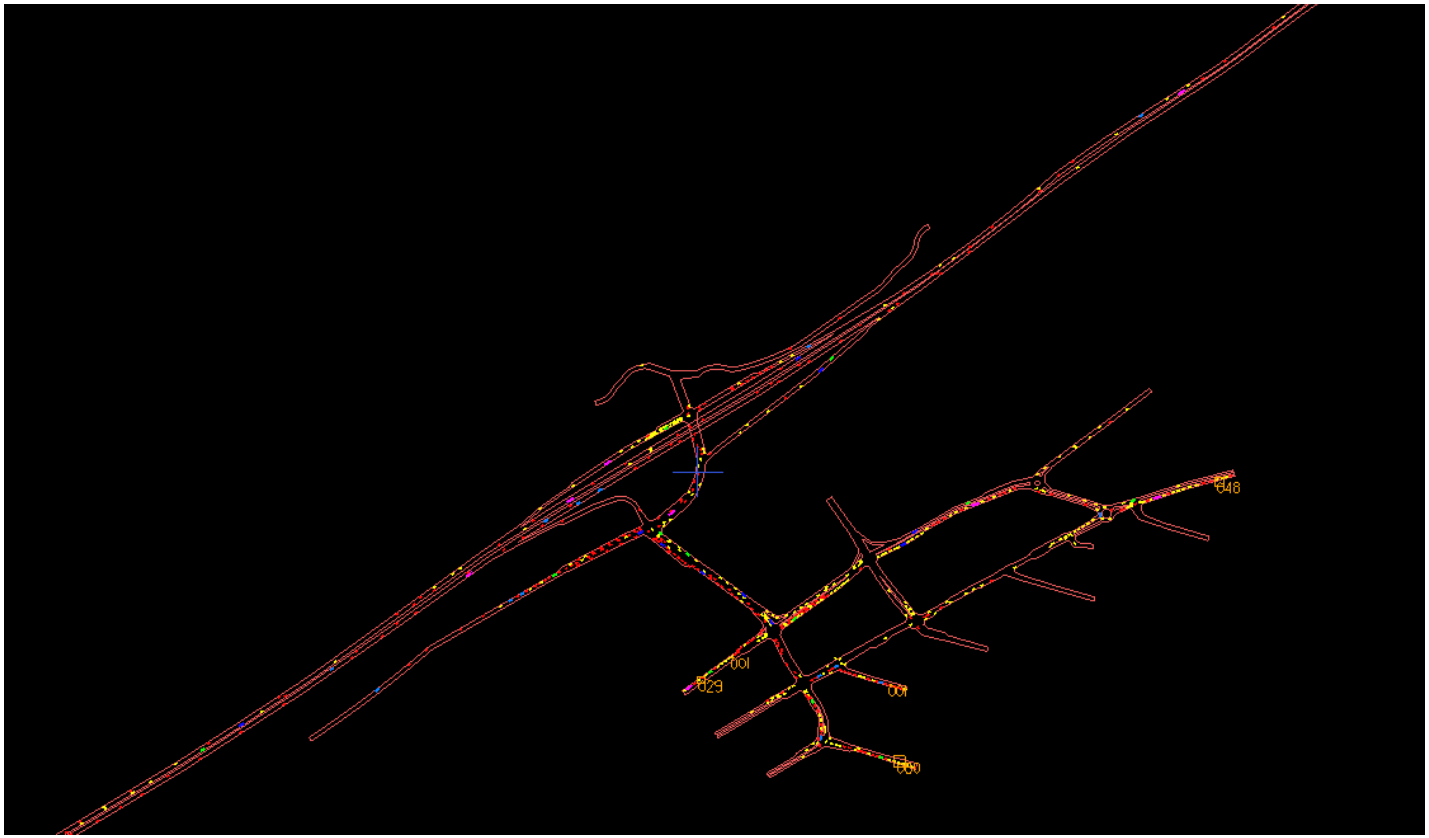


Figure B12: Typical Queues Predicted by PARAMICS – Option 9B Evening Peak



Appendix C Background Notes – Fit with Local Roading System

Memorandum

24 July 2018

To	SH2 Melling Intersection Improvements Team		
Copy to	John Gloag		
From	s 9(2)(a)	Tel	s 9(2)(a)
Subject	Multi-criteria assessment development and application	Job no.	51/37829/00

The purpose of this memorandum is to outline the high-level consideration of matters included within the 'fit with local road network' criterion (and sub-criteria), and corresponding assessment during workshop held 19th June 2018.

1 Options

On the 19th June 2018 a multi-criteria assessment workshop was undertaken to assess (through a range of criteria) three SH2 Melling intersection improvement options. The three options for infrastructure improvements at SH2 Melling provided by the project team were:

1. Option 1: Diamond interchange with an **indirect** connection to Queens Drive
2. Option 2: Diamond interchange with **direct** connection to Melling Link
3. Option 3: Diamond interchange with **direct** connection to Queens Drive

2 Development and application of criteria

Prior to the workshop a range of initial sub-criteria for workshop consideration was developed. The following outlines the background thought process and reasoning for sub-criteria development and consideration.

All criteria were assessed on a 5-point scale provided during the workshop (5 being least favourable and 1 being most favourable). The following outlines the initial sub-criteria assessment which was presented and discussed during the workshop, following which an overall criterion was agreed.

2.1 Pharazyn Street and Block Road Connectivity

Provides connectivity to Pharazyn Street to enable a connection to SH2 on the Western side of the Hutt River

On the western side of the Hutt River Pharazyn Street (along with Block Road), provides connectivity from State Highway 2 to residential, commercial and industrial areas in Melling, Alicetown and suburbs further south. Additionally, the existing Melling rail station and corresponding parking is located on Pharazyn Street. The Pharazyn Street / Marsden Street link between SH2 at Melling and Ewen Bridge also enables provision of alternative vehicle connectivity from Woburn (via Railway Ave) with the potential closure of part of Daly Street for flood mitigation improvements.

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As such, maintaining and providing connectivity between SH2 at Melling and Pharazyn Street is considered important to maintain wider network connections and route selection opportunities.

	Opt 1. Indirect Queens	Opt 2. Direct Queens	Opt 3. Direct Melling
Initial assessment	3	2	2

All options provided for connectivity to Pharazyn Street, however, option 1 provided a less legible connection for SH2 northbound traffic exiting at Melling.

Intersection operation not reliant on Block Road

The current SH2 at Melling and immediate local road network configuration is reliant on Block Road for connectivity between SH2 and Pharazyn Street. However, due to the level of Block Road (at the lowest point) in relation to the Hutt River, flood events on a reasonably frequent basis result in short term closure of Block Road. It is considered important that future intersection improvements provide for connectivity to the local road network on the western side of the Hutt River, un-reliant on Block Road.

	Opt 1. Indirect Queens	Opt 2. Direct Queens	Opt 3. Direct Melling
Initial assessment	1	1	1

All options remove Block Road.

2.2 Eastern Access Route Connectivity

Provides or enables connectivity/provision for an Eastern Access Route via Bloomfield Terrace or Cornwall Street

This criterion is to consider the ability of options to provide connectivity to a potential 'Eastern Access Route' via Bloomfield Terrace or Cornwall Street. Secondly, this criterion considered a 'compact' central area with the ability of options to also provide a legible connection to Queens Drive as an access route.

	Opt 1. Indirect Queens	Opt 2. Direct Queens	Opt 3. Direct Melling
Initial assessment	2	2	3

Both Queens Drive connection options provide a legible and logical connection to a potential Eastern Access Route, however, option 3 is a less direct connection for Queens Drive as an access route.

2.3 Local network connectivity

Connection to Rutherford Street from Bridge to provide access to/from Lower Hutt north of CBD

Consideration of how options provide connection to Rutherford Street to provide access to and from suburbs in the north of Lower Hutt (north of the central area) along High Street such as Boulcott, Epuni and Avalon. This also provides access to Hutt Hospital.

Note: This criterion was subsequently discarded in the workshop as it was considered to be captured under the 'Engineering degree of difficulty' criteria for Bridge landing at Rutherford (noting all options currently landed at Rutherford Street).

Directness/legibility of connections between local network and SH2

This criterion is to consider how legible connections are between SH2 at Melling and the local network. In particular, legible connections to the central area and to connecting suburbs on links such as High Street, Waterloo Road, Knights Road and Woburn Road.

	Opt 1. Indirect Queens	Opt 2. Direct Queens	Opt 3. Direct Melling
Initial assessment	3	2	3

Option 2 with a direct link to Queens Drive was considered the most legible network connection. Option 3 was assessed as being less legible than option 2, as this retained the existing connection location which is considered a difficult connection for wayfinding in the city. Option 1, while connecting at the same location as option 2, is not as legible and direct on the western side of the Hutt River between Pharazyn Street, Queens Drive, SH2 and the Western Hills.

Provision of Tirohanga Road and Harbourview Road connections and control

Initially considered as a criterion this was subsequently discarded given all options provide the same connectivity at Tirohanga Road and Harbourview Road from a vehicle viewpoint. Pedestrian and cycling connectivity however, is still considered important including connections to the rail station but was not assessed as part of fit with local road network.

3 Supplementary criteria

Considerations relating to the local road network (which were subsequently not included as part of local road connection assessment, but were covered elsewhere), included the following:

Constructability and network impacts

- Constructability and impact on local roads and connections during construction.

Vehicle conflict management

- Management of primary movements on SH2 at Melling i.e. SH2 through vs. Melling Bridge right turn vs SH2 right turn conflict management.
- Likelihood/queue risk onto the local road network e.g. potential for queuing back to SH2 or Rutherford Street from the intersection.
- Management of State Highway traffic entering Lower Hutt during peaks.

Multi-modal consideration

- Ability to provide safe and convenient connections to/from local road network for walking and cycling.

Regards

s 9(2)(a)

Appendix D Background Notes – Visual and Landscape Impacts, Urban Design Aspects and Recreational Amenity

NZTA SH2 MELLING INTERCHANGE

MULTI CRITERIA ANALYSIS

Thursday 28 June 2018

Boffa Miskell

ASSUMPTIONS + COMMENTS

- **WELL DESIGNED** BRIDGE
- EXISTING **MELLING BRIDGE REMOVED**
- RIVERLINK **LOCAL ROADS CHANGE** AS PROPOSED
- **PEDESTRIAN BRIDGE** IS IMPLEMENTED AS PART OF RIVERLINK
- **TRAIN STATION IS SHIFTED**
- ASSUME A HIGH LEVEL OF LANDSCAPE **MITIGATION WOULD OCCUR**
- **MANA WHENUA** ARE BEING INVOLVED IN THE DECISION MAKING
- **COMMUNITY FEEDBACK** IN REGARD TO RIVERLINK AND THE ENVIRONMENTAL STRATEGY SHOW A STRONG DEMAND FOR **WATER QUALITY** IMPROVEMENT AND **RECREATION** OPPORTUNITIES AND **SAFETY**

VISUAL + LANDSCAPE

				COMMENTARY
CRITERIA	1) QUEENS DRIVE DIRECT LINK	2) QUEENS DRIVE INDIRECT LINK	3) MELLING LINK	
VISUAL AMENITY	**3**	**5**	**2**	
1) RESIDENTIAL 2) ON ROAD USERS (SH2 + LOCAL ROADS) 3) ON RIVER CORRIDOR USERS 4) ON CITY CENTRE OCCUPANTS				• **All options will have adverse visual effects in terms of road users, people living in residential properties on the western hills, recreational users in the river corridor.** • **The bridge over SH2, ramps and retaining walls will be new built elements but not unfamiliar to SH2 users.** • **The visual effects, along the western side of side of SH2 are similar for all options.** • **The location of the bridge across the Hutt River will have potential adverse visual effects. because of its presence and scale but the level of effects will vary because of its location.** • **Both the Queens Drive Direct and Indirect Links will have adverse visual effects on Rutherford Street/CBD because of ramping required to connect to the local street network.** • **In addition, the Queens Drive Indirect Link will have the highest level of adverse visual effects because of the structure running through the western stopbank.** • **The Melling Link crosses the river and connects to the CBD in a similar position as the existing bridge and will be the lowest level of adverse visual effects.**
BIOPHYSICAL	**4**	**5**	**4**	
1) LANDFORM + EARTHWORKS 2) ECOLOGY (TERRESTRIAL + AQUATIC)				• **The level of landform change will be similar for all three options in relation to SH2.** • **In relation to the river the Queens Drive Indirect Link will have a greater level of landform change due to the works associated with the western stopbank.** • **The level of adverse ecological effects will be similar for all options.**
NATURAL CHARACTER	**3**	**4**	**3**	
1) RIVER ENVIRONMENT 2) ESCARPMENT				• **The character of the escarpment will be substantially modified in all three options, changing it from a vegetated face to retaining walls and ramps.** • **The existing natural character of the river environment is low given the level of channel modification, stopbanks and willow planting and any of the options will have similar effects.** • **Of the 3 options the Queens Drive Indirect Link will affect the natural character of the river corridor the most, because of the structure through the stopbank**
AGGREGATE	**3**	**5**	**3**	

URBAN DESIGN

				COMMENTARY
CRITERIA	1) QUEENS DRIVE DIRECT LINK	2) QUEENS DRIVE INDIRECT LINK	3) MELLING LINK	
LEGIBILITY	**1**	**3**	**2**	**Is connectivity (esp active modes) in other criteria?**
1) WAYFINDING FOR ROAD USERS (INTUITIVENESS)				**Melling link network connections are consistent with current usage expectations. However, current configuration of network on city side is not very legible (roundabouts etc) and lack of street form hierarchy. The wayfinding for QD (DL) is best as simplest and most direct to centre.**
2) WAYFINDING/CONNECTIVITY - RIVER CORRIDOR USERS				**Melling has least obstruction to passage along river bank. However, QD Links present some opportunity for use of old Melling Link as new river connection? QD (I) looks more complex to get around on west side? Interestingly the QD Links come reasonably close to the ped. bridge location - connectity/ accessibility value in having two bridges spaced, rather than two closer?**
GATEWAY	**1**	**2**	**3**	
1) LOCATION AS 'ENTRANCE' - POINTS TO THE CITY				**Proximity of landing place adjacent to city is positive for QD (DL) also is preferred direction of travel - leads people to centre. Melling less city edge position and also swinging away on QD (I) and Melling option**
2) PRESENCE/AESTHETIC OPPORTUNITIES OF THE BRIDGE				**Simpler the form - including ramping and changes to river landscape - the more presence the bridge will have. As noted above there may be some 'competition' between ped and road bridges to consider. Shorter span of Melling location means less presence and also hidden a bit by H. Norman. The need to build Melling in stages may also over complicate the structure and make this more grunty than refined**
CITY FIT	**2**	**4**	**1**	
1) PUBLIC REALM - STREETS AND SPACES				**How bridge ramps lands in streets for QD options and issue - cuts through blocks/awkward shapes - raising up of Rutherford Street (2-5m) and potential ramping edges beside re-made lots are issues - what is on ground experience/does it enable new/existing building edges to work or does it then require slip lanes alongside local roads for access? Will require acareful planning of not just street landings, but the blocks associated with this area.**
2) MAKING PLACES AND RIVERLINK INITIATIVES				**The QD options reduce the capacity for wetlands in the open area and reduces the capacity to extend the promenade to the east in future. Pharazyn street redevelopment is complicated also. Overhead structure at parking area/dominance/shading has effect from QD options**
AGGREGATE	**1**	**3**	**2**	**QD (DL) preffered, but will need to have more urban design thinking around how the bridge street landings will work with the city blocks - it might need**

RECREATION AMENITY

	OPTIONS		
CRITERIA	1) QUEENS DRIVE DIRECT LINK	2) QUEENS DRIVE INDIRECT LINK	3) MELLING LINK
RECREATIONAL FUNCTIONAL AMENITY	**3**	**4**	**1**

NOTES

- The presence of both the Queens Drive Indirect Link bridge and pedestrian bridge at only 260 m apart will impact on the recreational use of this popular stretch of the river corridor.
- Both Queens Drive Links impact on the recreational use of the existing car park/market area.
- Both Queens Drive options require extensive work around the West Bank to provide the function of the bridge which will complicate the recreation movement and accessibility to and along the river edge.
- Both the Queens Drive options will enable a new potential open space link to the river to be developed facilitated by demolition of the existing Melling Bridge.

Appendix E Background Paper – Natural Hazards Management Fit

DAMWATCH
ENGINEERING BEYOND THE SURFACE

RiverLink, NZTA Melling Interchange Options

Natural Hazards Multi Criteria Analysis

25 June 2018

Prepared for Greater Wellington Regional Council and NZTA

Issue 2

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Client	Greater Wellington Regional Council and NZTA
Client Contact	Alistair Allan GWRC,
Client Project Reference	
Damwatch Project No	E1865

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2	25 June 2018	Ditto			

Current Document Approval

Prepared By s 9(2)(a) [redacted]

Reviewed By

Approved For Issue

Signature: s 9(2)(a) [redacted]

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Executive Summary

Context

The Natural Hazards analysis, documented in this report, is one of ten criteria that were applied to three arrangements for an interchange and traffic management on SH2 at Melling in Lower Hutt. The analysis comprises a Multi Criteria Assessment (MCA) of the three interchange options against the ten criteria.

Natural Events and Hazards

The purpose of this MCA component is to evaluate the impact of natural events on the three interchange options, and the impact of the interchange options on existing hazard systems.

In this Melling location the natural events that may result in a hazard are:

- Flood
- Earthquake
- Tsunami
- Landslide

The hazards assessment includes the impact of the three interchange options on infrastructure set up by other agencies to mitigate natural events. The principal hazard system at the Melling interchange locations is the Hutt River Flood Protection Scheme.

The MCA assessment of the various impacts is carried out on a relative basis between the options and is not an absolute evaluation.

MCA Process – Natural Hazards

A workshop, held on Tuesday 19 June 2018, received the assessment of various experts assigned to each of the overarching MCA criteria. Experts in each field presented the assessments that in turn were moderated at the workshop. The workshop apportioned "importance factors" to the top level criteria.

Seismic, Tsunami and Landslide Natural Events

For earthquake, tsunami and landslide events prior discussions were held with relevant experts and other information was reviewed. It is considered that these events do not warrant specific assessment or moderation as part of the MCA process as their impacts are likely to be common to the three options.

Flood Hazard

For the flood hazard a formal workshop was held on Tuesday 12 June 2018 to confirm impacts on the flood protection system. Each of the interchange options is at a different location on the river, and has a different configuration and impact on the flood protection system.

A relative comparison of the impact of each of the three interchange options on the flood system and flood hazard was conducted. The three diamond interchange options are:

- The Direct Option
- The Indirect Option

- The Melling Link Option

Appendix A contains a spreadsheet that schedules:

- The overarching flood hazard criterion
- Sub-criteria / expected outcomes
- Weightings assigned to the sub criteria
- Discussion prompts that are the technical or physical measures for meeting the sub-criteria
- Interchange option scores for the Direct Crossing, Indirect Crossing and Melling Link Crossing
- Computations for the weighted sub-criteria scores and total weighted flood hazard score for each interchange option (highest performing 1, lowest performing 5)

The resulting specialist flood hazard scores for each option and scores after workshop moderation are:

	Specialist Assessment	**Workshop Moderated**
• Direct Option	2.2	2
• Indirect option	3.4	3
• Melling Link	3.5	5

The scores in the second column are after moderation at the 19 June 2018 MCA workshop. The moderated scores are rounded for the Direct and Indirect interchange options. The score for Melling Link is increased to 5 to reflect constraints this interchange option places on medium term flood protection development. These constraints, principally spacial and land related, are not easily addressed at this stage. The long lifespan of a Melling Link bridge would make flood protection improvements at this location very unlikely over that time.

The rationale for scores is set out in Appendix B.

A general description of the local constrained waterway at Melling, its interaction with the interchange bridge options, and the differentiating factors for the three bridge location options, are set out below.

Constrained Waterway

There is a very constrained section of the river that extends for approximately 200 - 300 metres from the downstream end of the Harvey Norman building up to the expansion onto a wide berm on the left bank. This is a very dynamic section of the river and at the 2,800 cumec design flow is characterised by high velocities, high surface slope, and high turbulence. The expected result is unstable flow patterns, an unstable sediment transport regime, and high scour potential. These characteristics are exacerbated by the left bank berm flow entry at the top end of the constrained waterway. This complex section of the river then transitions into the estuary reach, as the river moves away from the Wellington fault line.

The impacts of the constrained waterway on the three interchange options are included below.

Interchange Direct Option

- The overall bridge waterway is reasonable with acceptable hydraulic parameters but constrained by upstream waterway impacts and insufficient right bank berm width.
- The right berm at 20 m. does not meet minimum requirements. The wider left berm 48 m. exceeds minimum requirements and provides useful security to the system. These measurements are based on the bridge waterway not impacting on the riverworks preliminary design stopbank cross section, at the location.
- Bridge waterway should not result in unmanageable impacts on morphology at bridge location.
- However the unfavourable dynamic characteristics of the upstream waterway may transfer to the Direct Option bridge location. These may include scour, unstable sediment transport with aggradation / degradation of sediment.
- Does not preclude opportunities for future upstream channel improvement.
- Resolution options may include creating additional right bank berm width by moving the bridge ramps towards SH2, using vertical MSE walls in ramps and moving the western bridge intersection / abutment further up Tirohanga road.

Interchange Indirect Option

- The fill profile for the river bridge RB abutment, and the link ramp between the river and SH2 bridges, extends across the berm into the river channel. There is no effective right bank berm and the waterway does not meet minimum width requirements.
- Hydraulic performance is unbalanced with no RB berm, flow diversion and turbulence.
- The unfavourable dynamic characteristics of the upstream waterway may transfer to the Indirect Option bridge location. These may include scour, unstable sediment transport with aggradation / degradation of sediment.
- If constructed as currently presented the bridge location would fix in place an undesirable berm fill obstruction for the lifespan of the bridge.

Interchange Melling Link Option

- The Melling Link river bridge is located in a very constrained waterway section of river, noted above. The presence of bridge piers and abutments exacerbates the unfavourable characteristics noted.
- The left berm width 19 m. and right berm width 23 m. do not meet minimum waterway requirements. These measurements are based on the bridge waterway not impacting on the riverworks preliminary design stopbank cross section at the location.
- If the Melling Link bridge is constructed the bridge location would fix in place the unfavourable dynamic characteristics of the waterway for the lifespan of the bridge.
- Resolution options may include creating right bank berm width by moving the bridge ramps towards SH2, using vertical MSE walls in ramps and moving the western bridge intersection / abutment further up Tirohanga road.
- A medium term option is to improve left bank berm capacity in the constrained section.

The scoring above shows the specialist assessment presented to the workshop and the resulting score after moderation by the workshop.

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Appendix A: RiverLink Melling Interchange Options
Multi Criteria Assessment
Flood Hazard – Weighted Scores

Appendix B: RiverLink Melling Interchange Options
Multi Criteria Assessment
Flood Hazard – Scoring Rationale

APPENDIX C: RiverLink Melling Interchange Options
Flood Hazard – Design Elements

Appendix D: RiverLink Melling Interchange Options
Multi Criteria Assessment
Seismic Hazard

Appendix E: RiverLink Melling Interchange Options
Multi Criteria Assessment
Tsunami Inundation Map

1.0 Context

The Natural Hazards analysis documented in this report is one of ten criteria that were applied to three arrangements for an interchange and traffic management on SH2 at Melling in Lower Hutt. The analysis comprises a Multi Criteria Assessment (MCA) of the three interchange options against the ten criteria.

2.0 Natural Events and Hazards

The purpose of this MCA component is to evaluate the impact of natural events on the three interchange options, and the impact of the interchange options on existing hazard systems.

A hazard is defined as "an agent that has the potential to cause harm or damage to a vulnerable target", the latter may be people, property, infrastructure, the environment.

In this Melling location the main natural events that may result in a hazard are:

- Flood
- Earthquake
- Tsunami
- Landslide

The hazards assessment includes the impact of the three interchange options on infrastructure set up by other agencies to mitigate natural events. The principal hazard mitigation system at the Melling interchange locations is the Hutt River Flood Protection Scheme.

The interactions of the "natural hazards" with the interchange options are set out in this report.

The assessment of the various impacts is carried out on a relative basis between the options and is not an absolute evaluation.

3.0 MCA Process – Natural Hazards

The MCA workshop, held on Tuesday 19 June 2018, received assessments by various specialists assigned to each of the ten overarching MCA criteria. Examples of the ten criteria are Transport Benefits, Visual and Landscape Effects, Urban Design Opportunities, Natural Hazards etc. The specialists presented the assessments, that in turn were moderated at the workshop. The workshop also apportioned "importance factors" that will be assigned to the various top level criteria.

The only natural hazard that required a prior workshop to confirm impacts on the interchange options and infrastructure systems was the flood event. For earthquake, tsunami and landslide discussions were held with relevant experts and applicable information was reviewed. It is considered that these events do not warrant specific assessment or moderation as their impacts or design treatment are considered to be common to the three options.

The flood workshop was structured and convened by the author of this report, s 9(2)(a) an experienced Principal river engineer with consultant Damwatch Engineering Ltd. Workshop participants were s 9(2)(a) a river morphology expert and independent consultant, s 9(2)(a) a river hydraulics expert with consultant DHI, and Graeme Campbell, Colin Munn, Alistair Allan and Rebecca Polvere, four senior and experienced river engineers at Greater Wellington. The workshop was held on Tuesday 12 June 2018. s 9(2)(a)

prepared and presented the scored Flood Hazard MCA framework to the workshop, and outlined the rationale for his scoring. The workshop moderated the assessment and scoring. Valuable contributions were received and there were minor adjustments to the initial scoring.

4.0 Flooding Hazard

A natural flood event becomes a hazard when there is some form of intervention that results in the potential to cause harm or damage. For the Hutt River Flood Protection system the flood hazard is created when the natural flood event flows through the flood protection system. The latter is designed to enable safe conveyance of the design flood to the sea, in order to protect people and assets.

4.1 Interchange Options - interaction with proposed flood protection system

The construction of interchange components within and adjacent to the Hutt River Flood Protection system has the potential to modify the flood hazard.

A relative comparison of the impact of each of the three interchange options on the flood system and flood hazard was conducted. The three diamond interchange options (they are well documented and not repeated) are:

- The Direct Option
- The Indirect Option
- The Melling Link Option

Appendix A contains a spreadsheet that schedules:

- The overarching flood hazard criterion
- Sub-criteria / expected outcomes
- Weightings assigned to the sub criteria
- Discussion prompts that are the technical or physical measures for meeting the sub-criteria
- Interchange option scores for the Direct Option, , Indirect Option, and Melling Link Option
- Computations for the weighted sub-criteria score and total weighted flood hazard score for each interchange option (highest performing 1, lowest performing 5)

The resulting specialist flood hazard scores for each option and scores after workshop moderation are:

	Specialist Assessment	Workshop Moderated
• Direct Option	2.2	2
• Indirect option	3.4	3
• Melling Link	3.5	5

The scores in the second column are after moderation at the 19 June 2018 MCA workshop. The moderated scores are rounded for the Direct and Indirect interchange options. The score for Melling Link is increased to 5 to reflect constraints this interchange option places on medium term flood protection development. These constraints, principally spacial and land related, are not easily addressed at this stage. The long lifespan of a Melling Link bridge would make flood protection improvements at this location very unlikely over that time.

The rationale for scores is set out in Appendix B.

A general description of the local constrained waterway at Melling, its interaction with the interchange bridge options, and the differentiating factors for the three bridge location options, are set out below.

Constrained Waterway

There is a very constrained section of the river that extends for approximately 200 - 300 metres from the downstream end of the Harvey Norman building up to the expansion onto a wide berm on the left bank. This is a very dynamic section of the river and at the 2,800 cumec design flow is characterised by high velocities, high surface slope, and high turbulence. The expected result is unstable flow patterns, an unstable sediment transport regime, and high scour potential. These characteristics are exacerbated by the left bank berm flow entry at the top end of the constrained waterway. This complex section of the river then transitions into the estuary reach, as the river moves away from the Wellington fault line.

The impacts of the constrained waterway on the three interchange options are included below.

Interchange Direct Option

- The overall bridge waterway is reasonable with acceptable hydraulic parameters but constrained by upstream waterway impacts and insufficient right bank berm width.
- The right berm at 20 m. does not meet minimum requirements. The wider left berm 48 m. exceeds minimum requirements and provides useful security to the system. These measurements are based on the bridge waterway not impacting on the riverworks preliminary design stopbank cross section, at the location.
- Bridge waterway should not result in unmanageable impacts on morphology at bridge location.
- However the unfavourable dynamic characteristics of the upstream waterway may transfer to the Direct Option bridge location. These may include scour, unstable sediment transport with aggradation / degradation of sediment.
- Does not preclude opportunities for future upstream channel improvement.
- Resolution options may include creating additional right bank berm width by moving the bridge ramps towards SH2, using vertical MSE walls in ramps and moving the western bridge intersection / abutment further up Tirohanga road.

Interchange Indirect Option

- The fill profile for the river bridge RB abutment, and the link ramp between the river and SH2 bridges, extends across the berm into the river channel. There is no effective right bank berm and the waterway does not meet minimum width requirements.
- Hydraulic performance is unbalanced with: no RB berm, flow diversion and turbulence.
- The unfavourable dynamic characteristics of the upstream waterway may transfer to the indirect Option bridge location. These may include scour, unstable sediment transport with aggradation / degradation of sediment.
- If constructed as currently presented the bridge location would fix in place an undesirable berm fill obstruction for the lifespan of the bridge.

Interchange Melling Link Option

- The Melling Link river bridge is located in a very constrained waterway section of river, noted above. The presence of bridge piers and abutments exacerbates the unfavourable characteristics noted.
- The left berm width 19 m. and right berm width 23 m. do not meet minimum waterway requirements. These measurements are based on the bridge waterway not impacting on the riverworks preliminary design stopbank cross section at the location.
- If the Melling Link bridge is constructed the bridge location would fix in place the unfavourable dynamic characteristics of the waterway for the lifespan of the bridge.
- Resolution options may include creating right bank berm width by moving the bridge ramps towards SH2, using vertical MSE walls in ramps and moving the western bridge intersection / abutment further up Tirohanga road.
- A longer term option may be to improve left bank berm capacity in the constrained section.

For each interchange option the Flood Hazard weighted scores, and the rationale for the scores, contributed to the NZTA workshop on Tuesday 19 June 2018. The moderated outcomes of all of the criteria will be integrated to indicate a preferred option.

4.2 Interchange Options – Flood Hazard: Design Elements / Standards / Considerations

In the design of elements within each interchange option there are design rules, precedent, practices and considerations that minimise the impact of the interchange components on the flood protection system and corresponding flood hazard. Examples are pier design within a waterway, stopbanks, debris management and clearance, bridge abutment arrangements, and aquifer protection (Hutt Valley).

While the three interchange options may be different, these design parameters bring the residual impacts and performance of the element to a common and acceptable basis across the options. As a result while the configuration of the Interchange options may be different these elements do not need to be included in the Multi Criteria Assessment of the options. They have common mitigation outcomes and do not influence the selection of a preferred Interchange option.

Appendix C contains a schedule of design elements that will be considered as part of future design processes.

5.0 Seismic Hazard

A meeting held between s 9(2)(a) Stantec, and s 9(2)(a) s 9(2)(a) Damwatch Engineering identified and discussed:

- the elements of the three Interchange options,
- the seismic criteria that need to be satisfied in design of the three options

Their conclusion is that elements of the three options would be designed to common standards (NZTA Bridge Manual) and requirements that would result in similar serviceability and performance of the interchange options' components in a seismic event. The impact of seismic events on comparative elements of the three interchange options would be similar and there will be no significant differences between the three options from a seismic perspective.

With that understanding The Melling interchange options MCA process need not consider seismic impacts as a significant issue.

Stantec's email confirming the discussion and subsequent developed detail is attached in Appendix D.

6.0 Tsunami

Appendix D contains the Tsunami Evacuation Zone plan for Petone, Alicetown, Ava, Melling, Woburn and Moera (Wellington Region Emergency Management). The plan shows that the evacuation zone terminates at Melling Bridge, and in the vicinity of the bridge tsunami inundation is confined to the waterway of the flood protection system.

The tsunami flow and any associated surging is very unlikely to have any significant impact on any of the Melling interchange options under consideration, nor for that matter on the flood protection system. The flood protection system design standard is 2,800 cumecs, very much higher than any flow associated with a tsunami flood wave that may reach Melling (albeit flowing in the opposite direction).

Any tsunami effects are likely to be similar for the three interchange options.

The Melling interchange options MCA process need not consider tsunami as a significant issue.

7.0 Landslide

All three interchange options, at the western side of the proposed northbound lanes of SH2, indicate reasonably wide platforms and high cuts to form: on / off ramps for the interchange; the link road between Harbour View Road and Tirohanga Road; and re-alignment of Tirohanga Road. The cut faces are landslide hazards.

The earthworks for these elements are effectively the same for all three options. It is assumed that engineering for the platforms and cuts will result in serviceable solutions for these elements.

Because they are common design elements, the Melling interchange options MCA process need not consider landslide as a criterion in the Natural Hazards assessment.

There is the potential for landslide activity further up the Tirohanga valley, with possible blocking of roads and waterways. These matters need consideration and inclusion in future asset management and operational plans.

8.0 Summary

This report was drafted for use at the 19 June 2018 MCA workshop to assist selection of the preferred Interchange option for traffic management at the Melling intersection. The report has since been updated to reflect outcomes from the workshop

Appendix A

RiverLink Melling Interchange Options
Multi Criteria Assessment
Flood Hazard – Weighted Scores

20-Jun-18

APPENDIX A
FLOOD HAZARD
INTERCHANGE OPTIONS SCORING

RIVERLINK MELLING INTERCHANGE OPTIONS
MULTI CRITERIA ASSESSMENT
NATURAL HAZARDS

"Importance" over criteria to be established at workshop
"Weighting" over sub-criteria as entered below

MCA Process - rate each option on scale of 1 - 5, score in box, notes as rationale for score
Aim is to determine highest ranked (lowest score) option - it is a relative or comparitive process
1 = highest performance
5 = lowest performance

FLOOD HAZARD - INTERCHANGE OPTIONS SCORING

Flood Hazard Criterion	Importance	Sub Criteria / Expected outcome	Weighting	Owner	Discussion Prompts	Interchange Option and Score: Direct Option (DO)	Indirect Option (IO)	Melling Link (ML)
The impact of the Interchange option on the flood protection system during flood and following seismic events does not impact on the ability of the system to safely pass the 2,800 cumec design standard flood event.	Not yet included at this level	The Waterway at the Interchange bridge crossing and location is adequate to safely pass the 2,800 cumec design standard flood with acceptable hydraulic parameters.	30%	s 9(2)(a)	Acceptable corridor width between abutments / toe of abutments	3	5	5
					Bridge alignment obliqueness across river is acceptable	1	1	1
					ocal intrusions at bridge locations	3	5	4
					Hydraulic parameters at bridge location			
					> velocities / flow patterns / turbulence	3	2	4
					> headwater / water surface profile	3	2	4
					Total Score	13	15	18
					Potential score	**25**	**25**	**25**
					Total / Potential Score Ratio	0.52	0.60	0.72
					Weighted score	**0.16**	**0.18**	**0.22**
		The Interchange bridge crossing has an acceptable impact on the security of the flood protection system. Residual risk remains low.	30%		Berm widths on both LB & RB (required minmum 25 metres, includes lower berm	3	5	4
					Berm materials	3	3	2
					Bank edges protections	2.5	5	2.5
					Flow diversions caused by the Interchange bridge in channel or berms	2	5	3
					Total Score	**10.5**	**18**	**11.5**
					Potential score	**20**	**20**	**20**
					Total / Potential Score Ratio	**0.53**	**0.90**	**0.58**
					Weighted score	**0.16**	**0.27**	**0.17**
		The Interchange bridge crossing does not significantly impact on sediment transport and morphology of the river channel.	20%		Sediment transport through the system will not be impaired by the Interchange bridge	1	1	2.5
					Pier locations do not have an unacceptable impact on the channel morphology			
					> beaches, thalweg, pools riffles	1	2	2.5
					Total Score	**2**	**3**	**5**
					Potential score	**10**	**10**	**10**
					Total / Potential Score Ratio	**0.20**	**0.30**	**0.50**
					Weighted score	**0.04**	**0.06**	**0.10**
		The Interchange bridge crossing location does not impede future opportunities for development of the flood protection system.	20%			2	4	5
					Total Score	**2**	**4**	**5**
					Potential score	**5**	**5**	**5**
					Total / Potential Score Ratio	**0.40**	**0.80**	**1.00**
					Weighted score	**0.08**	**0.16**	**0.20**
		Adequate arrangements can be made for Maintenance and Operations in the vicinity of the Interchange and bridge.			Access to floodway and channel			
					Gravel extraction when required			
					Mowing and rock maintenance			
					(No distinctions at this stage. May be same for all options, a design discussion)			
					Total Score			
					Potential score			
					Total / Potential Score Ratio			
					Weighted score			
		Interchange bridge - Earthquake Failure Modes. Failures do not initiate damage to flood protection system, or impede maintenance after a flood event.			Example bridge deck drops into channel or berm.			
					Leakage from pier casings			
					Setttlement at abutments			
					(No distinctions at this stage. May be same for all options, a design discussion)			
					Weighted score			
		Summary	**1.00**		**Total Weighted Score**	**0.43**	**0.67**	**0.69**
					Maximum Weighted Score	**1.00**	**1.00**	**1.00**
					Total Weighted "1 to 5" based score	**2.17**	**3.35**	**3.44**
					Rounded "1 to 5" based score	**2**	**3**	**4**
					Flood Hazard - Workshop moderated score	**2**	**3**	**5**
					Importance score	**Importance weightings allocated at workshop and will be integrated into overall Interchange Options score**		

Appendix B

RiverLink Melling Interchange Options
Multi Criteria Assessment
Flood Hazard – Scoring Rationale

20-Jun-18

APPENDIX B
FLOOD HAZARD
INTERCHANGE OPTIONS SCORING RATIONALE

RIVERLINK MELLING INTERCHANGE OPTIONS
MULTI CRITERIA ASSESSMENT
NATURAL HAZARDS

"Importance" over criteria to be established at workshop — **Scoring 1 = highest performance**
"Weighting" over sub-criteria as entered below — **Scoring 5 = lowest performance**

Assumptions
Comments based on Assumption that Interchange options do not encroach inside Riverworks Preliminary Design stopbanks.
This assumption is not achieved by the Indirect option that encroaches on RB into the main channel.

FLOOD HAZARD - INTERCHANGE OPTIONS SCORING RATIONALE

Flood Hazard Criterion	Sub Criteria / Expected outcome	Discussion Prompts	Interchange Option2, Score and Scoring Rationale		
			Direct Option (DO)	Indirect Option (IO)	Melling Link (ML)
The impact of the Interchange option on the flood protection system during flood and following seismic events does not impact on the ability of the system to safely pass the 2,800 cumec design standard flood event.	The Waterway at the Interchange bridge crossing and location is adequate to safely pass the 2,800 cumec design standard flood with acceptable hydraulic parameters.	Acceptable corridor width between abutments / toe of abutments	**Score 3.** Waterway width 170 metres exceeds required 140m minimum. RB berm at abutment (20 m.) less than required 25 m..	**Score 5.** Waterway and RB berm heavily impacted by embankment/abutment fill, extends out to 90 m. channel edge. Upstream fill extends into active channel.	**Score 5.** Waterway less than 140m minimum. Bridge located in a long dynamic 200+ metre section of constrained waterway.
		Bridge alignment obliqueness across river is acceptable	**Score 1.** Bridge obliqueness does not cause issues.	**Score 1.** Bridge obliqueness does not cause issues.	**Score 1.** Bridge obliqueness does not cause issues.
		Local intrusions at bridge locations	**Score 3.** Does not achieve waterway objective because of upstream LB Harvey Norman (HN) constrained section. Part resolution by moving RB abutment and ramps towards SH2 (possible solutions - move bridge further towards Tirohanga Rd, use vertical MSE walls in ramps). Consider medium / long term opportunities with Repco / Harvey Norman property purchase and LB channel widening.	**Score 5.** Significant intrusion at RB abutment and connected upstream embankment. Eliminates RB berm, causes - LB / RB berm flow imbalance; diversions; irregular flow patterns. Resolution by moving abutment and embankment towards SH2 (part of solution may be a vertical MSE wall on riverside, or both sides, of embankment and ramps). Upstream constrained section has similar impact and resolution as for DO.	**Score 4.** Bridge located in very constrained section, lower end by HN "pinch point". Upstream berm flow entry amplifies narrow waterway. Upstream confined section resolution as for DO. To achieve an acceptable waterway LB property aquisition would need to be addressed before bridge construction.
		Hydraulic parameters at bridge location:			
		> velocities / flow patterns / turbulence	**Score 3.** Velocity reduces downstream of HN, approx 3.35m/s, filiament velocity 5m/s. Lower turbulence than ML section.	**Score 2.** Further reduction in velocity and associated effects below DO.	**Score 4.** High velocity 3.7m/s, approx filiament velocity 5.55m/s. High velocity, constrained channel, bridge piers and LB upstream berm flow entry will result in extreme turbulence and erosive stresses in design 2,800 m3/s flow. Velocity reduction can be achieved with measures suggested under "Intrusions".
		> headwater / water surface profile	**Score 3.** Surface gradient considerably flatter (between XS 410 - 420) than at ML section (XS 430 - 440).	**Score 2.** Surface gradient flatter again at IO (between XS 400 - 410) than DO section.	**Score 4.** High water surface gradient with 0.5m. drop over 70m (between XS 430 and 440), contributing to high turbulence and erosive forces as above.
		NOTES:	Hydraulic parameter issues are mitigated by suggested resolutions, under local intrusions.	As for DO	As for DO
	The Interchange bridge crossing has an acceptable impact on the security of the flood protection system. Residual risk remains low.	Berm widths on both LB & RB (required minmum 25 metres, includes lower berm)	**Score 3.** LB berm (approx 48 m.) exceeds minimum requirements, and provides added security at critical location. RB berm (20 m.) does not meet minimum requirements	**Score 5.** RB abutment and embankment fill cover full berm width and part channel (no berm). LB berm (64 m.) negated by RB abutment / embankment. Creates severe diversion effects.	**Score 4.** Berms (LB 19 m. RB 23 m.) do not meet minimum requirements.
		Berm materials	**Score 3.** LB and RB alluvium, moderate erosion resistance.	**Score 3.** LB and RB alluvium, moderate erosion resistance.	**Score 2.** LB consolidated silts / silty clay, good erosion resistance. RB alluvium, moderate erosion resistance.
		Bank edges protections	**Score 2.5.** LB willow band / mixed planting. RB rock riprap.	**Score 5.** LB willow band / mixed planting. RB rock riprap. Requires LB rock to mitigate flow diversion.	**Score 2.5.** LB and RB rock riprap.
		Flow diversions caused by the Interchange bridge in channel or berms	**Score 2.** Assumes pier design in channel and berms can avoid unacceptable diversions / scour and meet standard requirements. LB abutment not an issue with appropriate design.	**Score 5.** RB abutment causes excessive diversion. Assumes pier design as for DO.	**Score 3.** Assumes pier design in channel and berms will mitigate diversions and scour, but located in constrained section of channel. LB abutment not an issue with appropriate design.
	The Interchange bridge crossing does not significantly impact on sediment transport and morphology of the river channel.	Sediment transport through the system will not be impaired by the Interchange bridge	**Score 1.** Assumes in-channel impact of piers / locations on sediment transport will be minimised by pier design. Outer casing cut-off level will be suffiently low to enable sediment transport through base channel.	**Score 1.** Assumes in-channel impact of piers / locations on sediment transport will be minimised by pier design. Outer casing cut-off level will be suffiently low to enable sediment transport through base channel.	**Score 2.5.** Constrained waterway section with a less stable sediment transport regime; sediment pulsing, scour, flow patterns, also affecting downstream stability. Piers within this constrained section will further impact the sediment transport regime.
		Pier locations do not have an unacceptable impact on the channel morphology > beaches, thalweg, pools riffles	**Score 1.** At this relatively stable location, pier design / location will minimise impact on beaches, thalweg, pools and riffles.	**Score 2.** At this relatively stable location, pier design / location will minimise impact on beaches, thalweg, pools and riffles. RB diversion from abutment / embankment may impact on pier performaqnce and morphology.	**Score 2.5.** With unstable sediment transport regime and piers in constrained section of river, potential for additional scour, irregular and unpatterned beaches, thalwegs, pools and riffles. Creates an in-channel maintenance issue. Resolution by channel improvements noted above.
		The Interchange option bridge crossing location does not impede future opportunity for development of the flood protection system	**Score 2.** Opportunity to improve ararangement by including curved alignment at left abutment.	**Score 4.** The impact of a bridge and embankment in the corridor at this location is described above. The consequence is that these undesireable features will be set in place for the life of a bridge, maybe in the order of 50 - 70 years. Resolution by moving abutment and embankment out of channel and on/off ramps towards SH2.	**Score 5.** The impact of a bridge in a narrow dynamic section of river is noted above. The consequence is that if this option is constructed as indicated this unstable regime will be set in place for the life of a bridge, maybe in the order of 50 - 70 years. Resolution by berm widening on both banks or do not adopt this option.
	Adequate arrangements can be made for Maintenance and Operations in the vicinity of the Interchange and bridge.	Access to floodway and channel Gravel extraction when required Mowing and rock maintenance (No distinctions at this stage. May be same for all options, a design discussion)			
	Interchange bridge - Earthquake Failure Modes. Failures do not initiate damage to flood protection system, or impede maintenance after a flood event.	Example bridge deck drops into channel or berm. Leakage from pier casings Setttlement at abutments (No distinctions at this stage. May be same for all options, a design discussion)			

APPENDIX C

RiverLink Melling Interchange Options
Flood Hazard – Design Elements

Flood Hazard and Interchange Design Elements

In order to minimise the impact of interchange elements on the flood protection system, there are design rules, precedent, practices, considerations that put the Interchange components onto a common basis. Examples are pier design within a waterway, debris management and clearance, bridge abutment arrangements, stopbanks where they are integrated into bridge components, and aquifer protection (Hutt Valley).

While the three interchange options may be different, these considerations bring the residual impacts and performance of the elements to a common and acceptable basis across the options. While the configuration of the Interchange options may be different these elements do not need to be included in the Multi Criteria Assessment of the options. They have common mitigation outcomes and do not influence the selection of a preferred Interchange option.

These requirements and considerations will be clarified and expanded by Greater Wellington Flood Protection during design discussions. Relevant considerations may include:

Stopbanks (that also form part of the interchange)

- Buffer zone - a minimum 5 metre buffer zone at the outside base of the flood defences (stopbanks, retaining walls, hybrid retaining structures) to enable river operational activities, maintenance and to protect stopbank foundation. Can be part of public road or land provided access is available.
- Standard stopbank profile is: 3.5:1 slopes, 4 metre crest width. Other hybrid profiles may be considered.
- Stopbank and foundation geotechnical and water retaining design.
- Proximity to erosion potential.

Bridge Pier Parameters

- Bridge soffit (lowest point) at abutment is no lower than stopbank crest.
- Minimum debris clearance to bridge soffit (lowest point on bridge cross section) across bridge waterway.
- Debris clearance transition from bridge landing location (by agreement).
- Double piled pier sets are not conducive to flow alignment.
- Minimum pier spacing. Minimum pier to width ratio, including double casing impact. To mitigate flow concentration in channel and on berms.
- Piers double cased below bed level for berm, river bed and artesian aquifer security.
- Outside casing height does not significantly impede river sediment transport processes.
- Piers within the channel designed to mitigate downdraft erosion and located to avoid bank edge erosion risks.
- Piers on berms designed to mitigate downdraft erosion, located to avoid concentration of flows near stopbanks.

Bridge Abutments

- Appropriate design standard for seismic events and importance factors if appropriate
- Abutment foundations designed to prevent bridge subsidence and “spreading” of fill material in or below the abutment during earthquake events.
- Generally additional rock riprap required (above normal bank edge protections) at abutments.
- Shaded berm areas under bridge deck require specific treatment to resist scour as vegetative berm protection not possible.

Appendix D

RiverLink Melling Interchange Options
Multi Criteria Assessment
Seismic Hazard

s 9(2)(a)

From: s 9(2)(a) @stantec.com>
Sent: Friday, 15 June 2018 10:51 a.m.
To: s 9(2)(a)
Cc:
Subject: Melling Options

Hi s 9(2)(a) and I managed to catch up yesterday and considered the following three options you sent through to me in pdf format:

- Queens Drive Direct Link
- Queens Drive Indirect Link
- Melling Link

Further to my discussion with s 9(2)(a) and my subsequent telephone discussion with you, my take on the key seismic criteria to be considered for the above options are as follows (some of these will undoubtedly overlap with s 9(2)(a) flood work and the list is not necessarily exhaustive):

- Design standards to be used in bridge and retaining structure design
- Seismic resilience of the bridges and retaining structures
- Seismic resilience of the stopbanks if bridge abutments are built into it
- Proximity to seismic hazards i.e. Wellington fault
- Structural form of bridges and retaining structures
- Geotechnical/ground conditions
- Close proximity of individual structures and the potential/practicalities of merging these structures into longer single structures (i.e. Direct Link and Melling Link structures)
- Impact of bridge substructure elements on waterway i.e. piers/abutments
- Artesian risk

When considering the above criteria for the three options presented the following became apparent:

- All bridges and retaining structures on this project, regardless of the option chosen, should be designed in accordance with the NZTA Bridge Manual to meet current best practice for seismic design/resilience. The level of resilience provided for each structure would be dependent on the Importance Level of each structure and its structural type.
- All structures are in similar proximity to the Wellington fault
- Based on the length of each river crossing the structural form for all river crossing options would be fairly similar.
- The seismic susceptibility of structures due to poor ground conditions (ie. liquefaction and lateral spreading) for all three options are considered similar
- The impact of substructure elements (i.e. piers/abutments) on the waterway and stopbanks is similar for all options
- The artesian risk for the bridge foundations is similar for all options

As I hope you can appreciate there is not a lot to go on with the low level of detail shown on the pdf drawings sent through. That said, from a high level perspective, regardless of which option is chosen, and with the all other aspects of the project considered very similar in terms of structure extents and location, I feel comfortable in stating that subject to the best practice seismic design requirements imposed by the NZ Bridge Manual are implemented (which they would be anyway), I can see no real standout issues between the three options from a seismic perspective.

I hope this answers your question, but happy to discuss further.

Regards,

s 9(2)(a)

Stantec New Zealand
Level 13, 80 The Terrace,
Wellington 6011 New Zealand
Phone: s 9(2)(a)
Mobile

s 9(2)(a) @stantec.com

From: s 9(2)(a)
Sent: Monday, 11 June 2018 9:18 a.m.
To: s 9(2)(a) @stantec.com>
Cc: s 9(2)(a) l@damwatch.co.nz>
Subject: RE: Melling PDFs

Hi s 9(2)(a)

As discussed, please can you give s 9(2)(a) a call and arrange a catch up this week to discuss the resilience of the options in relation to earthquakes.

His contact details are below.

Regards,

s 9(2)(a)

Direct: s 9(2)(a)
Mobile

Stantec New Zealand
Level 13, 80 The Terrace
Wellington 6011

From: s 9(2)(a) @damwatch.co.nz]
Sent: Thursday, 7 June 2018 4:09 p.m.
To: s 9(2)(a) @stantec.com>
Subject: RE: Melling PDFs

Thanks s 9(2)(a) or the drawings.

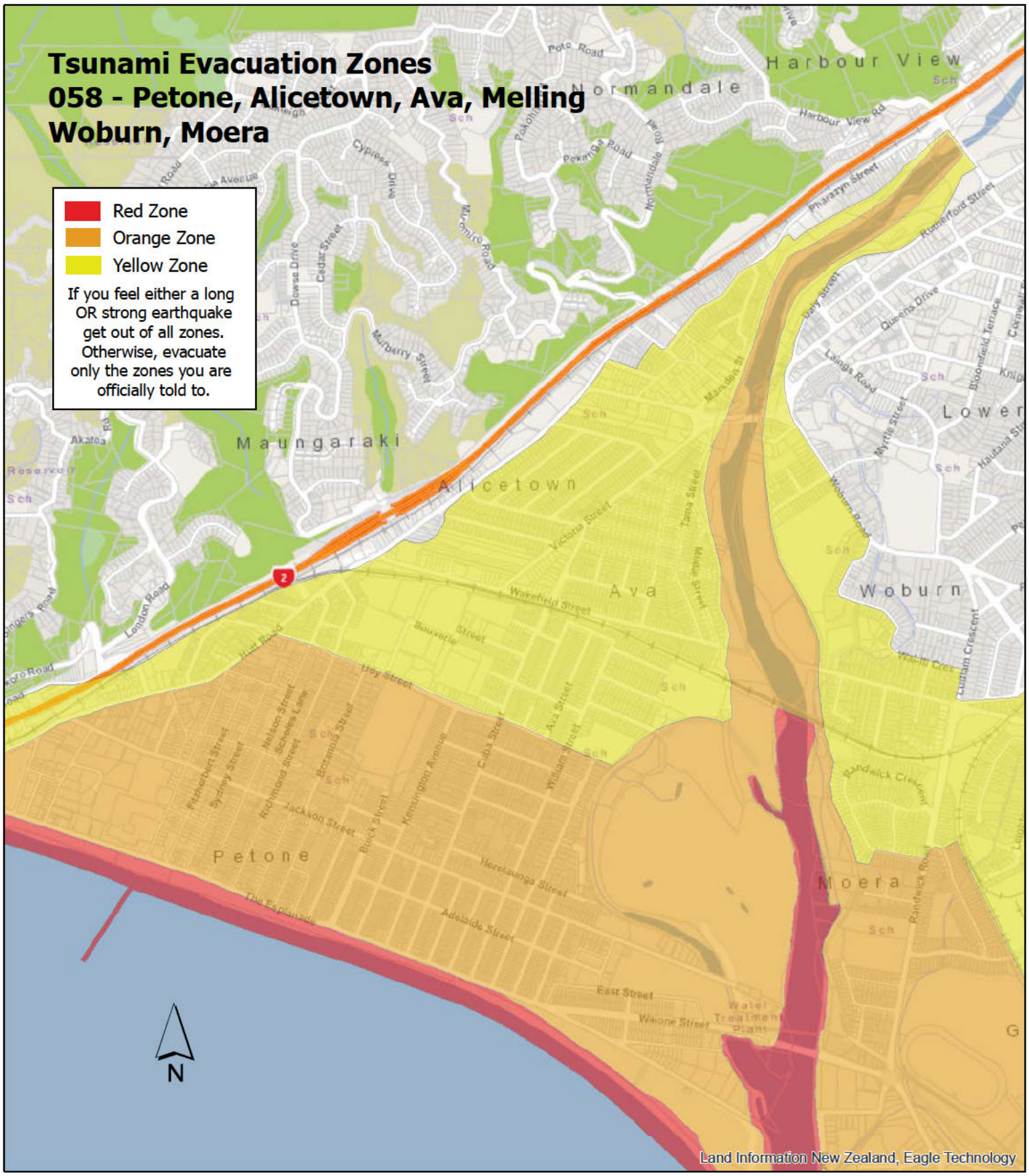
I am in work tomorrow if it suits to catch up.

Regards

Appendix E

RiverLink Melling Interchange Options
Multi Criteria Assessment
Tsunami Inundation Map

If you feel an earthquake that is either longer than a minute OR strong enough that it's hard to stand up THEN get to high ground, out of all zones, as soon as shaking stops!



Long or Strong, be Gone

For maps of the Wellington Region and detailed zone descriptions:
www.getprepared.nz/tz

WELLINGTON REGION EMERGENCY MANAGEMENT GROUP

GNS SCIENCE TE PŪ AO

0 250 500 1,000 Meters

Scale 1:24,000

greater WELLINGTON REGIONAL COUNCIL Te Pane Matua Taiao

Appendix F Background Notes – Landuse Impacts and Consentability

Melling Intersection Improvements - MCA - Landuse and Consentability

This report has been prepared for the benefit of NZ Transport Agency. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person.

Rev. No.	Date	Description	Prepared By	Checked By	Reviewed By	Approved By
1	22 June 2018	Landuse and Consentability criteria write up	s 9(2)(a)		s 9(2)(a)	

1 Introduction

The following is a background paper to inform the evaluation provided at the workshop on 19 June 2018 on land use and opportunities and consentablity criteria. It outlines the initial considerations and then captures the main aspects of the discussion at the MCA workshop that influenced the final scoring.

2 Land use Impacts and Opportunities Criterion

This is a broad criterion which addresses potential changes in the use of land across the project area. It takes into account adverse effects such as loss of access and reduced exposure to passing traffic in some areas, but also opportunities created by release and re-parcelling of residual land. It also covers construction impacts on the project's immediate neighbours.

For the purpose of the MCA, adverse effects related to visual, urban design and recreational impacts and natural hazard are covered under other criteria and therefore are not reported here.

The Melling Intersection improvements (including a replacement bridge across the Hutt River) are one component of a broader project involving floodway improvements and central city regeneration. The discussion in this paper has taken care to focus on those elements with a direct link to the intersection improvements and excludes impacts that are the result of the broader project and not the transport project .

2.1 Assumptions

The following assumptions have been made in relation to preparing the background paper:

Same for all options:

- Rail station moved
- Realigned Harbour View Road/ off ramp /on ramp connection and new connection to Tirohanga Road
- New southbound off ramp over existing Skate Park area
- Loss of existing parking for rail station adjacent to current rail station and along Pharazyn St
- impact on existing properties in Pharazyn St related to flood protection

Melling Link

- Raised bridge structure at Melling Link and Melling Link realigned to the east

Queens Direct Option

- New crossing to intersect with Queen Dr /Rutherford Street, forming new intersection
- Rutherford Street raised by up to 2.5m in height
- widening of Queen Dr between Rutherford and High Street

Queens Indirect Option

- New crossing to intersect with Queen Dr /Rutherford Street, forming new intersection slightly south of current location
- Raising of section of Rutherford Street by up to 5m
- Queens Drive realigned to High Street

2.2 Potential changes in use of land

A site visit was undertaken to investigate the potential impacts and opportunities, and follow-up work included a review of the Hutt City District Plan to identify any outstanding features, zoning and designations and a review of the Council's GIS to review property and access arrangements. The intention of the investigations was to help understand how existing land parcels and businesses could be affected by road realignments, new structures, and the works that will be necessary to implement any of the options. It was also to understand what if any 'protected' features valued by the community could be affected. The assessment takes into account the present landuses although legal arrangements between occupiers were not investigated, and it is possible that there will have been landuse and/or ownership changes prior to any land acquisition or other modification associated with the commencement of work on the project. It is also possible that tenancy arrangements and access over land for some businesses registered on titles will be affected, however these matters will be clarified later during specific consultation.

Melling Link

- The following properties are potentially directly affected by the Melling Link option as the Link is realigned to the north:

s 9(2)(b)(ii), s 9(2)(i)

Queens Direct Option

- The following properties are potentially directly affected by the Queens Direct option:

s 9(2)(b)(ii), s 9(2)(i)

Queens Indirect Option

- The following properties are potentially directly affected by the Queens Indirect option:

s 9(2)(b)(ii), s 9(2)(i)

The above changes were examined in greater detail and draft scorings are provided in the sections that follow.

2.3 Temporary effects

A component of the criterion related to the effects on landuses from temporary construction-related activities. While in most cases these would persist only for part of the project construction stage, they could be disruptive to landowners and business activities nearby and could cause economic impacts that are not directly apparent (such as the potential for a reduction in income in the case of landowners due to difficulty in finding tenants prior to and during the construction phase).

s 9(2)(b)(ii), s 9(2)(i), s 9(2)(j)

Scoring

	Melling Link	Queens Drive – Direct	Queens Drive – Indirect
Temporary adverse effects	4	3	3

2.4 Permanent effects

As part of the new interchange and bridge, there will be some permanent changes. It is noted that the changes identified below are those which are attributable only to this project and not part of the floodway development or changes in the city centre.

s 9(2)(b)(ii), s 9(2)(i), s 9(2)(j)

[redacted]

Scoring

	Melling Link	Queens Drive – Direct	Queens Drive – Indirect
Permanent adverse effects	1	2	2.5

2.5 Impacts on neighbouring properties that are not directly affected

This section identifies the actual and potential land use effects that are likely to result from temporary (construction) or permanent physical or traffic changes as a result of the project on properties that are nearby, but not directly affected (ie, by land requirement) by the project.

[1] Note that the visual impact of loss of vegetation is considered as part of the Visual and Landscape Impacts criterion.

[2] Proposed Plan Change 26 notified in 2015 is the subject of unresolved appeals.

[3] See Chapter 14E and associated Map Appendix 1, City of Lower Hutt District Plan (Item 14). These identified areas are currently not protected by any rules in the District Plan.

[4] While it is likely that there will be replacement opportunities, details are not yet certain.

s 9(2)(b)(ii), s 9(2)(i), s 9(2)(j)

[redacted]

Scoring

	Melling Link	Queens Drive – Direct	Queens Drive – Indirect
Indirect effects	2	2.5	3

2.6 Opportunities created by release and parcelling of residual land

The items noted in this section are all beneficial. They are noted for information only, but have contributed to the overall balanced scores provided below. In general terms, it is likely that the Melling Link Option would provide the fewest beneficial opportunities, whereas the Queens Drive Direct Option would provide the most. The additional length of roading involved in the Queens Drive Indirect, and the angle of approach onto Queens Drive slightly reduces the opportunities in this area.

Common to all

- Land required for the project (including construction space) but not needed for SH improvements will be available for redevelopment with multi-level development potential option – up to 4 levels. The extent of this area is not known at this stage, as it will be dependent on detailed design and actual land requirements.

Queens Drive Direct and Indirect Options

- Removal of traffic and road use from section of Melling Link north of Rutherford St means land is available for other uses.
- Higher value businesses may see benefit in locating along/around Queens Drive.

Queens Drive Indirect Option

- Realignment of Queens Drive means the existing section of road between High St and Rutherford St is potentially available for another use.

2.7 Combined Evaluation

Combining the above information provided scores of 7 for the Melling Option, 7.5 for the Queens Direct Option and 8.5 for the Queens Indirect Option, indicating a slight preference for the Melling Option in terms of landuse impacts.

This however, does not account for the possible benefits associated with "freed up" land and the new opportunities that might arise in the future as a result. If this is taken into account (particularly favouring the Queens Drive Direct Option over the Melling Option), and transferring the scores to the 1 to 5 range of the scoring system, overall scores of 3, 2 and 3 respectively were proposed.

At the workshop, the temporary effects component was discounted because of its short duration in the life of the overall project. This was not considered sufficient to modify the scores, which remained as below.

	Melling Link	Queens Drive – Direct	Queens Drive – Indirect
Overall score	3	2	3

3. Consentability

This criterion involves a high-level judgement of the issues relating to consentability, given the need to integrate a range of projects and designations and other consents in the three options. (Note – it was found from the first MCA that there was little to distinguish any options in terms of the provisions and requirements of the various applicable regional and district plans, so this criterion could be scoped slightly differently as the project moved on).

It was considered that all options were similar in relation to the issue of ability to obtain the necessary statutory approvals, except that in relation to the Part 2 matters that the decision maker must consider, the following would be likely to be key:

- section 6 - Matters of National Importance (h) the management of significant risks from natural hazards.
- Section 7 - Other matters (i) the effects of climate change.

S 6(h) puts greater emphasis to consideration of risks from natural hazards in all resource management decisions and the risk of natural hazard associated with the river is potentially increased due to the effects of climate change. Prior to the workshop it was not clear if there was an option that was any better or worse in terms of S 6(h).

Scoring this criterion in the end was subject to the outcomes of the scoring of the natural hazard criterion and discussion at the MCA process. That process indicated that due to the narrow distance between, and associated constriction of the river banks in relation to the Melling Link Option, that option was likely to contribute to a longer term greater risk of natural hazard exposure for the wider community and it was considered that this was highly likely to have a consequence in terms of consenting risk.

Scoring

	Melling Link	Queens Drive – Direct	Queens Drive – Indirect
Consentability	4	3	3

Appendix G Background Notes – Engineering Degree of Difficulty and Cost

NZTA
SH2 Melling DBC

MCA Workshop

19 June 2018

Stantec

Agenda

1. Engineering Degree of Difficulty
   - Interaction with stopbanks
   - Constructability (inc Temporary works)
   - Active modes network
   - Structural design
   - Impact on rail extension
   - Ease of design
2. Cost

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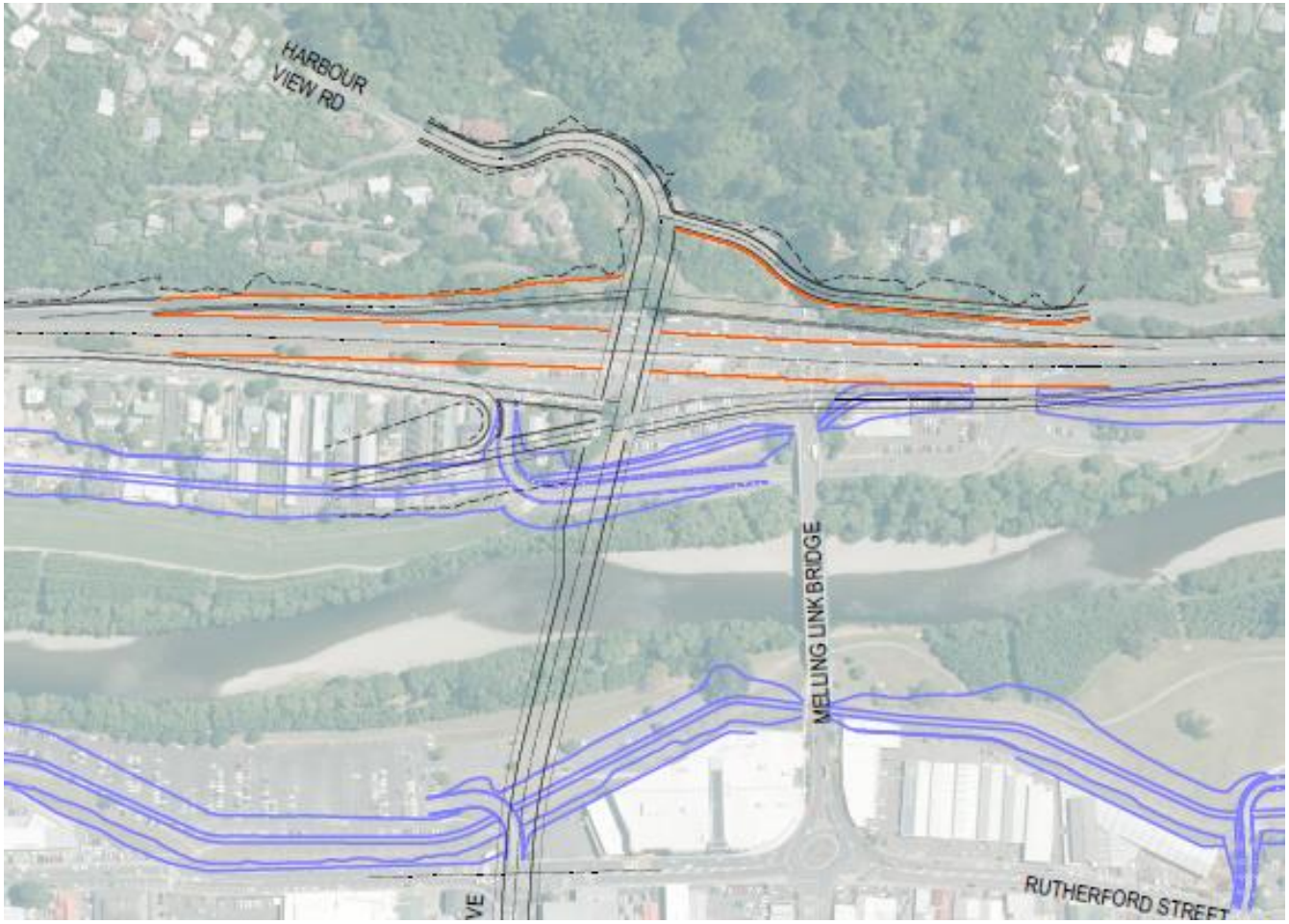
Engineering Degree of Difficulty

Stopbanks

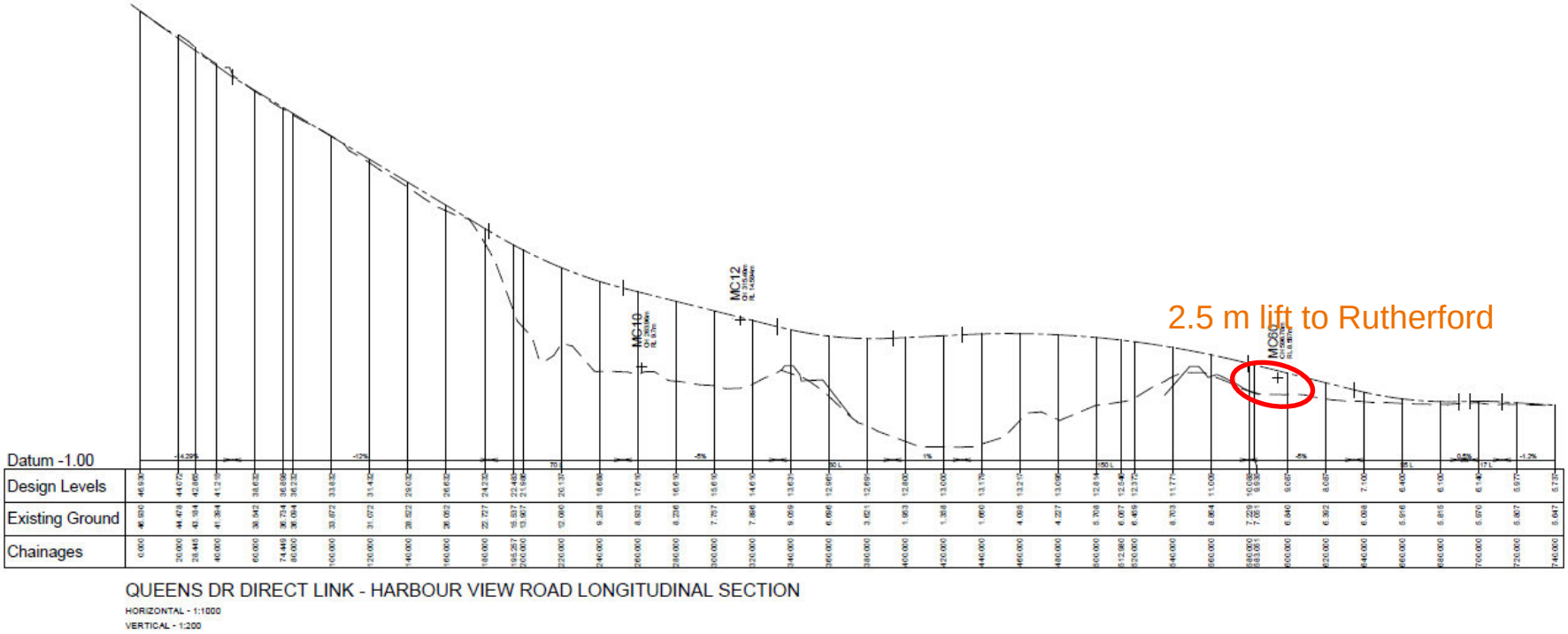
Queens Direct – abutments behind stopbanks



Engineering Degree of Difficulty

Stopbanks

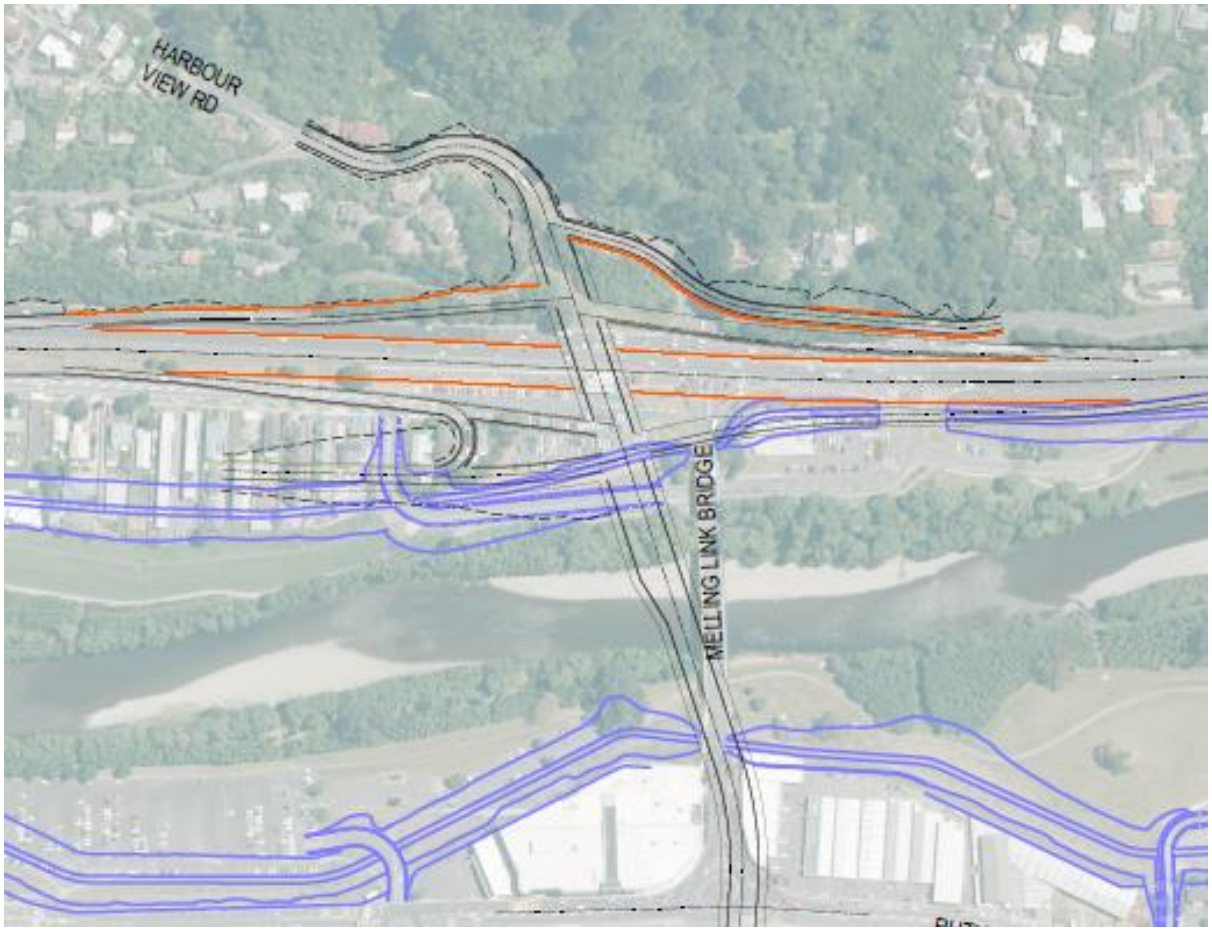
Queens Direct



Engineering
Degree of
Difficulty

Stopbanks

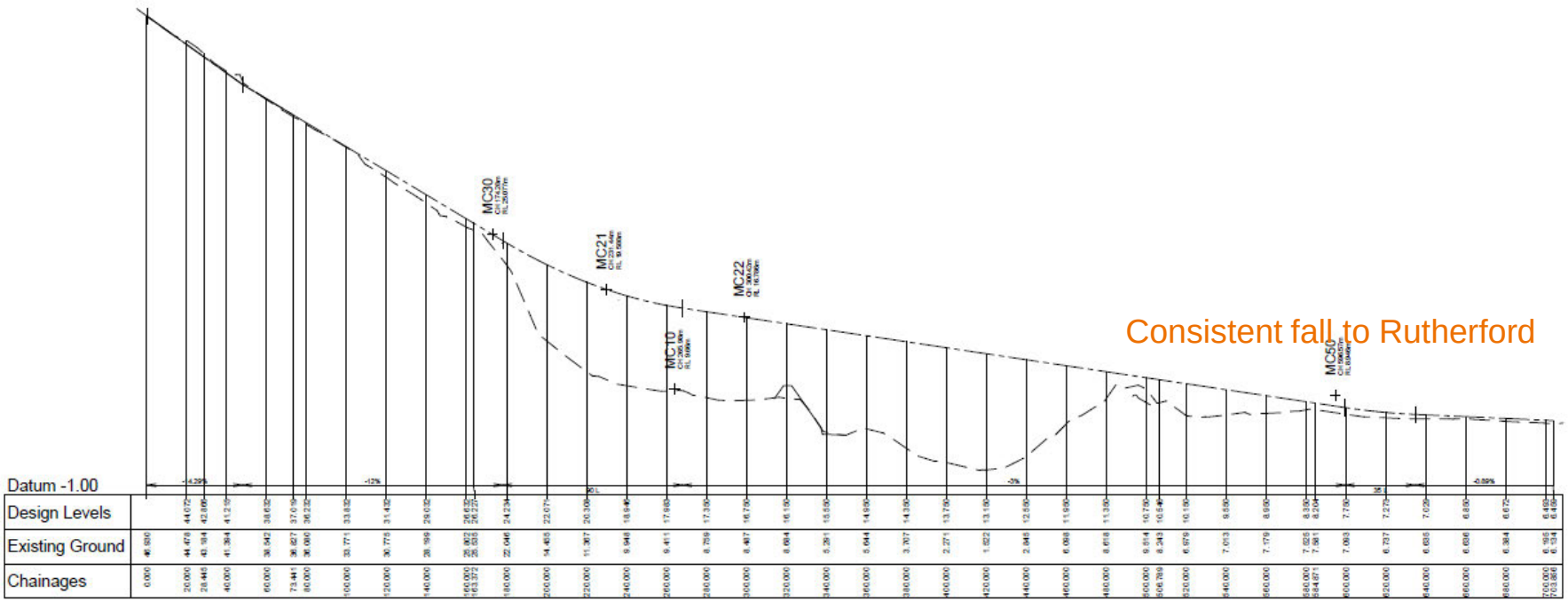
Melling Link – western abutment 6+ m above stopbank



Engineering Degree of Difficulty

Stopbanks

Melling Link



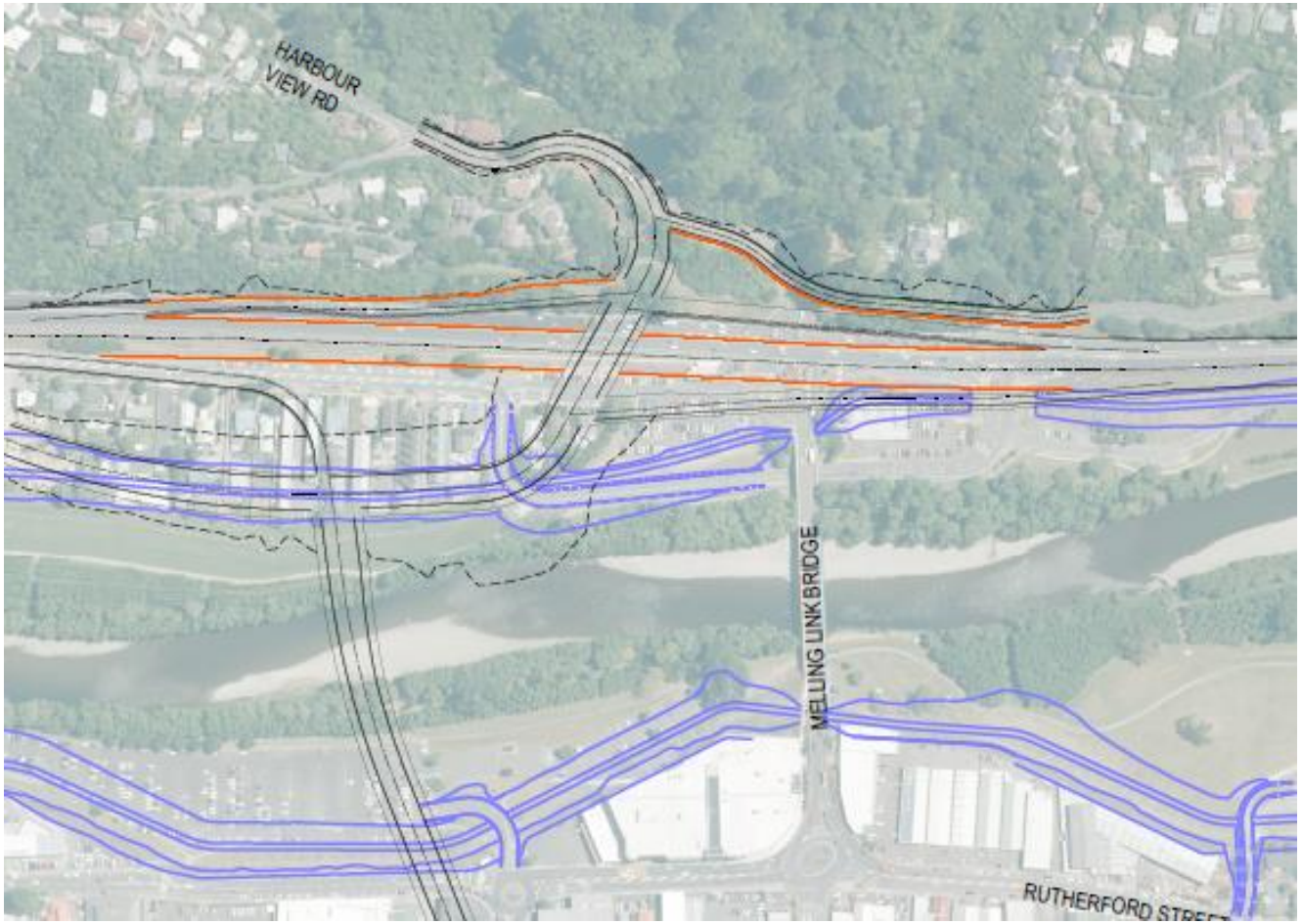
MELLING LINK - HARBOUR VIEW ROAD LONGITUDINAL SECTION

HORIZONTAL - 1:1000

VERTICAL - 1:200

Stopbanks

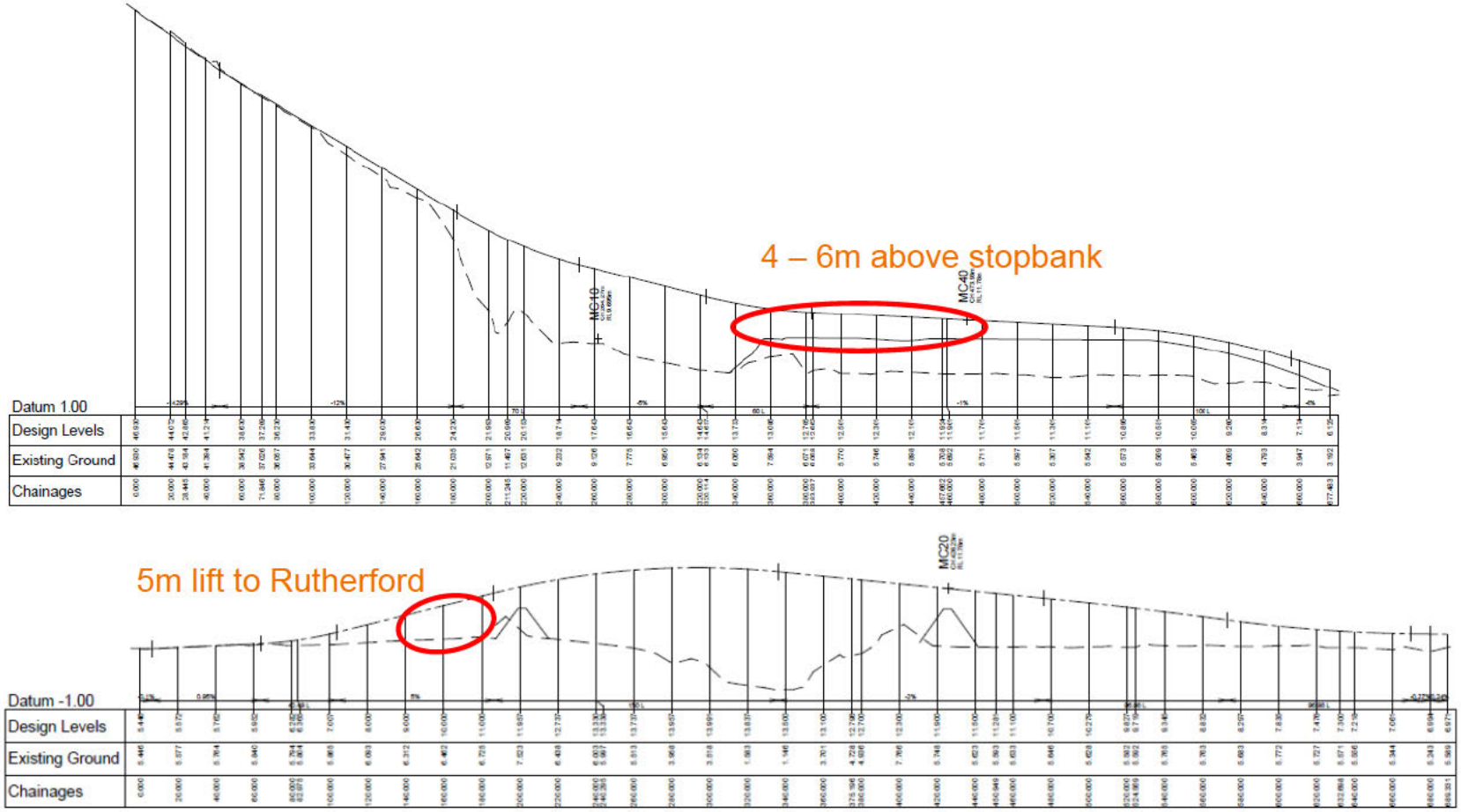
Queens Indirect – connection runs above western stopbank



Engineering Degree of Difficulty

Stopbanks

Queens Indirect



Stopbanks

Summary

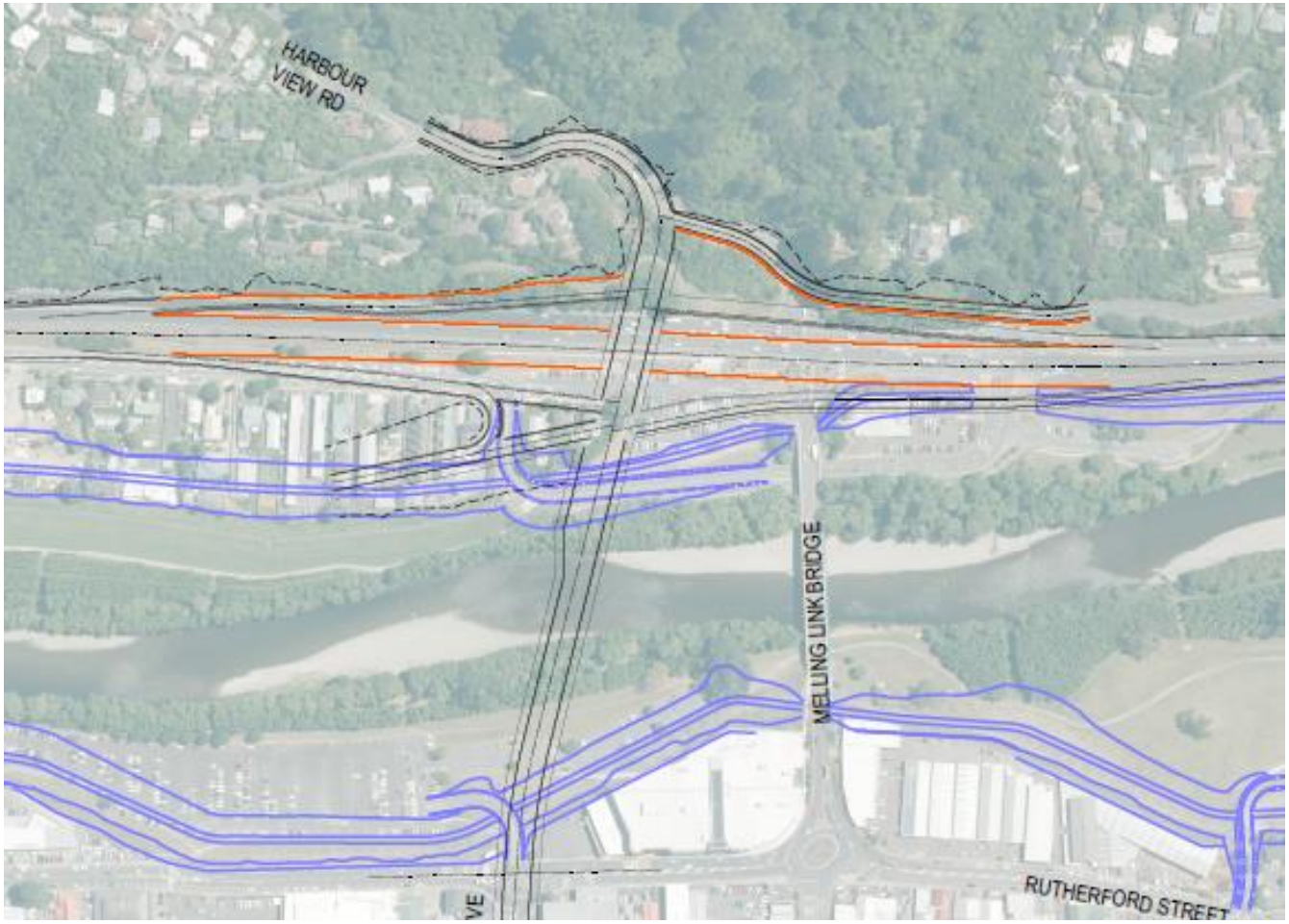
- Queens Direct has the least impact on the stop banks and may be able to be progressed with only minimal interaction with the stop banks
- Melling Link has a moderate interaction with the western stopbank (e.g. likely requires the abutment to be part of the stopbank or be piled through the stop bank)
- Queens Indirect has a significant interaction with the western stopbank and requires a 5m lift to Rutherford St if interaction with the stop bank is to be avoided

	Queens Direct	Melling	Queens Indirect
Stopbanks	2	4	5

Relative Scoring 1 – 5 (1 low, easy, cheap, etc – 5 high, complex, expensive)

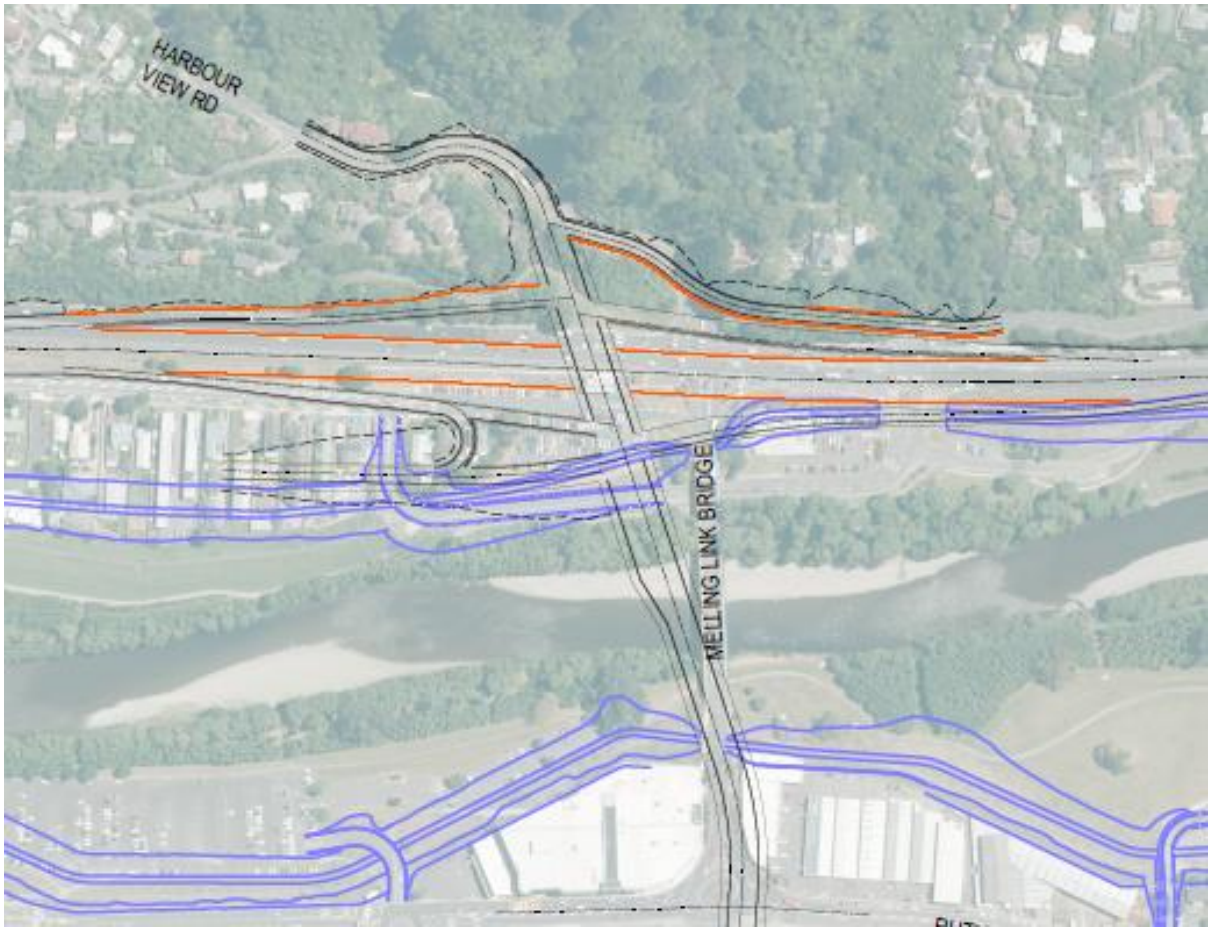
Constructability

Queens Direct – new structures largely ‘offline’



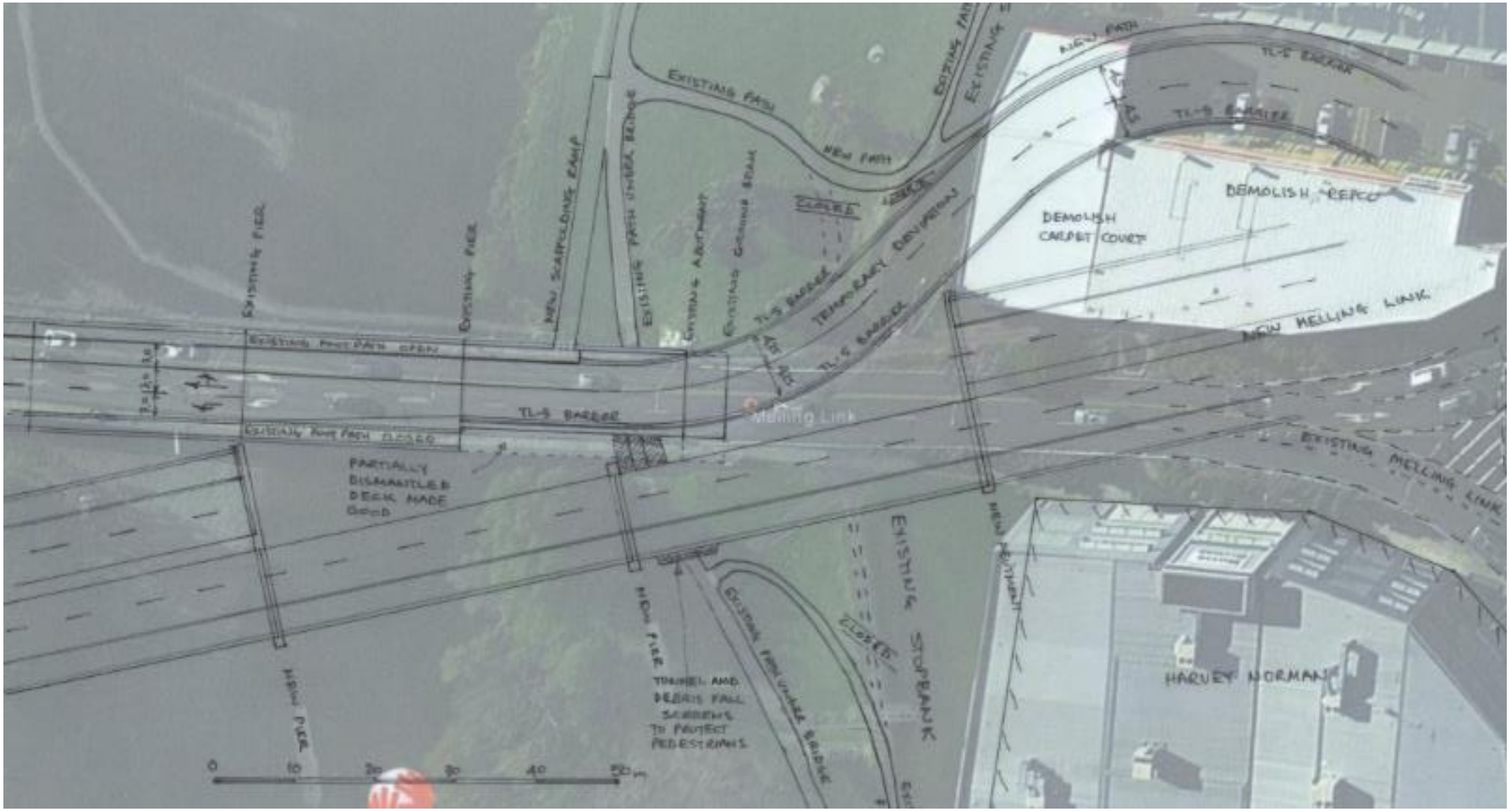
Constructability

Melling Link – significant interaction with the existing bridge



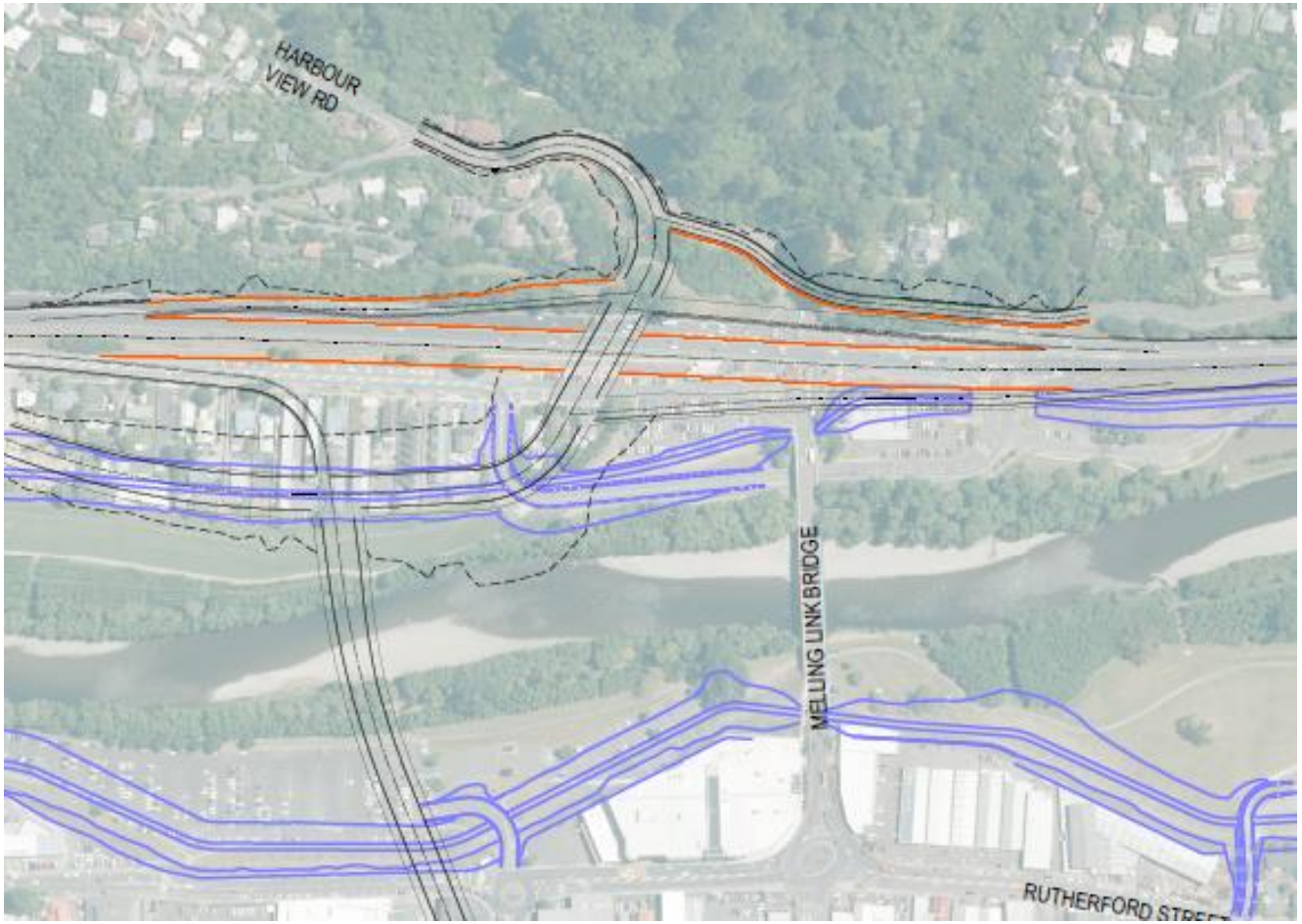
Constructability

Melling Link - potentially complex temporary works



Constructability

Queens Indirect - new structures largely ‘offline’



Constructability

Summary

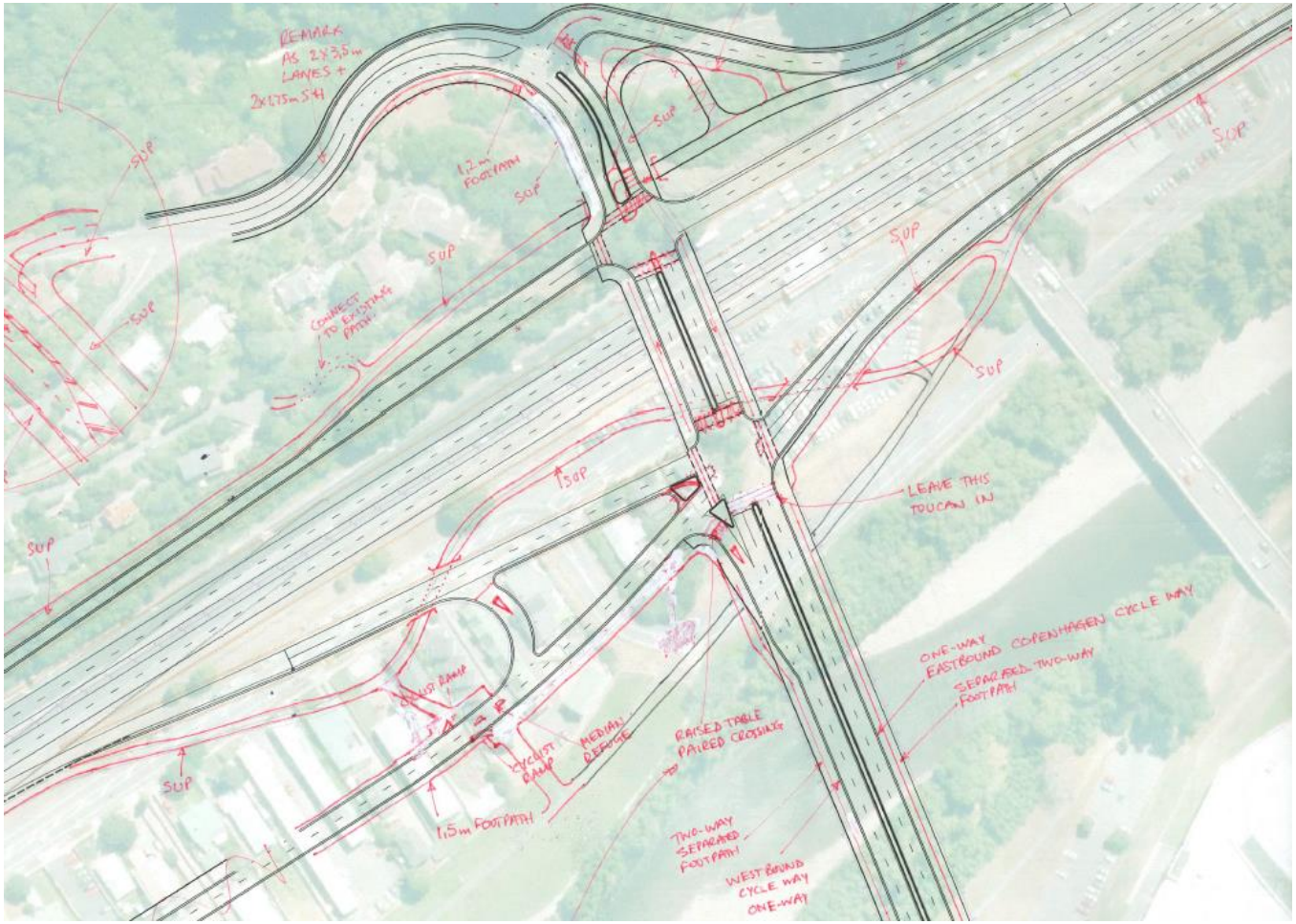
- Both Queens Direct and Queens Indirect options can be built largely offline
- Queens Indirect will require more complex engineering/construction of the stopbanks – also has a greater interaction with the fault line
- Melling Link could be a very complex option to construct if the existing SH2 intersection and Melling Bridge need to remain open

	Queens Direct	Melling	Queens Indirect
Constructability	3	5	4

Relative Scoring 1 – 5 (1 low, easy, cheap, etc – 5 high, complex, expensive)

Active Modes

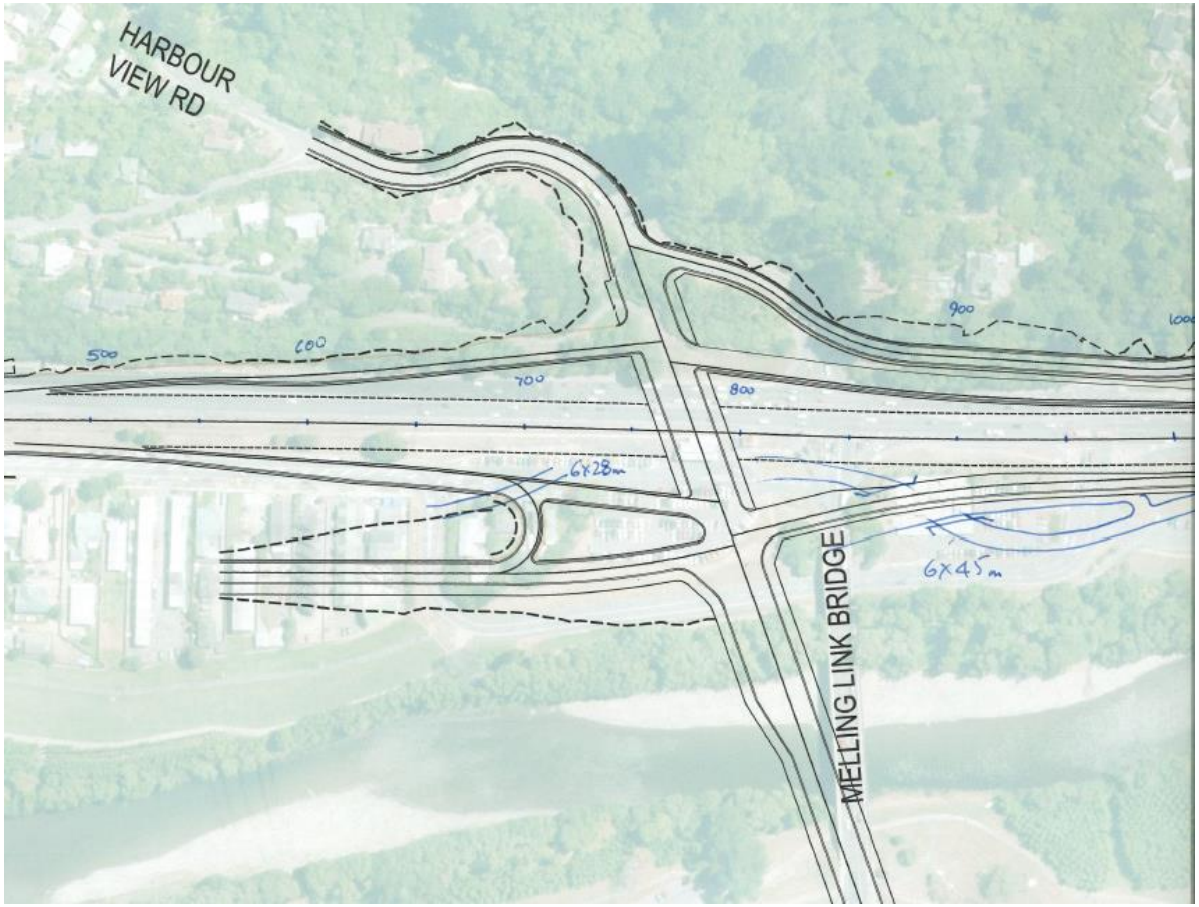
Queens Direct



Engineering Degree of Difficulty

Active Modes

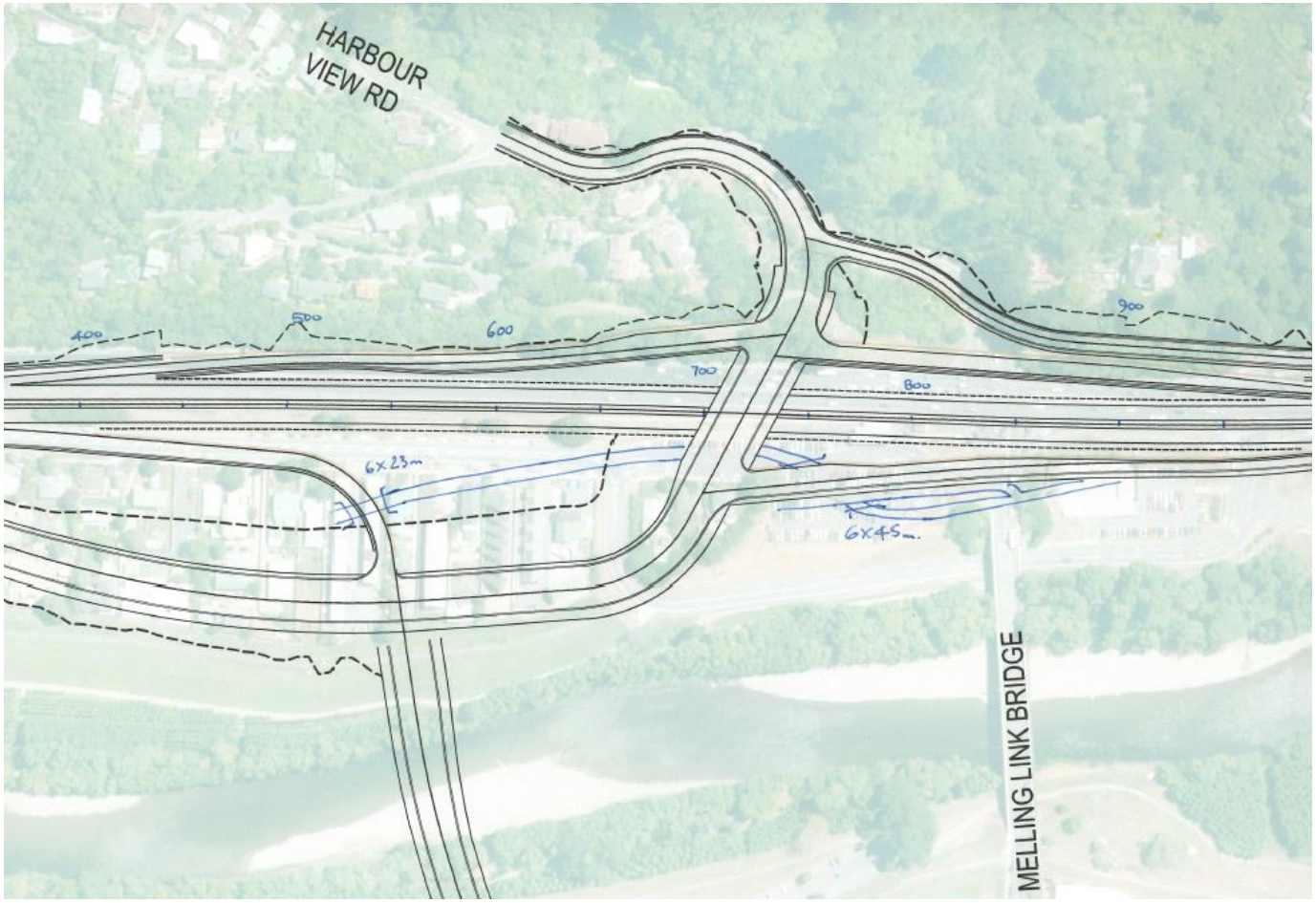
Melling Link



Engineering Degree of Difficulty

Active Modes

Queens Indirect



Active Modes

Summary

- The options are currently indistinguishable from a complexity, level of service, cost, etc perspective

	Queens Direct	Melling	Queens Indirect
Rail	3	3	3

Relative Scoring 1 – 5 (1 low, easy, cheap, etc – 5 high, complex, expensive)

Structures

Summary

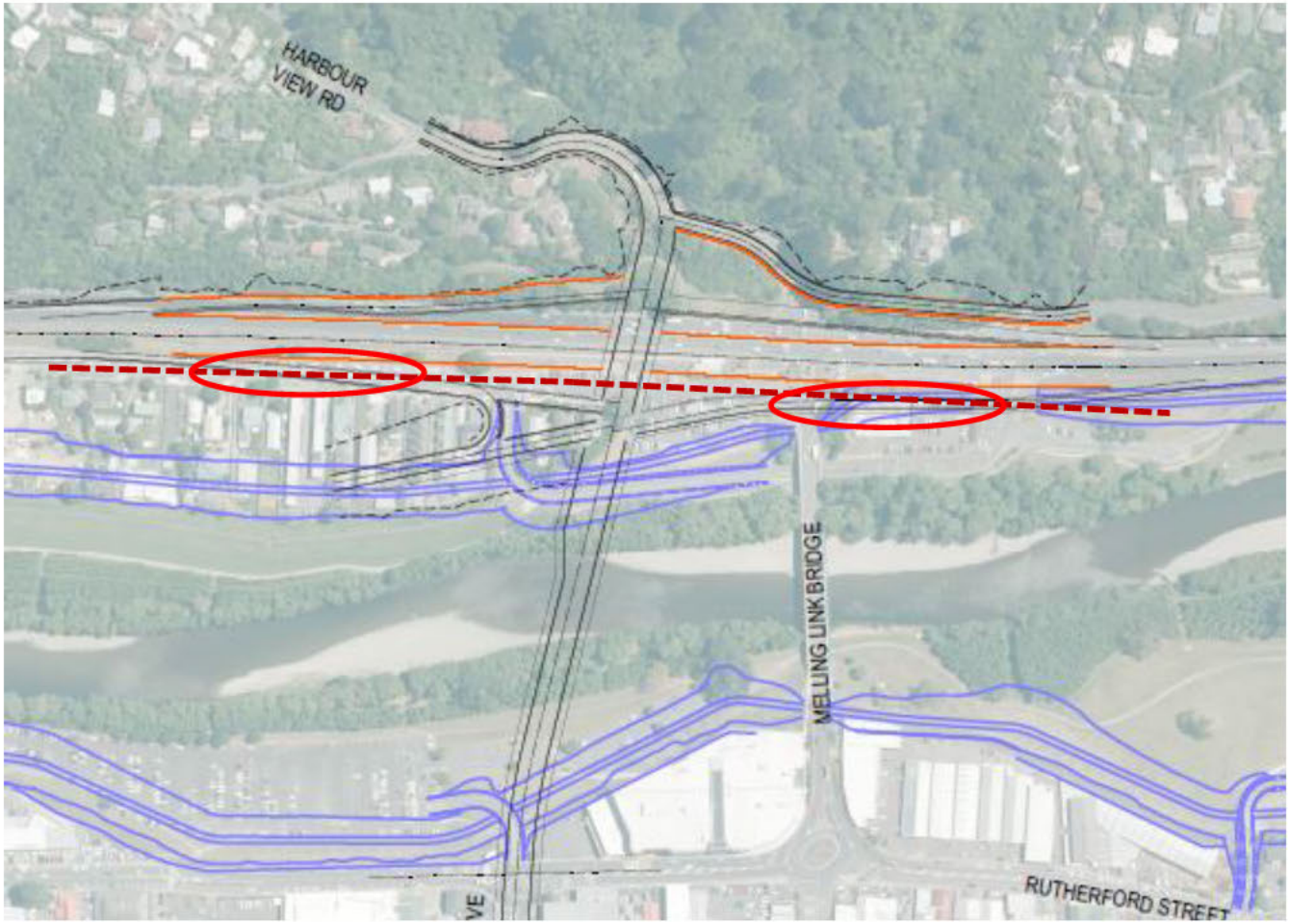
- All options will require significant structures
- Queens Direct is likely to be the least complex as the interchange abutment and western river bridge abutment may be able to be progressed without any interaction with the stop banks (i.e. there is more room to consider a range of solutions)
- Melling Link is very tight for room which may eliminate some structural solutions and the western river bridge abutment would likely need to be part of the stopbank (or piled through it)
- Queens Indirect has the additional complexity with the western abutment and connection to interchange likely to be a structure running above or through the stopbank (and the fault line)

	Queens Direct	Melling	Queens Indirect
Structures	3	4	5

Relative Scoring 1 – 5 (1 low, easy, cheap, etc – 5 high, complex, expensive)

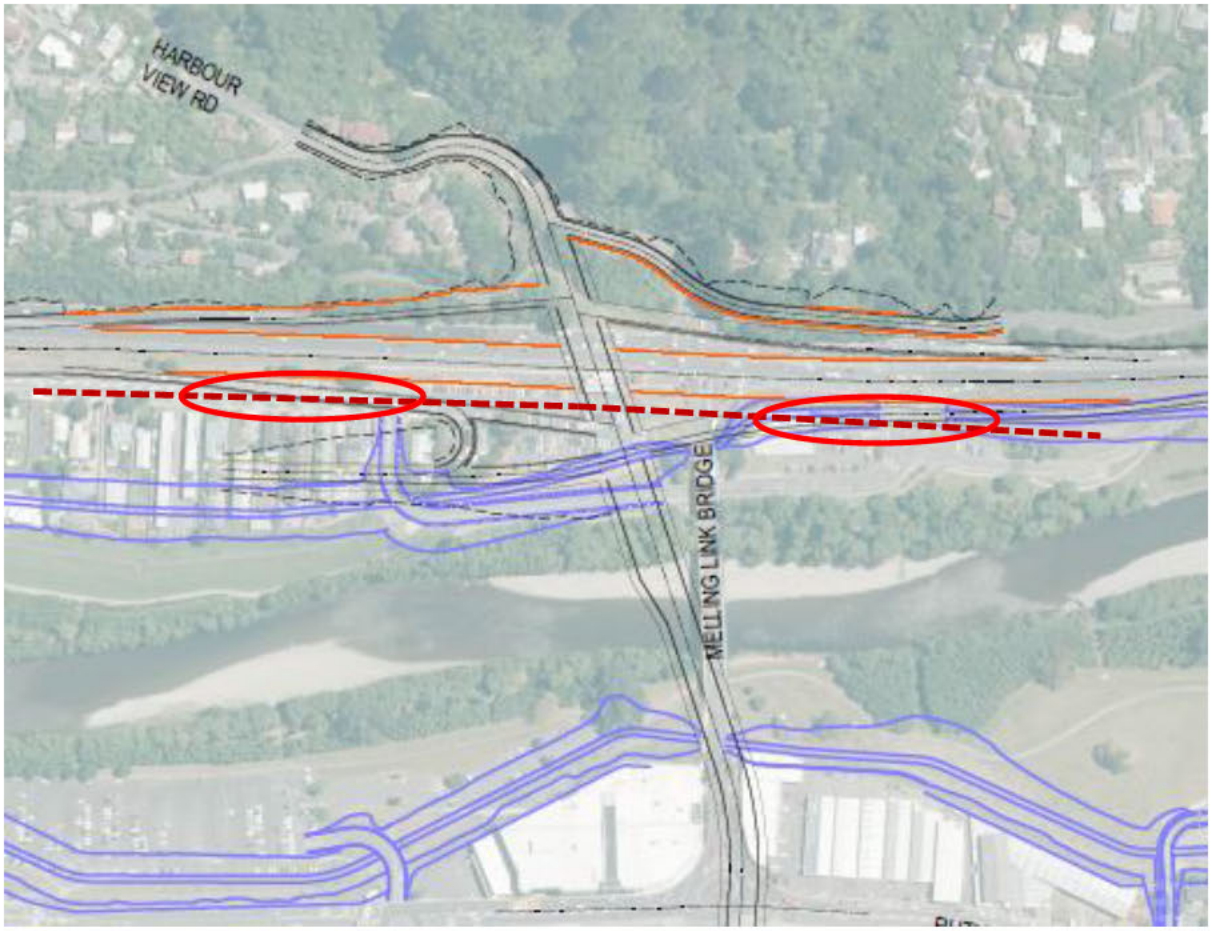
Rail

Queens Direct – trench under onramp, offramp bridge + realignment



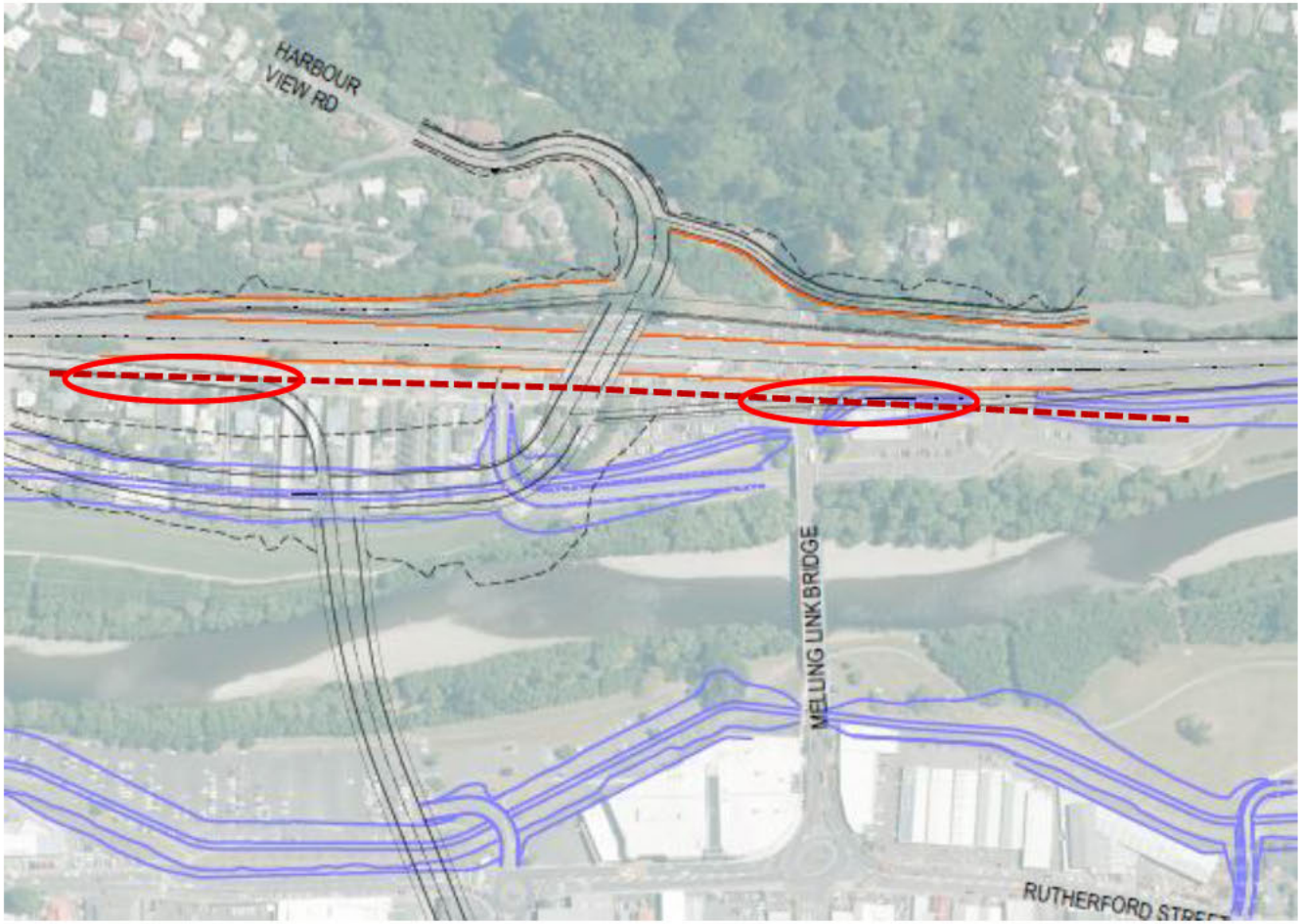
Rail

Melling Link – trench under onramp, offramp bridge + realignment



Rail

Queens Indirect – trench under onramp, offramp bridge + realignment



Rail

Summary

- All options would require the rail to cross both the onramp and offramp and thread through the interchange
- The onramp crossing could be in a trench, but the offramp would need to be at grade in order to not cut into the stopbank. This would necessitate a realignment and lifting of the offramp
- Queens Direct and Melling Options are relatively tight
- Queens Indirect has construction room

	Queens Direct	Melling	Queens Indirect
Rail	4	4	3

Relative Scoring 1 – 5 (1 low, easy, cheap, etc – 5 high, complex, expensive)

Ease of Design

Summary

- Queens Direct - Not easy, but the least complex option
- Melling Link - Additional complexity with western abutment in stopbank (on fault line) and temporary works design to keep existing bridge operational while the new bridge is being built (adjacent and above)
- Queens Indirect – Additional complexity with western abutment and connection to interchange running along (and above) the stopbank (and the fault line) which will require a complex engineering solution

	Queens Direct	Melling	Queens Indirect
Ease of Design	3	5	5

Relative Scoring 1 – 5 (1 low, easy, cheap, etc – 5 high, complex, expensive)

Summary of scoring

	Queens Direct	Melling	Queens Indirect
Engineering DoD	**3**	**4.5**	**4**
Stop Banks	2	4	5
Constructability	3	5	4
Active Modes	3	3	3
Structures	3	4	5
Rail	4	4	3
Ease of Design	3	5	5

Scoring 1 – 5 (1 low, easy, cheap, etc – 5 high, complex, expensive)

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Cost

Summary of scoring

Summary

- All options are very similar based on current estimates – all likely within a 20% spread

	Queens Direct	Melling Direct	Queens Indirect
Cost	3	3	4
Bridge - Interchange	3	3	3
Bridge - River	3	2	4
Retaining Walls	3	3	4*
Earthworks	3	3	4*
Pavement	3	3	4
Temporary Deviations	3	5	3

* assumes additional cost (structures or earth) for connection between bridge and interchange

Scoring 1 – 5 (1 low, easy, cheap, etc – 5 high, complex, expensive)

Appendix H Background Notes – Ability to be Staged

NZTA
SH2 Melling DBC

MCA Workshop

19 June 2018

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Staging

- With RiverLink elements
- With Transport Improvement elements
  - Safety
  - Efficiency
  - Resilience
  - Urban Design / Gateway

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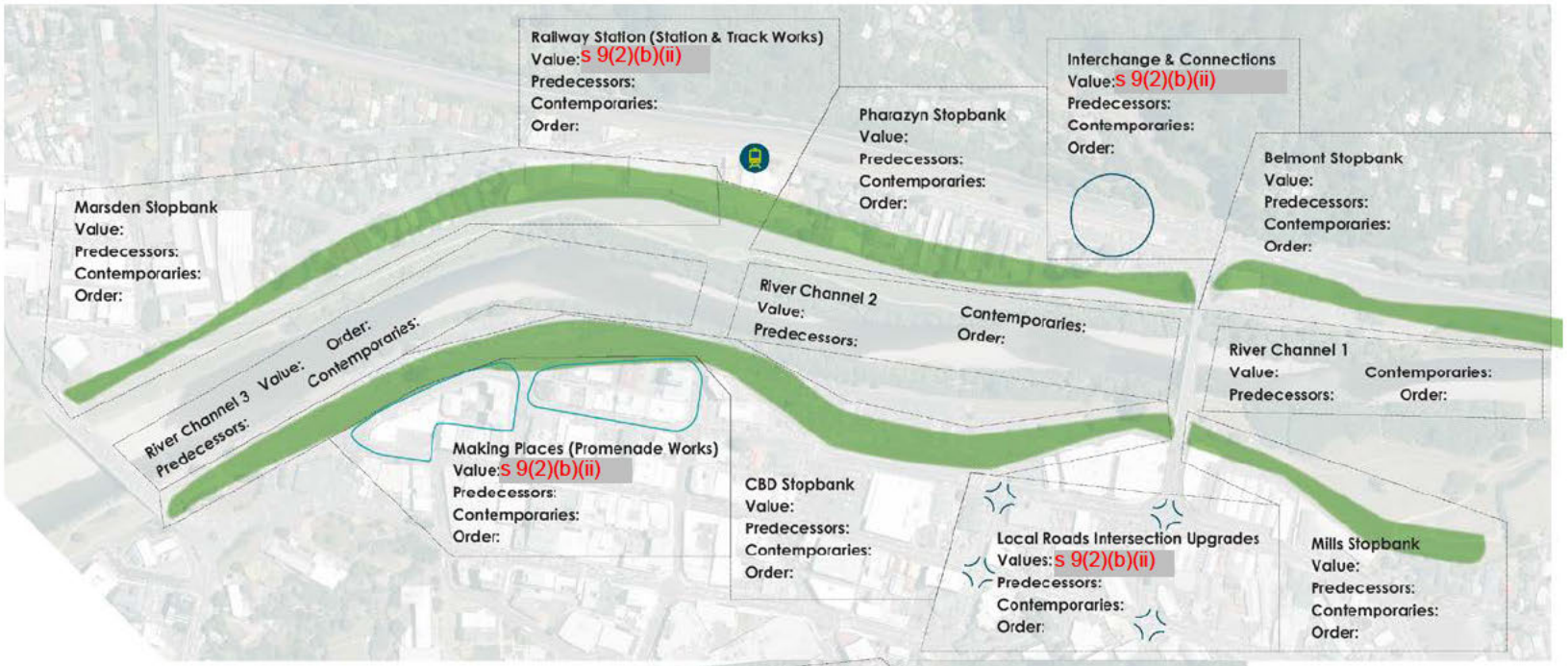
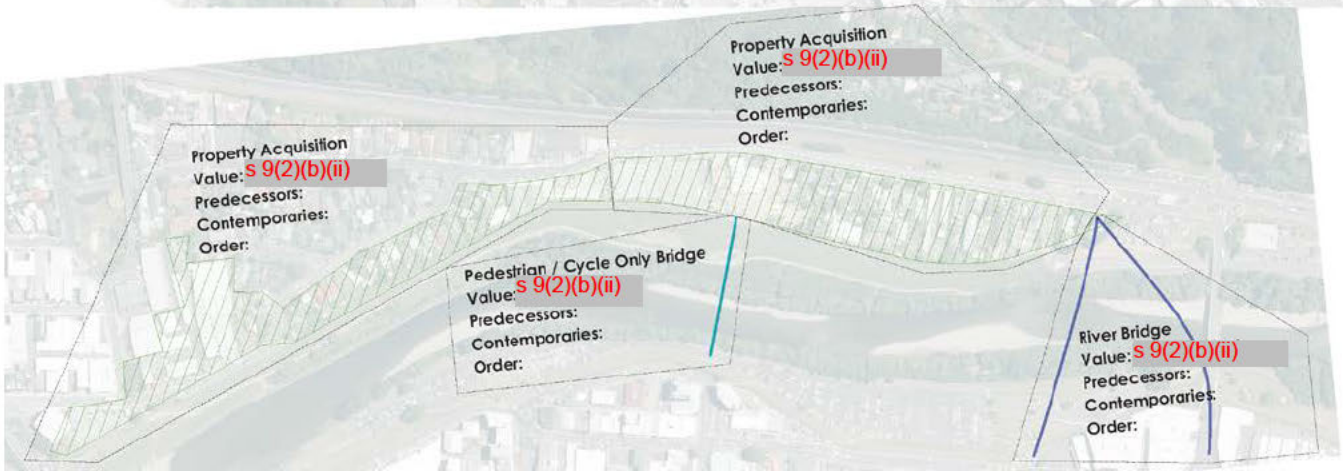
Staging

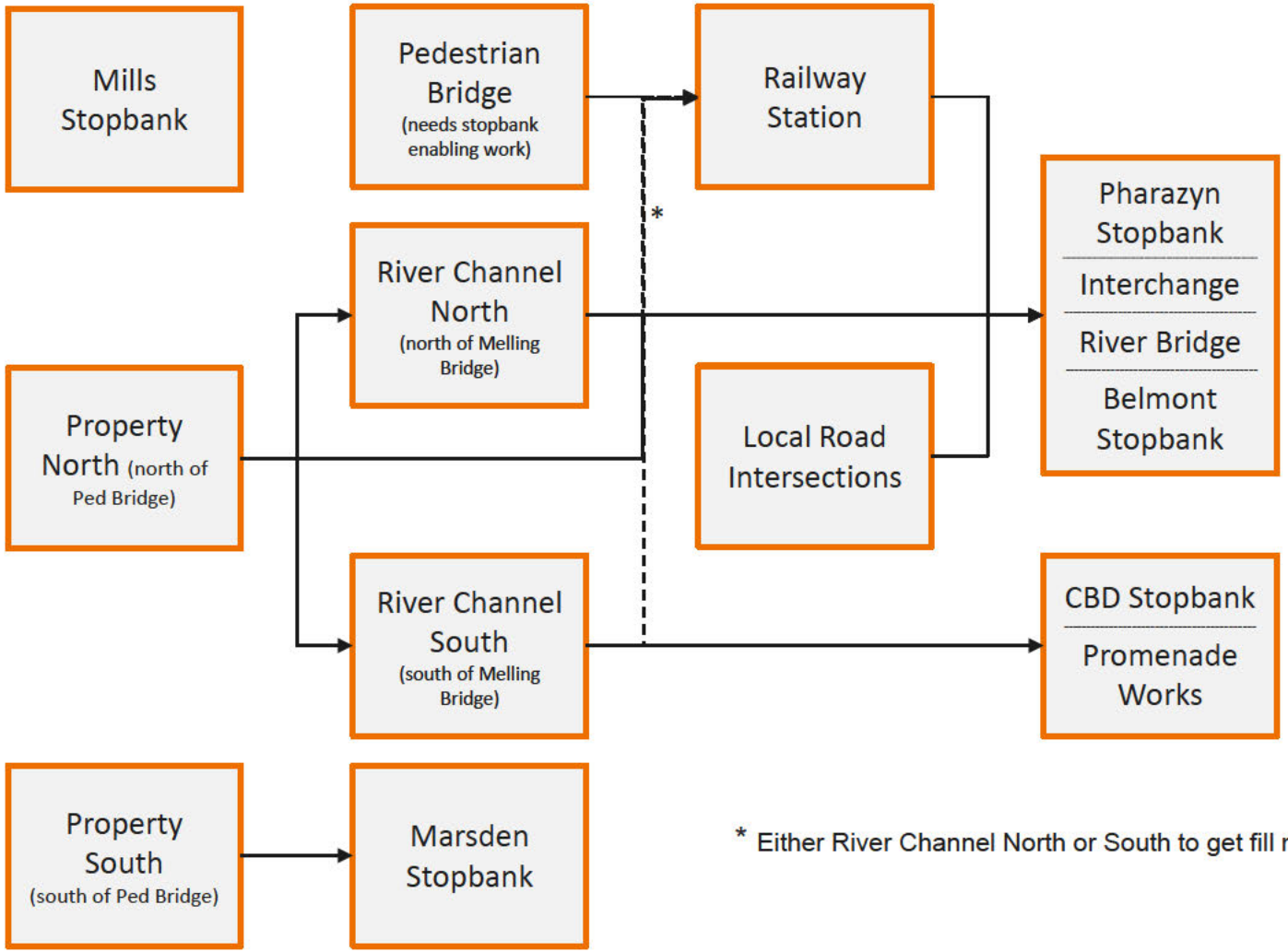
Staging

RiverLink





RiverLink



* Either River Channel North or South to get fill material

RiverLink

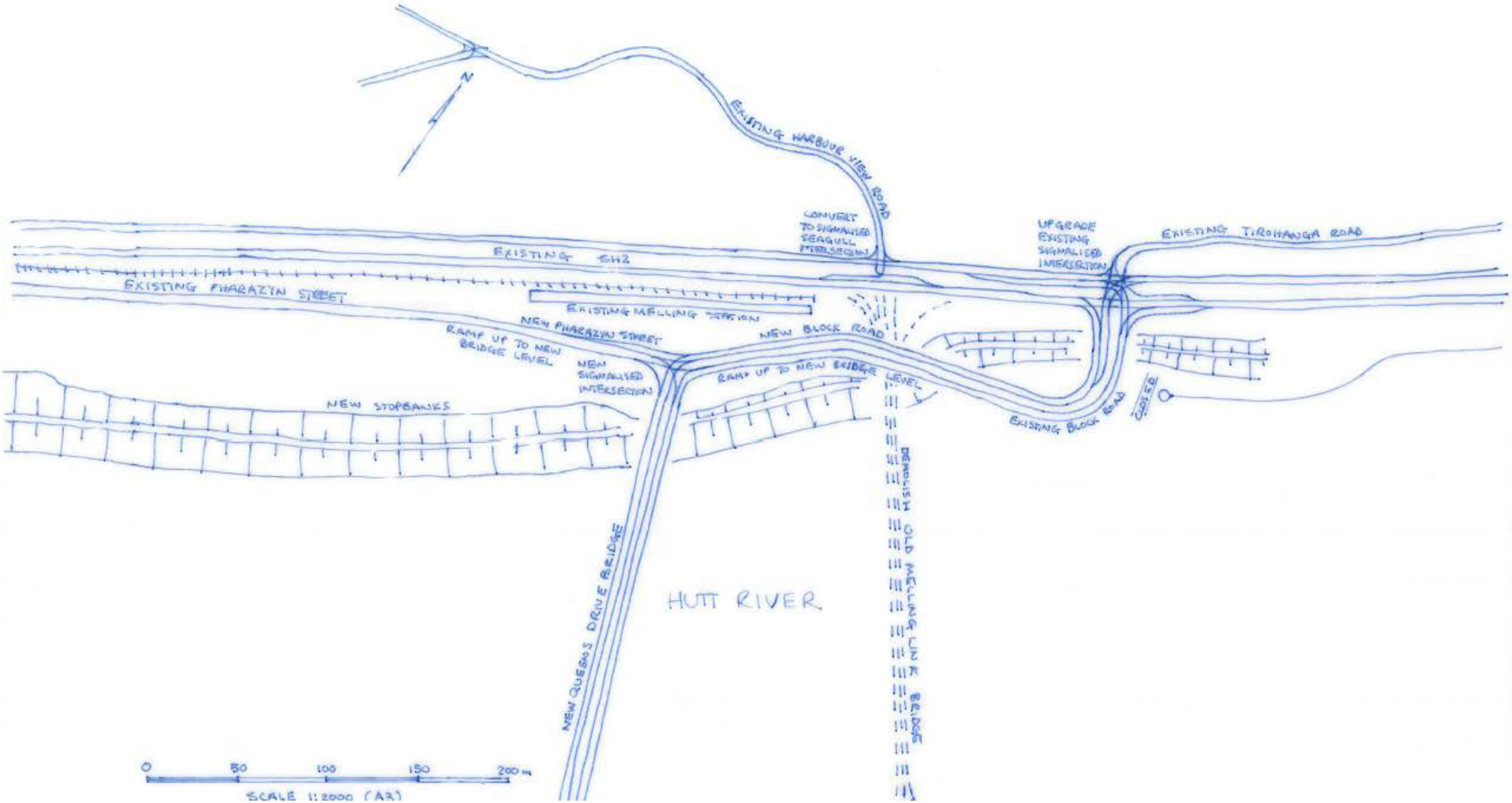
No real difference between options

- Bridge and Interchange need to be built near the end of the programme
- Stopbanks need to be built before/with bridge to enable construction and compaction of material
- Local road intersections of new bridge and Rutherford Street shouldn’t be built before the new bridge as they are very disruptive.

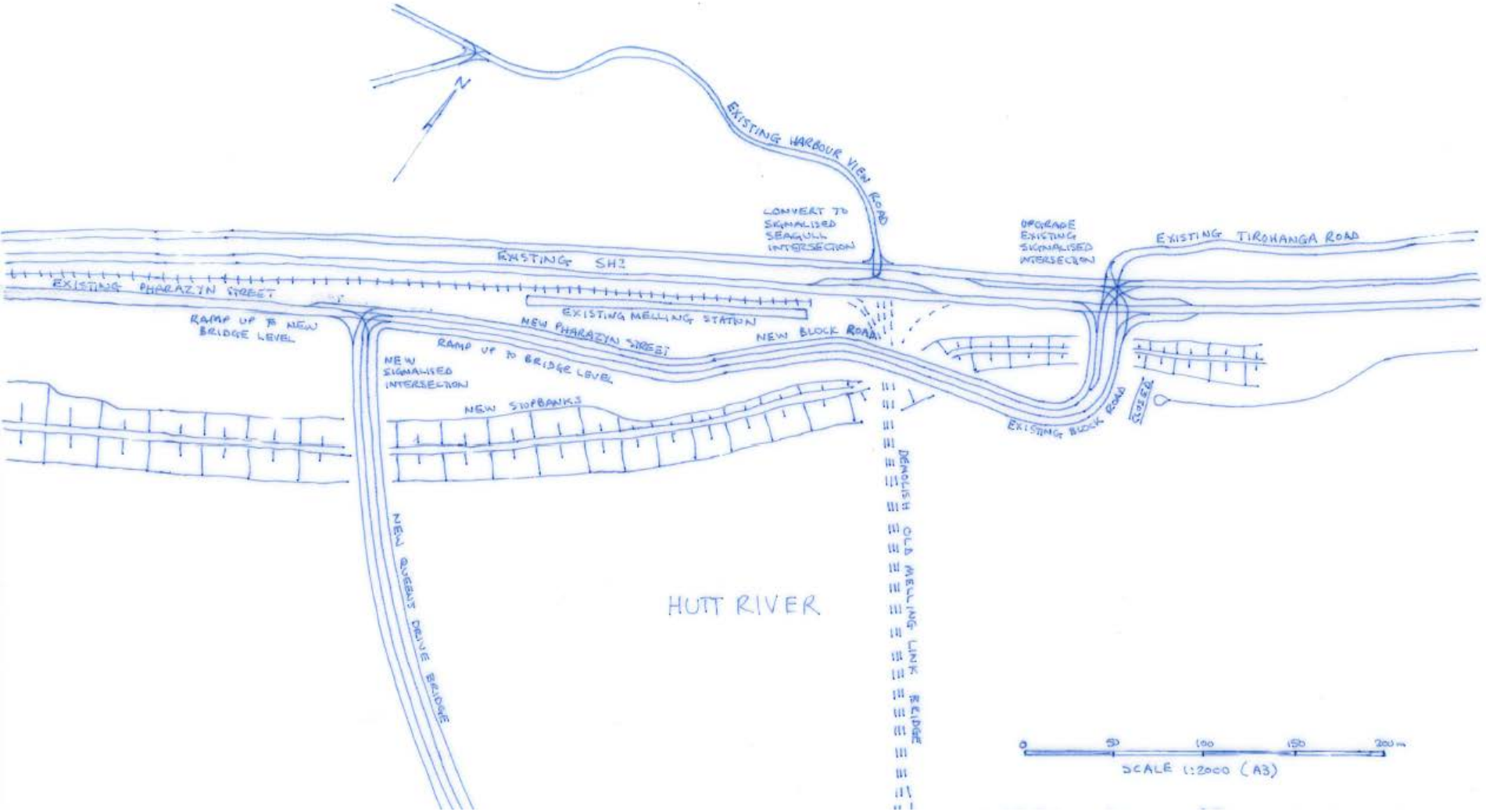
Transport Improvements

- Interchange before Bridge – not possible as interchange too high to connect into current bridge
- Bridge before Interchange - feasible

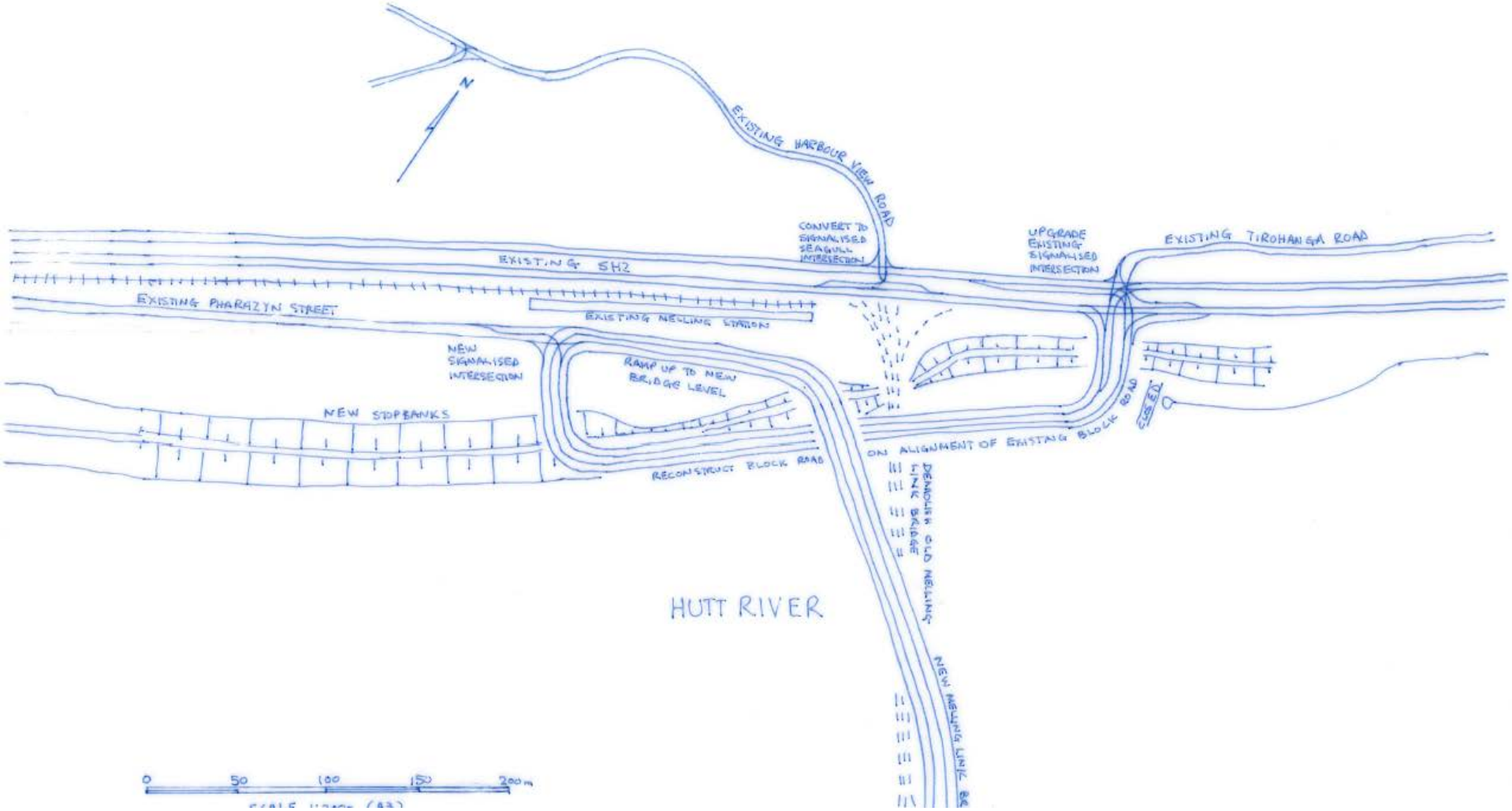
Queens Direct



Queens Indirect



Melling


N
EXISTING HARBOUR VIEW ROAD
CONVERT TO SIGNALISED SEAGULL INTERSECTION
UPGRADE EXISTING SIGNALISED INTERSECTION
EXISTING TIROHANGA ROAD
EXISTING SH2
EXISTING PHARAZYN STREET
EXISTING MELLING STATION
NEW SIGNALISED INTERSECTION
RAMP UP TO NEW BRIDGE LEVEL
NEW STOPBANKS
ON ALIGNMENT OF EXISTING BLOCK ROAD
CLOSED
RECONSTRUCT BLOCK ROAD
DEMOLISH OLD MELLING LINK BRIDGE
HUTT RIVER
NEW MELLING LINK BR
0
50
100
150
200 m

Bridge before Intersection

- Safety – all options similar
- Efficiency – all options similar and worse than current
- Resilience – Melling option has route through floodplain
- Gateway
  - Melling is convoluted (600m)
  - Queens Indirect is a long way travelling back upon yourself if coming from Wellington (500m)
  - Queens Direct still involves back tracking but to a much lesser extent (350m)

Bridge before Intersection

	Melling	Queens Direct	Queens Indirect
Safety	2	2	2
Efficiency	5	5	5
Resilience	4	2	2
Gateway	5	3	4

Summary

- No difference between options for staging overall RiverLink programme
- Significant differences for staging the transport improvements
- Overall, staging would not provide benefits across the project objectives

	Melling	Queens Direct	Queens Indirect
Staging	5	4	4

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