Before Hearing Commissioners

under: the Resource Management Act 1991

in the matter of: notices of requirement and resource consent applications by the NZ Transport Agency and Hamilton City Council for the Southern Links Project

Rebuttal evidence of David van Staden (*concept design philosophy*) on behalf of the **NZ Transport Agency and Hamilton City Council**

Dated: 8 July 2014

Hearing date: 21 July 2014

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REBUTTAL EVIDENCE OF DAVID VAN STADEN ON BEHALF OF THE NZ TRANSPORT AGENCY AND HAMILTON CITY COUNCIL

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INTRODUCTION

1 My full name is David Eric van Staden.

2 I have the qualifications and experience set out in paragraphs 2 to 5 of my statement of evidence-in-chief (*EIC*) dated 12 June 2014.

3 Since issuing of my statement of EIC I have joined Beca in a similar role as what I was doing at AECOM.

4 My rebuttal evidence is given in support of notices of requirement (*NORs*) and applications for resource consents lodged by the NZ Transport Agency (*the Transport Agency*) and Hamilton City Council (*HCC*) on 9 August 2013 in relation to the construction, operation and maintenance of the Southern Links Project (*Project*).

5 I repeat the confirmation given in my EIC that I have read and agree to comply with the 'Code of Conduct for Expert Witnesses' contained in the Environment Court Practice Note 2011.

6 In this statement of rebuttal evidence, I respond to the relevant sections of evidence of the following:

6.1 Mr Paul Ryan (planning) on behalf of Hamilton City Council as Territorial Authority (Submitter No. 44);

6.2 Mr Ian Johnson (planning) on behalf of Alan Tsai, Joyce Lee, Shih An Tseng and Hsueh Chu Chao (Submitter No. 16); and

7 The fact that this rebuttal statement does not respond to every matter raised in the evidence of submitter witnesses within my area of expertise should not be taken as acceptance of the matters raised. Rather, I rely on my earlier technical Link Option Assessment, my EIC and this rebuttal statement to set out my opinion on what I consider to be the key engineering and design matters for this hearing.

8 This rebuttal statement also covers some remaining issues from the s42A Report prepared by MWH (dated 30 May 2014).

RESPONSE TO EXPERT EVIDENCE OF SUBMITTERS

Mr Paul Ryan (on behalf of Hamilton City Council as Territorial Authority)

9 In accordance with Mr Ryan's suggestion[1], the applicable drawings around Cobham Bridge and the north end of the north-south Arterial have been updated to reflect the path layouts and connectivity depicted in Annexure B of my EIC. The updated drawings are attached in **Annexure A** of my Rebuttal Evidence. The updated drawings will be referred to in the Hamilton City Council's updated proposed conditions[2].

10 The Preliminary Design Philosophy Statement (*PDS*) has also been updated (in Section 9.2.1) to reflect the intentions for the path connections. The updated PDS is attached in **Annexure B** of my Rebuttal Evidence.

11 With the abovementioned additions to the drawings and the PDS, I do not believe a designation condition is necessary as has been requested by Mr Ryan[3].

Mr Ian Johnson (on behalf of Alan Tsai, Joyce Lee, Shih An Tseng and Hsueh Chu Chao)

12 Mr Johnson requests that the designation be amended to accommodate a pedestrian underpass across the north-south arterial in the vicinity of the intersection with the Ring Road Extension[4]. In response, I confirm that the gully bridge (3B) and the existing designation envelope around it is able to accommodate shared use paths beneath the bridge[5] so no amendment to the designation is required.

13 Mr Johnson also requests that the Peacocke Structure Plan (*PSP*) be amended to remove the proposed collector road[6] which crosses the collector further south. While I cannot comment on the change to the PSP as it is out of scope of the NOR, I consider that these aspects are related with regard to the pedestrian and cyclist connectivity.

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[1] Paul Ryan evidence, Paragraph 22.

[2] Refer Grant Eccles (planning) rebuttal evidence, Annexure A

[3] Paul Ryan evidence, Paragraph 21.

[4] Ian Johnson evidence, Paragraphs 7.6 and 7.7.

[5] Ian Johnson evidence, Paragraph 7.7.

[6] Ian Johnson evidence, Paragraph 7.5.

14 When considering the length of the north south arterial between bridge 3B and the Ring Road Extension, there are 3 crossing points for pedestrians and cyclists to cross the arterial – namely, an underpass at bridge 3B, the collector road overbridge and the signals at the Ring Road intersection. I believe this would provide suitable connectivity.

15 If the collector road were to be removed from the PSP as proposed by Mr Johnson, I am of the opinion that another grade separated facility would need to be considered. An underpass at the Ring Road intersection, as suggested by Mr Johnson, is a viable option.

16 If the collector road was removed and an underpass was considered necessary, the existing designation envelope around the Ring Road intersection is already sufficiently wide to accommodate an underpass at this location. As proposed, the road is some 2.8m above the existing ground level. The underpass and paths would need to take into consideration the proposed stormwater pond 6-2 and landscaping as suggested by Mr Johnson[7].

17 Mr Eccles proposes a condition in his rebuttal evidence (Condition 16 in the HCC s168A condition set) which I believe sufficiently covers the pedestrian connectivity at the northern extent of the north-south arterial. I believe some flexibility needs to be allowed for in the conditions for the detailed design to match the surrounding development at the time.

FURTHER COMMENT IN RESPONSE TO S42A REPORT

Glare and Light Spill

18 The s42A Report sought confirmation as to whether any construction lighting is required and comment on the lighting effects of the Project[8].

19 Night time construction will likely be needed for critical construction elements which will require temporary lighting to be installed. Examples of critical construction activities which may require lighting include large concrete pours at bridges or other structures, lifting and placing bridge components over existing roads/rail, connections or tie in works on busy roads, resurfacing or reshaping of existing intersections and trunk service relocation/installation.

20 Rail line closures are typically limited to a few days which will likely require 24 hour operations during the closures. Farmland adjoins the Southern Links network crossing of the North Island Main Trunk Railway Line, so I do not foresee night time lighting issues arising from 24 hour operations in that locality.

[7] Ian Johnson evidence, Paragraph 6.1.

[8] Section 42A Report, Sections 19.5 and 19.6.

21 Most night time activities will likely be of short duration, and lasting no longer than a few days. The Construction Management Plan (CMP)[9] will be required to outline the timing and duration of such operations and also the mitigation measures put in place to reduce the effects of light spill.

Road Design Standards

22 The s42A Report sought inclusion of appropriate design standards[10] as a condition. Such a condition is not necessary or proposed by the Requiring Authorities. The Preliminary Design Philosophy Statement (PDS) provides the starting point for following design phases. It is common for the PDS to be reviewed at the start of a design phase based on design standards and best practice current at the time of design. Any changes or updates are then discussed and agreed moving forward. In my opinion, a designation condition should not be set around the standards. Formal independent audit procedures will ensure that current standards and best practice are applied at the appropriate time.

CONCLUSIONS

23 Mr Paul Ryan (on behalf of Hamilton City Council as Territorial Authority) requested more detail concerning path connections and underpasses around the Cobham Bridge. This detail is provided with in my Rebuttal Evidence. I do not believe an additional designation condition is required as requested by Mr Ryan.

24 Mr Johnson (on behalf of Tsai et al) requested a condition and adjustment of the designation for location of a pedestrian underpass to cater for east-west pedestrian movements at the north-south arterial intersection with the Ring Road Extension. The designation envelope identified in the NOR can already accommodate an underpass at this location. However, the need for such an underpass would have to consider whether the collector road is retained in the Peacocke Structure Plan and where it is ultimately located. I believe the current proposed designation condition for consideration of underpasses in this area is adequate.

25 Finally, I have provided further comment regarding queries raised in the s42A Report around likely needs for construction lighting and design standards.

[9] Condition 2 in the HCC s168A condition set, and corresponding conditions for the Transport Agency

[10] Section 42A Report, Section 11.6.5.

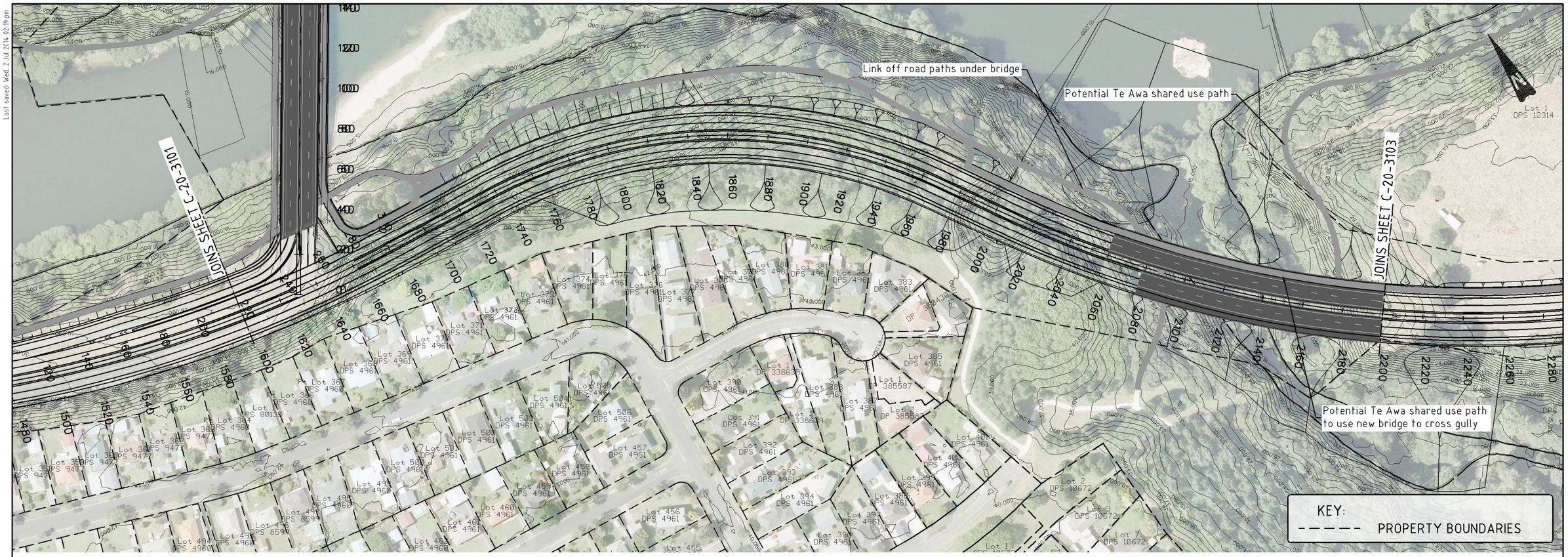
David van Staden

8 July 2014

Annexures

A Updated drawings 3102-C and 4101-C

B Updated Preliminary Design Philosophy Statement (RevB)



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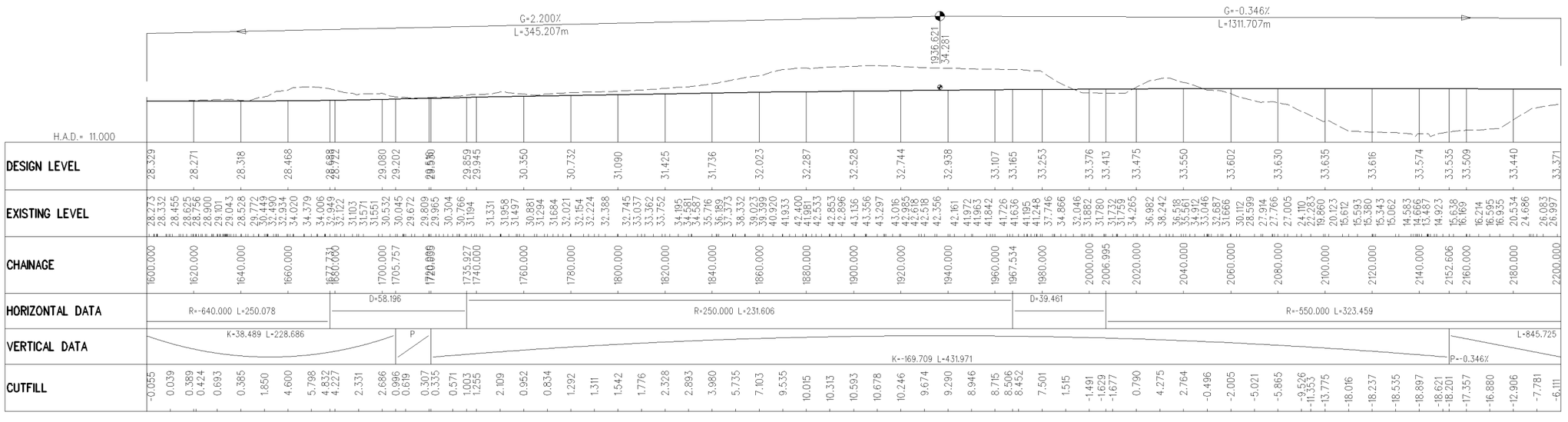

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B	KC	30.05.13	General Updates	DJM
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1: 2000 (A3) 1: 1000 (A1)

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Hamilton City Council Te kaunihera o Kirikiriroa

Southern Links

Peacockes North / South
Layout Plan and Long Section

Sheet 2 of 11

A1	STATUS: For Information Only	DRAWING NO. 60164546-C-20-3102	REV: C

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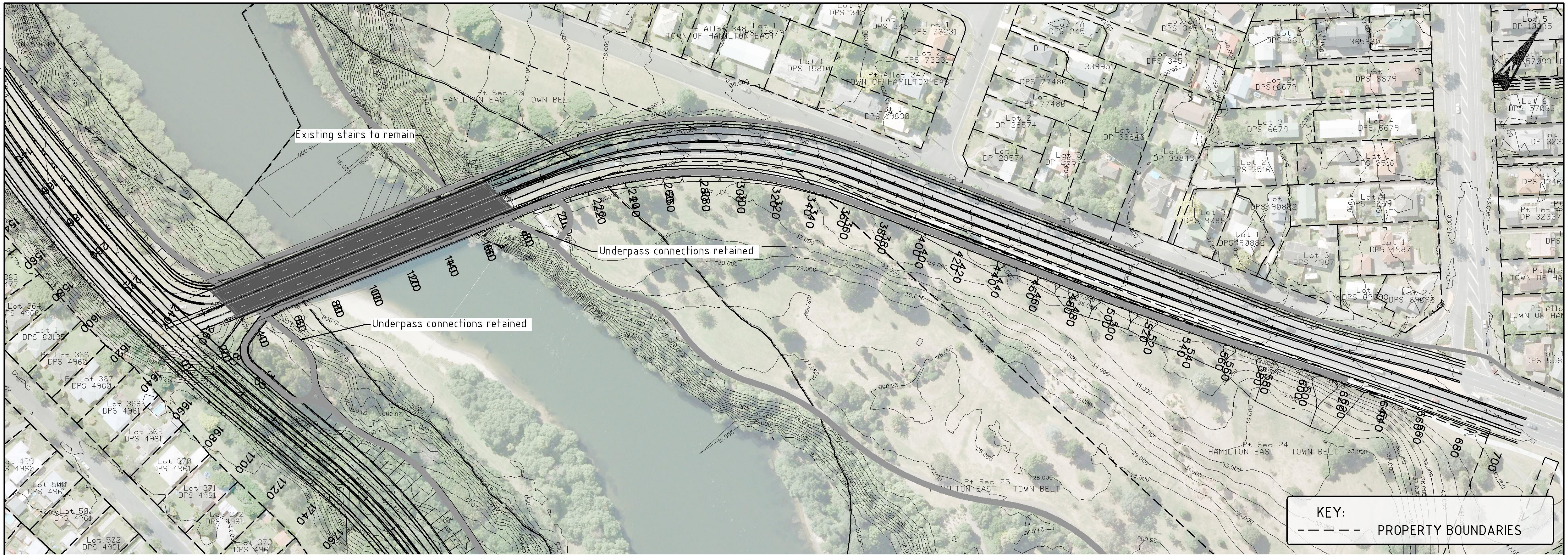
Annexure A



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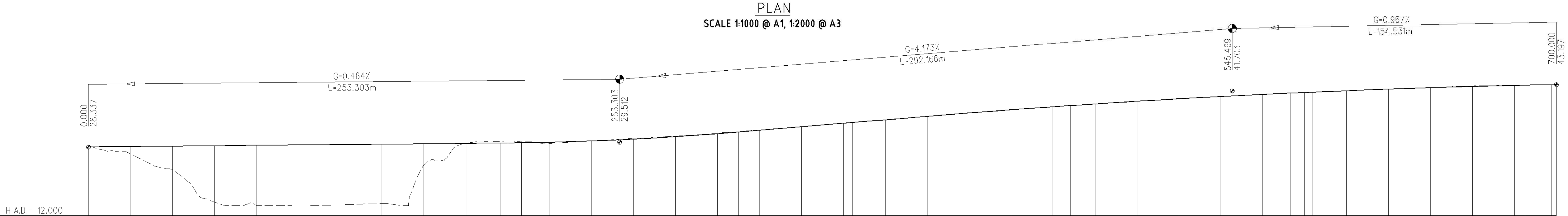

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LONGITUDINAL SECTION MCH0

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Southern Links
Cobham Drive
Layout Plan and Long Section

Sheet 1 of 1

A1 STATUS: For Information Only DRAWING NO: 60164546-C-20-4101 REV: C

Hamilton Southern Links Investigation
New Zealand Transport Agency and
Hamilton City Council
19-Jun-2014

Southern Links Preliminary Design Philosophy Statement

Scheme Assessment Stage

Southern Links Preliminary Design Philosophy Statement

Scheme Assessment Stage

Client: New Zealand Transport Agency and Hamilton City Council

Co No.: N/A

Prepared by

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19-Jun-2014

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Quality Information

Document: Southern Links Preliminary Design Philosophy Statement

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Date: 19-Jun-2014

Prepared by: David Van Staden, Nick Oehley

Reviewed by: Mike O'Halloran

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
1	24 Sep 2012	Issue with SAR	Mike O'Halloran Southern Links Project Manager	
A	18-Jun-2014	Final SAR	Mike O'Halloran Southern Links Project Manager	
B	19-Jun-2014	Updates as per NoR	Mike O'Halloran Southern Links Project Manager	

Table of Contents

1.0 Introduction

1.1 General

This Preliminary Design Philosophy Statement has been provided for Hamilton City Council (HCC) and the New Zealand Transport Agency (NZTA) to establish standards, philosophies and references for design activities as part of the Professional Services Contract NZTA 2/09-019/501: Hamilton Southern Links Investigation.

1.2 Purpose of Preliminary Design Philosophy Statement

The specific purpose of this preliminary design philosophy statement is to identify, document and to set design parameters moving into the scheme assessment phase and to identify design issues resulting from preliminary design undertaken during the scoping phase. The philosophy statement is further updated for key issues identified during the development of the scheme design and through the Notice of Requirement.

The draft consent conditions for the Notice of Requirement include the provision of specific features, including underpasses. This preliminary design philosophy statement should be read in conjunction with any agreed consent conditions.

In particular there is a need to identify various standards for this network as differing territorial authorities are responsible for planning, construction, operation, maintenance and asset management of the infrastructure.

1.3 Philosophy Outline

This report develops the design proposals included in the background report and describes our design philosophy and the key design criteria to be adopted during the scheme assessment design phase. Areas where criteria may be challenging to achieve are outlined together with the reason for potential non-compliance.

2.0 Geometrics

2.1 Overall Design Requirements

The following design engineering standards and guidelines for State Highways are listed below:

- Austroads Guide to Road Design (All parts 1 to 8)
- Manual of Traffic Signs and Markings (MOTSAM) Part I: Traffic Signs: Jan 2010
- Manual of Traffic Signs and Markings (MOTSAM) Part II: Markings: Jun 2009
- Manual of Traffic Signs and Markings (MOTSAM) Part III: Motorways and Expressways: Jun 2009
- NZTA's State Highway Location Referencing Management System (LRMS) Manual: July 2004
- NZTA Planning Policy Manual: Aug 2007
- NAASRA Guide Policy for Geometric Design of Freeways and Expressways: 1976.
- NAASRA Guide to Grade Separated Interchanges: 1984.
- AASHTO Road Design Guide.
- Policy for the Design of Highways and Streets: 2004.

It is noted that the State Highway Geometric Design Manual (SHGDM) is draft and has never been formally adopted as a standard but is used as a guideline. This guideline has now been superseded by Austroads and NZTA is advising through workshops and general notification throughout New Zealand that Austroads shall be the guideline document to be used for State Highway design practice.

For local roads, the geometric standards are listed below.

- Hamilton City Development Manual: 2006 (adopted by Waikato District Council, Waipa District Council).
- Austroads Guide to Road Design (All Parts 1 to 8).

The Hamilton City Development Manual comprises five volumes as follows:

- Volume 1: Subdivision Processes
- Volume 2: Design Guide
- Volume 3: Technical Specifications
- Volume 4: Quality Systems
- Volume 5: District Council Supplement

The overall philosophy for the scheme design is to provide suitable standards within a chosen corridor that will cater for traffic flows based on 2041 modelling forecasts.

The following table indicates the minimum and desirable design parameters for each road type in the network.

	Design Speed (km/h)		e_{max} (%)	Radius Desirable Min (m)	Radius Min (m)	General Max Grades (%)	Desirable Min Crest K Values
	Desirable Minimum	Minimum					
Reference: Section 3 Austroads	Table 3.1	Table 3.1	Table 7.7	Table 7.5	Table 7.5	Table 8.3	Table 8.7
State Highway	120	110	6	700	700	4-6	205
Major Arterial	90	80	7	320	240	4-6	80
Minor Arterial	70	60	7	150	105	5-7	30

Note that:

- *Values for grade are found based on rolling terrain.*
- *Vertical alignment K Values are quoted based on Desirable Minimum Design Speed and a 1.05m driver height to 0.0m object height.*

2.2 Identified Issues

The corridor between Normandy Ave / Cobham Drive intersection and existing Peacockes Road through the Mangakotukutuku Stream Gully is considered to be the most constrained section of the project. Lower design speeds in this area enables an alignment to “fit the contours” more easily, resulting in potentially less impact on residential properties, less environmental impact and smaller structures. A design speed of 70km/h has been achieved in this area, with a view that the posted speed will be 60km/h.

The Ring Road Extension / Cobham Drive Interchange is also constrained by adjoining residential property north of the interchange, with the cemetery and redoubt site to the south. A design speed of at least 70km/h has been achieved on this section of the alignment with a view that the posted speed will be 60km/h.

2.3 Intersection Design Requirements

All intersection forms will be based on detailed traffic modelling where required in order to confirm lane numbers and turning bay lengths. Intersection design has been based on forecast traffic flows for 2041.

Intersections will be designed in accordance with the standards stated below, while taking into account the requirements of the RoNS when connecting to the Waikato Expressway south of Hamilton City.

	Design Speed (km/h)		Safe Stopping Sight Distance (m)	Approach Sight Distance (m)	Safe Intersection Sight Distance (m)
	Desirable Minimum	Minimum			
Reference: Austroads	Section 3 Table 3.1	Section 3 Table 3.1	Section 3 Table 5.4	Section 3 Table 5.5	Section 4A Table 3.2
State Highway	120	110	210	210	285
Major Arterial	90	80	130	130	180
Minor Arterial	70	60	85	85	150

Note: For connection to SH1, RoNS requires sight distance based on reaction time of 2.5s and deceleration rate of 0.26g, thus giving a Sight Distance of 260m. 0.36g has been used for urban and rural roads.

2.4 Identified Issues

2.4.1 New Airport Road Interchange

Due to the proximity of the Airport Road interchange and the Waikato River crossing, the interchange ramps would extend onto the bridge adding significant additional width to the structure. The scheme design for the interchange has been designed as a “lane-gain” and “lane-drop” in each direction which eliminates the need to provide merge or diverge lengths on the river bridge, and provides significant cost savings. Based on the modelling done as part of the Scheme Assessment Report this will not introduce capacity issues at the interchange. If this arrangement is adopted in detailed design special consideration will need to be given to appropriate signage for lane selection on each approach.

The designation boundary has been widened in this location to accommodate the full width through the interchange as well as full ramp lengths if required.

2.4.2 Waikato Expressway Interchange

The spacing between the existing Tamahere Interchange and the proposed Waikato Expressway Eastern Interchange does not meet the required spacing between opposing ramps. The design proposes to close the south facing ramps at the existing Tamahere Interchange and include all movements at the new Waikato Expressway Eastern Interchange. The designation has been set so that adjustments can be made to the ramp terminals in later design stages.

Retaining connectivity to Tamahere Drive (currently a roundabout) is a key factor in the operation of this interchange and surrounding network. If the roundabout on Tamahere Drive is removed, special consideration will need to be given to traffic impacts in Tamahere as well as along SH21 (Airport Road) and maintenance or upgrade of the existing Narrows Bridge.

The south facing ramps could potentially be retained if the Tamahere Drive roundabout is removed, noting that the ramp spacing could lead to other safety issues.

2.4.3 SH3 / 21 Interchange

The eastern roundabout for this interchange has the potential to be constructed as an early stage which will allow access to the Airport Western Precinct. The 5-legged roundabout has been adopted in the amended road layout for the Airport Western Precinct. It is acknowledged that 5-legged roundabouts operate safer with a single circulating lane, and later design stages should pay attention to achieving suitable separation between the legs and the potential staged development.

3.0 Cross Section

3.1 Design Requirements

Design standards shall be in accordance with:

- Austroads Guide to Road Design (Parts 1 to 8).
- Hamilton City Council - Development Manual & Standard Technical Specifications;
- Transit New Zealand - Bridge Manual;
- Transit New Zealand - State Highway Geometric Design Manual (SHGDM).

3.2 Design Philosophy

The overall philosophy for the scheme design is to protect a corridor which will allow the provision and staged development of the transport and infrastructure needs. The main aspects of the cross section are as follows:

- For the highway routes the NZTA Safe System Approach has been adopted including a median barrier and barriers on the shoulders;
- The major arterial routes, carriageways to be separated by solid median (minimum 4m wide);
- Cycle lanes and footpaths included on all existing and future urban routes, and allowance for footpaths on all realigned local rural roads;
- Provision made to meet clearzone requirements, or allowance made for barrier protection where the clearzone requirement may not be met;
- Provision for public transport envelopes, which may include bus priority lane(s) and/or light rail.

4.0 Public Transport Provisions

4.1 Design Requirements

Design standards shall be in accordance with:

- Austroads Guide to Road Design (Part 3: Geometric Design)
- Hamilton City Council: Development Manual;
- Transit New Zealand: Bridge Manual;
- State Highway Geometric Design Manual (SHGDM);
- Hamilton City Council: Access Hamilton Passenger Transportation Plan;
- Transit New Zealand: Guidelines for Safe Siting of School Bus Stops.

4.2 Design Philosophy

The philosophy for the scheme design is to identify and protect a corridor which will allow for the provision and staged development of passenger transport infrastructure. The main aspects of this are to include provision of the appropriate lane widths as per Table 4.21 and the accompanying notes in Austroads, these being a preferred kerb lane width of 4.5m. Our approach is to provide for this by either:

- A 3.5m kerb lane and a 1.5m marked cycle lane with the cycle lane serving the dual purpose of serving cyclist traffic and accommodating any wide bus movements;
- A single 4.5m kerb lane marked for bus use that is jointly used by buses and cyclists.

4.2.1 Light Rail Consideration

In addition to the above provisions, an envelope has been developed to include the possibility of light rail infrastructure along the main corridors. It is noted however that consideration of light rail is only on the network

into Peacockes and potentially connecting further south to the airport. It is unlikely that the light rail network will run along the 80km/h section of the network. Changes to major intersections and accommodation of stations would likely require changes to the designation in several locations once the network is confirmed.

The Notice of Requirement has not specifically assessed the effects of light rail, e.g. noise, visual, vibration, etc. an alteration to designation would be required.

5.0 Drainage

5.1 Design Requirements

Design standards shall be in accordance with:

- Hamilton City Council: Development Manual & Standard Technical Specifications;
- Transit New Zealand: Bridge Manual;
- Transit New Zealand: Specification F/3 for Culvert Construction;
- Transit New Zealand: Highway Surface Drainage Manual;
- New Zealand Transport Agency: Stormwater Treatment Standard for State Highway Infrastructure, May 2010.

Other standards referenced in the above documents or otherwise applicable to this project include:

- Environment Waikato Erosion and Sediment Control - Guidelines for Soil Disturbing Activities.
- Austroads Guide to Road Design, Part 5: Drainage Design;
- NZ Institution of Engineer's: Guideline and procedure for Hydrological Design of Urban Stormwater Systems, December 1980';
- Auckland Regional Council: TP10 Stormwater Management Devices: Design Guidelines Manual;
- Auckland Regional Council: TP131 Fish Passage Guidelines for the Auckland Region;
- NIWA – Fish Passage at Culverts: A Review of Possible Solutions for NZ Indigenous Species, December 1999;
- Environment Waikato: Best Practice Guidelines for Waterway Crossings;
- US Federal Highway Administration: Hydraulic Design of Highway Culverts;
- US Federal Highway Administration: HEC 14, Hydraulic Design of Energy Dissipators for Culverts and Channels;
- US Federal Highway Administration: HEC 22, Urban Drainage Design Manual

5.2 Design Philosophy

Our philosophy for the extent of this project is to mitigate the effects of additional stormwater runoff from the proposed roading infrastructure. This will be achieved through effective conveyance, treatment, storage and attenuation, and discharge to appropriate locations with eventual discharge to existing farm drainage or gully systems discharging to the Waikato River.

Permanent drainage system design for this project will be in accordance with the Transit New Zealand Highway Surface Drainage Manual and the Hamilton City Council Development Manual as appropriate for the section of roadway.

Waikato Regional Council (WRC) refers to the Auckland region's design guide TP10 as its standard for stormwater treatment. The NZTA has a draft guideline for *Stormwater Treatment Standard for State Highway Infrastructure, May 2010*. For this project all new stormwater infrastructure will be designed to include appropriate water quantity and quality controls which align with the principles of TP10 and the NZTA guideline. The HCC Development Manual requires the use of landscaped engineering devices for stormwater treatment and also references ARC TP10.

The main aspects of the proposed permanent drainage system design are as follows:

- Roadside swales will be utilised wherever possible for the collection and conveyance of runoff to either a piped network or open drains. Swales will also provide primary treatment where ground conditions permit.
- Where kerb and channel is required for roading design purposes, such as interchanges and intersections for state highways or where urban road design requirements within Hamilton City do not provide sufficient area, collection will be via catchpits and pipelines.
- Where secondary treatment is required and/or achievable, ponds or wetlands may be used to achieve this.
- For Hamilton City Council roading infrastructure, primary treatment and disposal by soakage could be implemented where soakage rates are favourable, followed by discharge into treatment ponds which may be utilised by future urban development. The location and size of the ponds will be defined by HCC as part of the Catchment Management Plan.
- All new culverts within waterways will be designed and constructed in accordance with WRC's Best Practice Guidelines for Waterway Crossings and where appropriate will include provision for fish passage.

The stormwater management philosophy to be utilised on this project is in accordance with Hamilton City Council, WRC and NZTA requirements. Low impact environmental design solutions are proposed which will achieve water quantity, water quality and aquatic resource protection requirements.

6.0 Structural Design, Bridges and Major Structures

Numerous network options were considered and reduced down to essentially 2 main options with slight variations. The effects on bridges forming part of these options were captured in the MCA (Multi-Criteria Assessment). The various types of bridges and structures required for the different network options are similar, including typical road-over-road and rail bridges, larger intersections as well as smaller bridges over streams. Major bridges are required to cross the Waikato River on both local and State Highway Networks. Special attention will be given to the bridge crossing the North Island Main Trunk (NIMT) railway corridor, as it potentially has a large skew.

Preliminary bridge options for each of the structures are described in the Bridge Inventory (see Section 4 of Southern Links Scoping Structures Report). The final Structures Report is appended to the Scheme Assessment Report as Appendix H3.

Retaining walls associated with bridge abutments and wing walls will be located on the bridge concept drawings and/or on the roading geometry drawings as appropriate.

Major drainage culverts will be required along the route. These will also be located on the roading geometry drawings as location and approximate sizes are finalised.

The overall philosophy for the scheme design is to provide suitable standards that will cater for the next 50 years.

6.1 Summary of Guiding Principles for Design of Bridges

A selection of the key ‘Guiding Principles’ for the development of the culvert and bridge solutions are listed below:

- Bridge and retaining wall solutions will be developed in conformance with the Transit New Zealand Bridge Manual (TNZBM) (Transit, 2003).
- Best value bridge solutions, with due consideration for whole-of-life performance, are recommended and will be proposed in the SAR ahead of cheapest conforming design options.
- The risk of large earthquakes, with consequential liquefaction in the region, influences the selection of structural types. Robust structural forms with high levels of redundancy are therefore recommended for the bridges.
- Bridge substructures supporting underpasses and overbridges should be consistent in form and align with standards of Hamilton City Council for the urban network and NZTA for State Highway bridges.
- Where ever possible, integral abutments and piers should be adopted for the bridges, eliminating maintenance intensive bearings and joints in addition to providing additional structural redundancy and robustness.

Given the fact that the Southern Links Project will have an impact on sensitive urban areas, aesthetics will be given a high priority. Appropriate aesthetics are important and due consideration must therefore be given to this in the development of the structural concepts.

Optimisation of major river/stream crossings will be considered holistically with the hydraulic modelling, taking into account climate change. Special attention will be given to the Waikato River crossings to minimise the effects of the new bridges on the existing river.

Minimising the environmental impact of bridges will have a high priority. Special attention will be given to Maori cultural views where the Waikato River is crossed.

6.1.1 Bridge Types

The guiding principles above are likely to lead to the following bridge options for the project:

- Spans up to 6m (i.e. larger culverts): Fully framed robust reinforced concrete box type structures. In addition to providing a best value, low maintenance option, seismic performance of these types of bridges is expected to be excellent with little remedial work required after a major earthquake.
- Spans up to 30m: Hollow core and super 'T' bridges. These bridges will be detailed as fully integral structures. Integral structures have cast in-situ concrete connections between the superstructure components (deck and beams), and substructure (piers and abutments), which provide very good resistance to earthquake forces and potential ground movements. The bridge solutions are cost efficient and low maintenance.
- Span range of 30m – 60m: Steel composite bridges are proposed for bridges with spans in this range as the span lengths exceed the range of precast beam and slab decks, unless roading geometry and pier positions can be further adjusted so that shorter spans can be achieved. The bridge type is cost efficient and with careful selection of coating systems, joints and bearings, can be relatively low maintenance.

6.1.2 Waikato River Bridges

A base assumption has been made that piers will not be constructed in the river. This requires bridge forms which typically have long spans such as arches, balanced cantilevered spans, cable-stayed or suspension bridges. Other options, such as steel composite bridges could be considered if the restriction of piers in the river is relaxed.

Two bridge options will be evaluated for these structures. These include:

- Network arch bridge, spanning the main river channel with end spans and providing an iconic bridge at an affordable price.
- Large-span post tensioned concrete box superstructure, possibly with fully integral piers. This bridge option's performance in a major earthquake is expected to be excellent. This form of construction is economic for spans in excess of 60m and is typically low maintenance.

6.2 Key Design Aspects

The key bridges forming part of this project encompass significant waterway crossings, rail and State Highway under or overpasses, or subways.

Key design aspects to these structures are:

- Potential flood impact of new bridges on existing bridges and surrounding areas.
- Careful staging consideration to cater for interface with bridge construction and the operational rail and road corridor.
- Potential groundwater and flood impacts on any sub-surface structures such as subways within the urban environment.
- Consideration of pedestrian and cyclist safety.
- Consideration of PT priority lanes on key bridges.
- Consideration of alternative cost effective structural forms at highly skewed railway crossings.

- Geotechnical or ground conditions and the potential for liquefaction will determine the choice of structural form and foundations.
- Seismic hazards such as close proximity of faults will also be determining factors in developing options.

Careful consideration of structural form and aesthetics, taking into account consistency between urban, rural and State Highway structures needs to be taken. Sensitivity to the surrounding project area which includes not only rural sections but also interacts with the urban context as well as the surrounds of the Waikato River is also required.

Maori cultural views and values regarding the Waikato River need to be included. These may include requirements regarding piers in the river.

Ensure that options are cost-effective with demonstrable whole-of-life performance.

6.3 Guiding Principles

6.3.1 Cost Efficiency

Value-for-money bridge solutions, with due consideration for whole of life performance, will be proposed. The nature of the topography and local road and State Highway alignment result in bridge structures which can broadly be described as typical highway structures. These types of structures have known cost-effective solutions based on other similar projects. The skew rail crossing provides opportunity for some innovation in structural form, choice of materials as well as optimisation of roading alignments.

From a whole-of-life perspective, structural form and configuration will focus on elimination of high-maintenance elements such as bearings, expansion joints etc. Where steel options are adopted, coating systems providing 40years protection to first major maintenance will be adopted.

6.3.2 Flood Hazards and Hydraulic Performance

Sizing bridge water clearances (freeboard) and culverts for flows generated by a 100 year return period event will be completed in accordance with the requirements in the TNZBM (Table 2.1 & Section 2.3 Waterway Design). Freeboard of 1.2m has been adopted for major river and steam crossings. Allowance for climate change will be included in waterway calculations.

6.3.3 Functional Requirements

Bridge widths are determined by the roadway geometric design. Clearances under the bridges follow the recommendations of Appendix A of the TNZBM as well as KiwiRail clearance envelope requirements.

6.3.4 Environmental Considerations

Environmental considerations will influence the selection of bridge solutions in a number of ways. In the case of Waikato River Bridges and other larger urban Stream Bridges, longer spans will result in fewer piers thereby limiting the number of construction access tracks that will be required to enable the bridge piers to be built. The final ground level footprint of the structure is also reduced as a result of fewer pier locations.

7.0 Utility Services

7.1 Design Requirements

Provision for utilities to support the Southern Links network, in particular Peacocke development needs to be allowed for within the proposed designation. All services and utilities with be allowed for in accordance with Hamilton City Development Manual: 2006 or the relevant utility owners requirements.

7.2 Design Philosophy

The extent of the project will need to include within the road corridors an allowance for all future foreseeable services. Consideration will be given to timeframes of when the services may be installed, access for construction, impact on traffic and other services during construction, future access for maintenance and maintenance costs in general.

8.0 Pavement, Sealing & Road Marking

8.1 Pavement Design and Seal Design

The following standards apply for the pavement design:

- Austroads 2008. Pavement Design: A Guide to the Structural Design of Road Pavements
- Transit New Zealand Supplement to Austroads Pavement Design Guide

8.1.1 Design Philosophy Adopted:

- A flexible unbound granular pavement
- Design lifespan of 30 years.
- Provision of a cost effective sealed wearing course in accordance with the desired noise requirements
- Provision of a sealed wearing course across bridge structures.

8.2 Pavement Markings

All road signage shall be designed in accordance with the following:

- MOTSAM: Part II: Markings (June 2004)
- MOTSAM: Part III: Motorways and Expressways (June 2005)
- Land Transport Rule – Traffic Control Devices 2004 and amendments
- NZTA P/12 Specification for Pavement Markings
- HCC Signage Policy – Reference #4/9/1

9.0 Miscellaneous Elements

9.1 Urban Design

9.1.1 Design Requirement:

The development of urban design requirements shall generally be in accordance with:

- NZTA's Professional Services Guideline PSG/12 Urban Design Professional Service Guide.
- HCC's urban design framework for the city: 'CityScope' and 'Vista - Hamilton City Design Guide'.
- The Peacockes Structure Plan (HCC).
- RTA Urban and Regional Design Practise Notes.
- NZS4404 Land Development and Subdivision Engineering.

9.1.2 General Design Philosophy:

The primary design aim of this project is to align the new roading network to create urban and natural feature boundaries that support character distinctions within the Peacockes area. This will be achieved through the proposed roading structures formation as a backbone for the 7,500 new sections and associated development proposed in the area, integrating them into a considered and responsive environment.

Key considerations/objectives include:

- Utilising Urban Design Principles to develop an integrated design solution combining traffic, civil engineering, urban design, landscape ecology, stormwater and heritage aspects, with these aspects being brought together and opportunities developed and enhanced;
- The provision of a network hierarchy of roads and road types to suit the context and needs of future development while acting as a city boundary creator;

- Consideration of cyclists, pedestrians and open spaces through public transport provision, integration of safe pedestrian and cycle facilities to link the broader area and enhancement and maintenance of the river, river corridor and gully systems to create opportunities for ecological enhancement to be integrated into the roading network and open spaces.

A number of opportunities present themselves with the development of this project:

- Development of the roading network to support a sense of place and character that responds to the variety of natural land types, without creating undesirable land pockets;
- Improving the options for cyclists and pedestrians with the integration of existing networks, links with other modes of transport, off and on-road cycleways, roadside and recreational footpaths, and links to recreational amenities, in particular the Waikato River;
- The opportunities to engage and consult with the local and greater community to incorporate aspirations where feasible.

9.1.3 Design Philosophy Adopted for Structures & Bridges:

There are several types of bridge crossings on the proposed Southern Links network, these create the following opportunities and constrains:

- River – The visual and environmental effects of the bridges crossing the river should be mitigated through innovative, culturally sensitive and quality design.
- Gully – provide appropriate structures across gullies to minimise ecological degradation.
- Railway – the crossing point over the railway is un-instructive, in a rural environment and not visual from approach or afar.
- Abutments – where possible the structure should be designed to bare the least impact on the land in which they sit, both visually and environmentally.
- Pedestrian – links should provide safe, accessible and pleasant crossing points for pedestrians and cyclists to prevent severance issues.

The urban design approach to the bridges will look to assess the following opportunities and constrains at the design stage:

- Establishing a hierarchy to bridge structures and their aesthetical qualities in regards to their location and context.
- Identify key bridges for possible ‘gateway’ treatment.
- Ensure environmentally, ecologically, and culturally sensitive bridge design is achieved.
- Integrate pedestrian and cycle facilities into all bridges.

Major/raised intersections with on/off ramps can become pedestrian un-friendly environments. To prevent these intersections creating severance within an area, there is the opportunity to mitigate such issues with; quality landscaping, designated, accessible and safe pedestrian routes and avoidance of isolated underpasses/tunnels and elongated access routes.

9.2 Walking and Cycling

Walking and cycling standards will be in accordance with the following standards:

- Hamilton City Development Manual: 2006.
- EW Regional Walking and Cycling Strategy.
- Bridge footpaths loads are in accordance with the Transit Bridge Manual section 3.4.14.
- Austroads Guide to Traffic Engineering Practice Part 13: Pedestrians.
- NZTA’s Pedestrian Planning and Design Guide.

- Handrails will be provided on bridges, retaining walls and reinforced earth embankments, where protection from falling is required by the NZ Building Code. Handrails will comply with the requirements of the NZ Building Code. The minimum desirable height of pedestrian/cycle safety rails is 1.4m.
- NZTA Cycle Network and Planning Guide.

No signs or street furniture will be installed within the footpaths and any signage overhanging these paths will have a minimum of 3.0m vertical clearance.

9.2.1 Cobham Drive / Cobham Bridge Network

The scheme design makes allowance for the following key components in the walking and cycling network in the vicinity of Cobham Bridge and Cobham Drive:

- New dedicated shared use paths on both sides of the bridge. Shoulder widths proposed across the bridge are not appropriate to encourage use by cyclists.
- Maintaining the off-road path along Cobham Drive including the extension of the north-south arterial as it extends south of Cobham Bridge.
- Maintaining the underpasses under Cobham Bridge on both sides of the Waikato River and connecting with the existing riverside paths.
- Special consideration should be given to encouraging cyclists onto the off-road path to bypass the signalised intersection between Cobham Drive and the north-south arterial.

9.2.2 Hamilton Ring Road / Cobham Interchange

While off-road paths are also allowed for around this interchange, it is acknowledged that access across the ramps will likely be required as well. Later design stages should take this into account regarding the configuration of the ramp terminals and signal phasing.

9.3 Lighting

The street lighting will be designed to be in accordance with:

- AS/NZS 1158 V3
- Hamilton City Development Manual: 2006
- State Highway Geometric Design Manual (SHGDM)

9.4 Noise

Noise mitigation measures will be designed in accordance with the following guidelines and standards:

- Hamilton City District Plan (Proposed);
- NZTA: Guidelines for the Management of Road Traffic Noise;
- Standards New Zealand: NZS 6806: 2010.

It must be noted that NZTA is in a transition period as NZS6808 is adopted in place of the previous Guidelines. This may have an impact on the standard of the mitigation measures used.

Possible options for control of traffic noise from the proposed network include:

- Low noise road surfaces, particularly near residential areas and the river;
- Buffer zones for reduced noise exposure to sensitive land uses;
- Landscaping/Bunding;
- Barriers/Screening, provided at the road edge for high density areas;
- Acoustic Insulation of existing residences.