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20 November 2017

**Attention: Greig Stephen**

Dear Greig

**SH2 Pedestrian and Cyclist Grade Separation Options at the B2B Project**

Please find attached working draft copy of the SH2 Pedestrian and Cyclist Grade Separation Options at the B2B Project report.

Yours sincerely

s 9(2)(a) [redacted]

Associate - Civil Engineering

on behalf of
**Beca Limited**
s 9(2)(a) [redacted]

**Copy**
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Report

# SH2 Pedestrian and Cyclist Grade Separation Options at the B2B Project

Prepared for NZ Transport Agency (Tauranga)

Prepared by Beca Limited

17 November 2017

## Revision History

| Revision Nº | Prepared By | Description | Date |
|---|---|---|---|
| 1 | s 9(2)(a) [redacted] | Draft | 24/04/17 |
| 2 | | Working draft for input from client urban design team. | 23/05/2017 |
| 3 | | Working Draft Following RMT | 11/07/2017 |
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| | | | |

## Document Acceptance

| Action | Name | Signed | Date |
|---|---|---|---|
| Prepared by | s 9(2)(a) [redacted] | | 16/11/2017 |
| Reviewed by | | | 16/11/2017 |
| Approved by | | | 16/11/2017 |
| on behalf of | Beca Limited | | |

# Executive Summary

The proposed Baypark to Bayfair Link Upgrade grade separation of the Maunganui Girven intersection (MGI) removes the current underpass of Maunganui Road. NZ Transport Agency has requested Beca prepare an options report that assesses the feasibility of:

1. Extending the existing underpass;
2. Constructing a new underpass; and
3. Constructing a new overpass/bridge.

Good walking and cycling facilities can expect the following benefits:

- Improved Accessibility – individuals who do not own a car have access to community services (work, education, shopping and public transport);
- Congestion reduction – increasing cyclist and pedestrian mode share decreases the number of people driving; and
- Improved Liveability and health - if residents can easily walk or bike within their neighbourhood, it allows them to fit exercise into daily routine through active transport.

Extending the existing underpass has significant challenges.

- The existing underpass dimensions are less than ideal. Extending it beyond the foot print of the proposed MGI would double the length of the underpass. This is likely to deter people from using the underpass due to personal security concerns, particularly outside of peak hours.
- The existing underpass would likely be affected by differential settlement due to the proposed embankment above part of it.
- No deep ground improvements have been placed under the existing underpass. Without these ground improvements any embankment built above the underpass would be subject to unacceptable movement in earthquake events.

On this basis, it is recommended that the option to extend the existing underpass is not pursued.

An alternative to extending the existing underpass would be to construct a new underpass that is higher, wider, better lit and has approaches that allow those entering and exiting the underpass to have good visibility. An underpass provides a safe crossing facility for pedestrians and cyclists by reducing pedestrian and cyclist conflict with motorised vehicles. Furthermore, if no grade separated facility is provided some existing or potential users (particularly commuting cyclists) may cease using this route they feel inadequate facilities are provided. However, a new underpass faces a number of challenges:

- Has significant capital cost due to the constrained urban environment with multiple high value services affected and high ground water effects to mitigate.
- Low economic benefits due to the relatively low number of users expected to use it.
- Will impact on the existing utilities. Some of these utilities are regionally significant and will add considerable cost and time to relocate. Additional land may be required to accommodate these services diversions.
- Land is required from Bayfair Shopping Centre and the underpass affects the driving range access, on the eastern and western sides of MGI respectively, which is expected to have a significant impact on their operations.

- A key principle of Crime Prevention Through Environment Design (CPTED) is to allow passive surveillance.  While a new wider, higher underpass would be more attractive to some users, an at-grade facility is likely to be the preferred option for many, particularly outside the peak commuting times due to personal security concerns. That is because drivers and others at ground level can see those using a crossing facility and those users know they can been seen giving a feeling of security.

For the reasons provided, it is recommended that the option to construct a new underpass is not pursued.

An alternative to the underpass options is to provide an overpass/bridge near the intersection.  An overpass/bridge has the benefit of not conflicting with the numerous services and is considerably less capital cost than a new underpass.  The key issues associated with the overpass/bridge include:

- Pedestrians and cyclists from Girven and Matapihi Rd would have to travel off their desired route to use this facility, therefore it is not expected that it would get much use.
- It would have significant visual impact on Bayfair and neighbouring properties and would likely need to go through an RMA designation process.

As a direct replacement for the existing underpass, an overpass/bridge is not expected to be a viable option, however when considering an alternative link (such as further north at Concord Avenue), a new connection is expected to:

- Provide a more direct connection from Mount Maunganui residential suburbs north of Concord Avenue to planned TCC networks.
- Connect with future cycle network connections, identified by TCC which includes connections with Links Avenue.
- Remove concerns regarding impacts on the B2B D&C contract.
- Reduce the number of affected parties/landowners.

Although any new option represents a notable increase in cost to the B2B project cost, there is an increased focus to improve cycling facilities by NZTA, leading to a need to investigate the viability of this option further, specifically detailed costs and alignments.

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## Appendices

# 1 Background

## 1.1 Scope

The proposed Baypark to Bayfair Link Upgrade grade separation of the Maunganui Girven intersection (MGI) removes the current underpass of Maunganui Road. NZ Transport Agency has requested Beca prepare an options report that assesses the feasibility of extending the existing underpass, constructing a new underpass and constructing a new overpass/bridge.

## 1.2 Project Purpose

The B2B Project will separate SH2 traffic from the local road network through the provision of two grade-separated interchanges at the Maunganui Road / Girven Road Intersection (MGI) and SH29a/SH2 intersection. Both intersections will be converted from roundabouts to traffic signals controlling access between SH2 and local roads, while traffic on SH2 will be uninterrupted as it is grade separated from both intersections. The general project extent is shown in **Figure 1**.

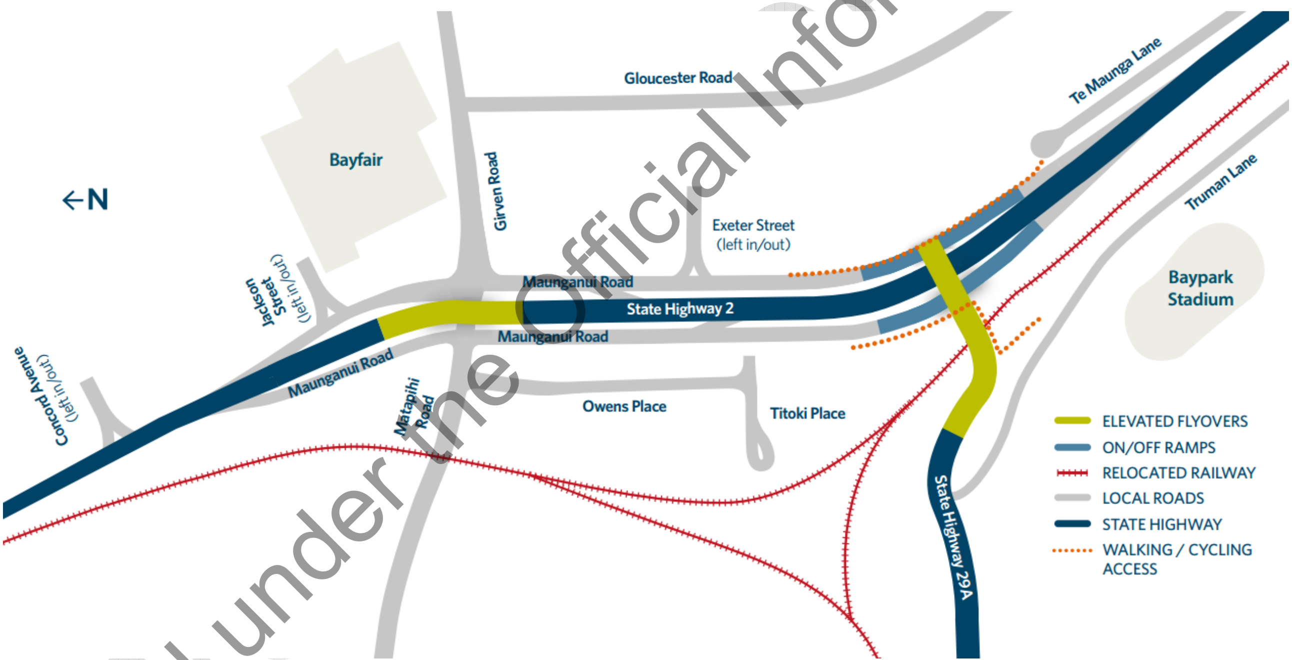


Figure 1: B2B Link Upgrade

## 1.3 Site Location

The B2B project area is located in the Tauranga Suburb of Mt Maunganui, approximately 5km north-east of the Tauranga CBD. The underpass under review of this assessment provides a grade separated pedestrian and cyclist connection underneath Maunganui Road / State Highway 2 (SH2). The specific location of the underpass relative to key connections is shown in **Figure 2**.

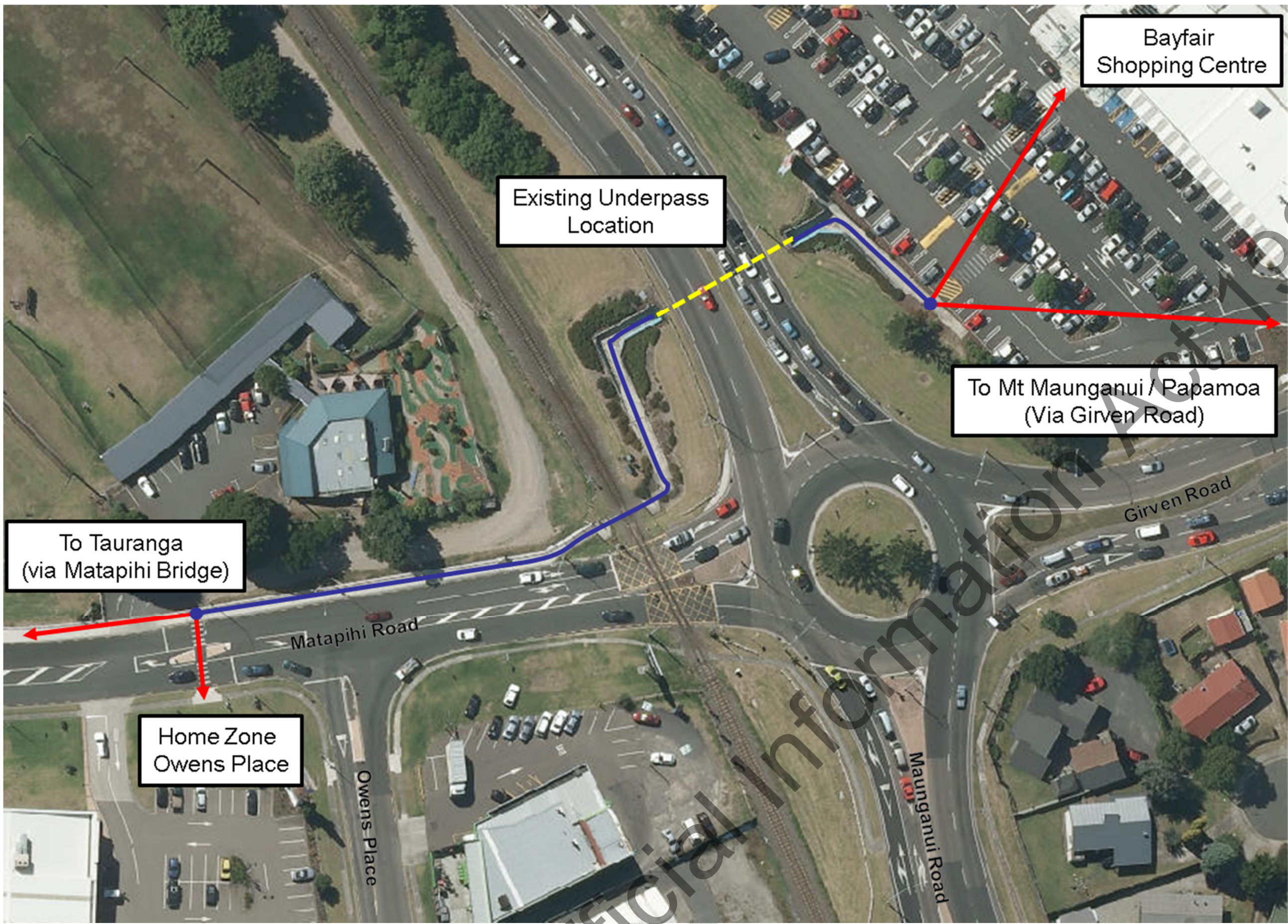


Figure 2: Existing Underpass Location & Site Context[1]

## 1.4 TCC Walking and Cycling Network

The Tauranga walking and cycling network is presented in **Figure 3**[2]. The crossing of SH2 at Bayfair is one of the few along Maunganui Road and connects directly with proposed and existing infrastructure connecting to Mt Maunganui and Papamoa.



[1] Source: TCC GIS Portal (http://gismob.tauranga.govt.nz/Html5/index.html)

[2] http://econtent.tauranga.govt.nz/data/transportation/files/tauranga_cycle_maps.pdf


Figure 3: Tauranga City Cycle Network

## 1.5 Key Desire Lines

This connection caters for a number of different desire lines:

- Between Bayfair Shopping Centre and the Owens Place Home Zone (shopping);
- Between Mt Maunganui/Papamoa suburbs and the Tauranga CBD via Matapihi Bridge (commuting);
- Between the Matapihi area and local schools (particularly Arataki); and
- Connections with other key attractors in the area (such as Baywave or Omanu Golf Club & Driving Range).

Without an underpass, the above desire lines would need to be catered for through an alternative crossing of SH2. If these are not catered for in a manner that users consider safe and efficient, people currently making these trips may choose to use alternate modes, likely to be private cars. The currently proposed B2B project provides for these movements by replacing the underpass with signalised crossing on all arms of MGI.

## 1.6 Existing Underpass Users

For the purposes of this assessment, two counts of pedestrians and cyclists have been used. Peak hour counts provided by TCC from 2011 indicated the following:

- 22 pedestrians and 8 cyclists between 7:00 AM and 9:00 AM;
- 66 pedestrians and 6 cyclists between 11:00 AM and 12:30 PM;
- 137 pedestrians and 23 cyclists between 3:00 PM and 5:00 PM; and
- Previous reports have noted approximately 225 pedestrian users per day.

A more recent survey undertaken for this project (March 2017) using CCTV footage of the underpass during the AM peak period indicated the following number of users:

- 34 pedestrians and 50 cyclists between 7:00 AM and 9:00 AM.

Comparing the 2011 usage with 2017, indicates a considerable amount of growth, particularly in the number of cyclists. Although the survey was not continued into the other hours of the day, there is sufficient enough of an indication of growth to suggest that high numbers of cyclists would be expected during the PM peak.

High number of users have also been observed on weekends, when demand peaks at Bayfair Mall. Future expansion of the mall may further increase the demand for connections between Bayfair and the Home Zone.

## 1.7 Methodology

Our assessment has included the following key tasks:

- Review the impacts of the B2B project on the existing underpass, which is currently in the Construction Stage of a Design and Construct Contract,
- Review the CPTED considerations when designing pedestrian and cyclist infrastructure,
- Review the high level significance of having a grade separated walking and cycling connection in this location,
- Review the feasibility of extending the existing underpass to accommodate the B2B upgrade,
- Identify the best location for a replacement underpass that could be incorporated into the B2B project, should the existing underpass not be able to be extended,
- Consider alternative options, including an overpass/bridge structure, and
- Identify any remaining issues and / or next steps for the assessment.

# 2 Benefits of Walking and Cycling Connections

## 2.1 Importance of Good Walking and Cycling Connections

Provision of good walking and cycling connections encourages more active transport use, which has the following benefits to the community and the transport network:

- Accessibility – individuals who do not own a car have access to community services (work, education, shopping and public transport),
- Congestion reduction – increasing cyclist and pedestrian mode share decreases the number of people driving,
- Safety and security – the "safety in numbers" effect as drivers expect to see cyclists on the road and therefore treat them as legitimate road users by giving them space to ride, and
- Liveability and health - if residents can easily walk or bike within their neighbourhood, it allows them to fit exercise into daily routine through active transport.

Safety is often highlighted as the main reason many people do not ride a bike, therefore providing a safe facility increases the likelihood of more people choosing cycling as a viable transport choice in the future.

## 2.2 Relevance to MGI

The underpass is used by pedestrians and cyclists travelling between Matapihi Road and the Bayfair/Arataki area, as illustrated by the pedestrian counts in Section 1.4.

There is a wide age range of users, from school children, commuting cyclists, and shoppers walking between the Home Zone and Bayfair. Specifically of note for facilities in the Tauranga region is the high proportion of elderly pedestrians. The underpass provides a grade separated facility for vulnerable road users.

Without the underpass it is likely that some users would change mode i.e. drive instead of walk/cycle. In particular, parents may not let their children bike/walk to school, and elderly people or those with limited mobility may stop walking because they don't feel safe walking across a busy signalised intersection.

Conversely, some people may not feel safe using the underpass for personal security issues. Particularly outside of peak use. These people may currently not walk or cycle and may change if a safe and efficient crossing facility is provided.

There are many recreational and commuting cyclists who use the underpass. An online petition to retain the underpass, led by the community bike group Bike Mount, received 900 signatures in December 2016. This demonstrates the strong community support to maintain a grade separated facility at this intersection.

## 2.3 Future Demand

There are residents living in the area who currently don't ride for certain reasons (e.g. perceived safety), but as congestion worsens around Tauranga they may consider other transport modes, especially for commuting to work. Tauranga has the highest private vehicle dependency in the country with around 97 per cent of journeys taken by private car. It also has the lowest public transport uptake, the lowest cycling uptake and the lowest walking uptake.

The Transport Agency's goal is to increase the total number of annual cycling trips by 10 million in the next four years. Retaining the underpass provides a grade separated facility for less confident cyclists to cross this intersection.

## 2.4 Effect of replacing the Underpass with a Signalised Intersection

### 2.4.1 Local Context

Compared to the existing underpass, which grade separates pedestrians and cyclists from traffic on MGI, a signalised intersection would mean pedestrians and cyclist not confident in using the road through the intersection would have to cross multiple times and wait at each crossing point.

While the CPTED principles would suggest that providing a safe and attractive at-grade facility would encourage more pedestrian use, international research predicts this does have an increased risk to pedestrians and cyclists.

Pedestrians would be delayed at each crossing point in the signalised intersection. It is likely that some pedestrians will not wait for the signals and cross in an uncontrolled manner. Slow or late entering cyclists may be putting themselves at risk of being hit by vehicles entering the intersection from the side. This can be mitigated by the phasing sequence of the lights but the perceived risk may discourage people from cycling through the intersection.

Both a signalised intersection and a signalised roundabout were safety audited during the development of the B2B tender designs. The Safety Audit Team stated, "*The SAT endorses the proposed signalised roundabout at the MGI, being a more safe system compliant form of intersection than a conventional signalised intersection incorporating cross movements and an inherently large number of conflict points which can lead to an increase in crash risk and crash severity, including additional risks to vulnerable road users.*"

Applying the iRAP safety tool kit to an intersection with neither signal control nor an underpass would suggest that providing a signalised crossing reduces the causality rate to pedestrians by 25%-40% and to cyclists by 25%-40%. Providing a grade separated crossing will reduce the causality rate to pedestrians by 60% or more. There is no figure quoted for the reduction in causality rate for cyclist using a grade separated facility. While we would expect the reduction to be similar to that for pedestrians (60% or more) it would be more intrinsically linked to the number of cyclist who used the grade separated facility in preference to staying on the road.

### 2.4.2 International Research

International research shows that multi-lane roundabouts are less safe for cyclists than signalised intersections (refer Appendix B for references).

The intersection improvements proposed at MGI are to replace the current multi-lane roundabout with a signalised roundabout.

NZ Transport Agency literatures states "*Signalising roundabouts can improve safety for people on bikes riding on-road at roundabouts…Signalisation may assist with reducing vehicle speeds and increasing safety for cyclists on the roadway, however this is unlikely to provide for less confident cyclists…Where roundabouts are signalised to assist cyclists, advanced stop boxes and head-start cycle phases should be considered. If a roundabout is signalised, designers may also be able to include provision for cyclists (and pedestrians) to travel directly through the central island, i.e. a short section of off-road provision, with signalised crossings. This provides a more direct alternative to peripheral paths for cyclists travelling straight through the roundabout.*"

The Planning and Design for Pedestrians: Guidelines from the Department of Transport for Western Australia provides a good evaluation of the trade-offs between grade separation and signal controlled crossings. Excerpts from this guide are below. *"Grade separation of a pedestrian crossing from a roadway can be achieved using either a bridge or an underpass. This type of crossing provides the highest level of protection for pedestrians and minimises the disruption to road traffic."*

The following points summarise the research review.

**Advantages**

- The safest type of pedestrian crossing facility,
- No delays to vehicular traffic.

**Disadvantages**

- High capital cost,
- Level difference can cause problems for the elderly and persons with a mobility impairment,
- Generally poorly patronised (except at a school or where fencing is used) due to the level difference and longer walking distance (particularly at a pedestrian bridge) and reduced perception of personal safety,
- Many pedestrians prefer to cross at-grade, often without using any crossing facility,
- An underpass has reduced personal security, high lighting cost and is prone to vandalism,
- Usage can be increased if it links well to principal shared paths and links to community facilities / destinations for both pedestrians and bike riders.

# 3 Impacts of the B2B Project

The construction contract of the B2B project was awarded to CPB Contractors in April 2017. Any changes to the scope of that project (e.g. retaining and extending the existing underpass, providing a new underpass or overpass/bridge) may affect the programme of the overall project and would increase the costs as detailed in Section 8. This report has not considered in detail the likely effects these changes would have on the B2B contract (i.e. variation, costs, redesign delays, AMP separable portion etc.).

## 3.1 Impact on the Existing Underpass

In order to accommodate a flyover at MGI, a new structure will be built to elevate the road above the intersection. The structure will be built directly above the existing underpass and the road will be widened over the western side of the underpass. If the existing underpass is to be retained, the existing underpass will need to be extended and its structural capability of accommodating the new flyover will need to be addressed.

## 3.2 At-Grade Crossing Facilities

### 3.2.1 Signalised Intersection

As part of the B2B project, at-grade cyclist and pedestrian crossing facilities will be provided. Cyclists and pedestrians crossing SH2 will be able to cross all sides of the intersection. The infrastructure proposed as part of the B2B project at the time of tender is shown in **Figure 4**.

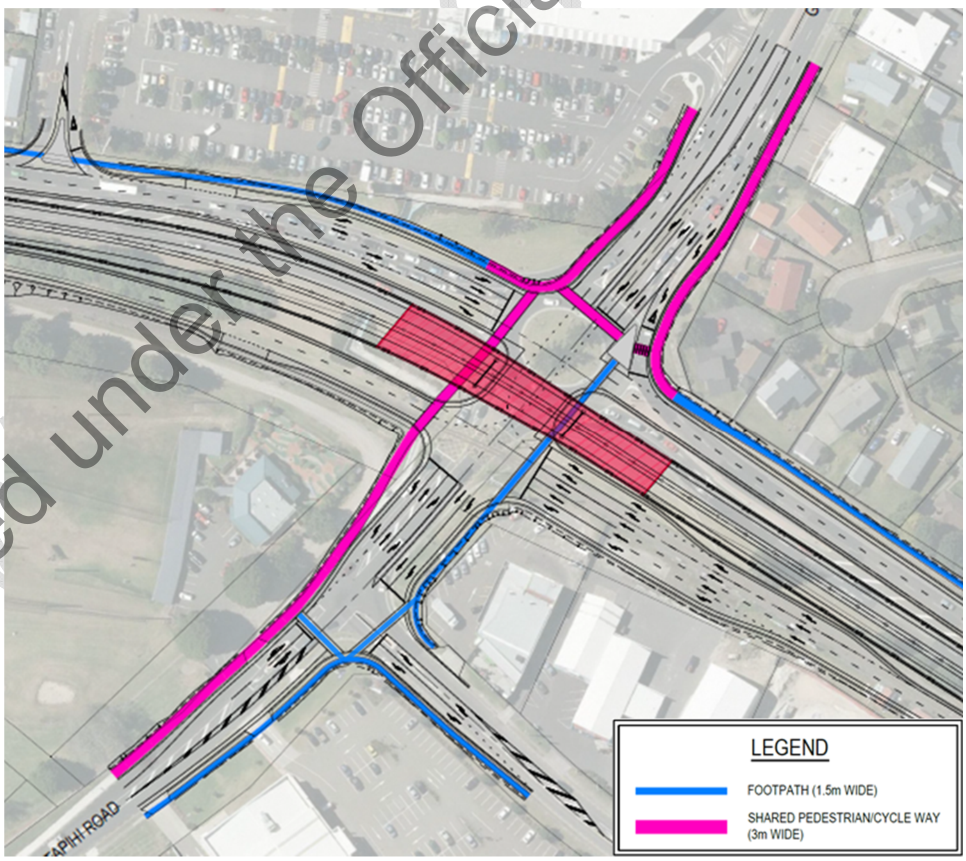


Figure 4: Proposed Cyclist & Pedestrian Infrastructure

## 3.3 B2B Project Variation – Signalised Roundabout

Since the award of the B2B contract, a variation has been agreed to replace the signalised intersection layout with a signalised roundabout. The reasons for the signalised roundabout are as follows:

- A design solution aligned with the safe system approach,
- Fewer lanes for pedestrians to cross per phase,
- Addresses issues identified during the B2B Safety Audit,
- The alternative layout includes a longer span structure over the intersection which offers more openness and provides the opportunity to achieve an excellent urban design outcome,
- Reduced signal cycle time due to more movements being accommodated per phase, and
- A more balanced traffic flow for all approaches.

This changes how desire lines are accommodated within the intersection, with pedestrian and cyclist crossings being located through the central island. An additional crossing across the north bound exit is being considered to improve efficiency of the crossing times for off road cyclists. Although reduced cycle times are expected to reduce crossing wait times, there are more crossings required, typically four compared with two or three, thus providing similar overall crossing times for users.

This change to the project is currently in the early stages of development, and therefore some details with regards to the roundabout's operation have yet to be confirmed. This assessment has focused on feasibility of providing a grade separated facility, in conjunction with at-grade crossing facilities being provided through a signalised roundabout.

## 3.4 Reference Plans

To evaluate the above impacts, the following plans have been used in this assessment:

- *B2B-DRG-RD-2101.*

All concepts have been considered in conjunction with the above plans.

# 4 Crime Prevention through Environmental Design

## 4.1 CPTED Principles

Crime Prevention through Environmental Design (CPTED) has emerged as one of the most commonly used and effective methods of reducing opportunities for crime. The fundamental idea of CPTED is that it is possible to combine local knowledge and CPTED principles to design environments in ways that reduce or prevent the incidence of crime. One of the most important concepts behind CPTED is that crimes against people are less likely to occur if other people are present, thereby creating passive surveillance. Another important CPTED philosophy is that the perception of crime or danger is as valid as the actual occurrence of it. A place may not necessarily pose a threat to safety, but if it looks unpleasant or threatening, people will avoid it, thus generating greater potential for actual crime to occur.

In 2005, the Ministry of Justice prepared National Guidelines for CPTED, titled 'Crime Prevention through Environmental Design in New Zealand'. These guidelines outline seven qualities for safer places, and form the basis for the CPTED assessments as well as a basis on which to check the merits of a proposed design solution:

**Access: Safe movement and connections**

Places with well-defined routes, spaces and entrances that provide for convenient and safe movement without compromising security.

**Surveillance and sightlines: See and be seen**

Places where all publicly accessible spaces are overlooked, and clear sightlines and good lighting provide maximum visibility.

**Layout: Clear and logical orientation**

Places laid out to discourage crime, enhance perception of safety and help orientation and way-finding.

**Activity mix: Eyes on the street**

Places where the level of human activity is appropriate to the location and creates a reduced risk of crime and a sense of safety at all times by promoting a compatible mix of uses and increased use of public spaces.

**Sense of ownership: Showing a space is cared for**

Places that promote a sense of ownership, respect, territorial responsibility and community.

**Quality environments: Well designed, managed and maintained environments**

Places that provide a quality environment and are designed with management and maintenance in mind to discourage crime and promote community safety in the present and the future.

**Physical protection: Using active security measures**

Places that include necessary, well designed security features and elements.

## 4.2 Relevance to the existing underpass

Reviewing the existing Bayfair underpass in terms of CPTED principles the underpass has the following design issues:

- The adjacent Bayfair carpark area has a low occupancy with minimal " eyes on the street",

- Passing drivers are unable to play an observation role as the ramps and underpass are hidden from view,
- There is little opportunity for sense of ownership as the underpass structure is located on its own and disconnected to any occupied buildings, public spaces that would assist in creating territorial responsibility.

### 4.2.1 Existing crime statistics and relationship to CPTED

Based on the design premise that the design of each underpass should be generated from a site specific response the existing environment is a significant factor in how a space is and will be perceived from a safety and sense of safety perspective.

The existing Bayfair underpass crime event statistics (Calls for Service for Police attendance 2012 – 2016) have been sourced from NZ Police (see table below). These provide an indication of the safety of the area around the Bayfair underpass and the southern carpark.

| Count of Event Number | Column Labels | | | | | | |
|---|---|---|---|---|---|---|---|
| Row Labels | Damage | Disorder | Drugs | Suspicious Activity | Theft | Assault | Grand Total |
| 2012 | | | | 66 | | | 66 |
| 2013 | | 50 | 7 | 11 | | 1 | 69 |
| 2014 | | 96 | | | | | 96 |
| 2015 | | 10 | | | 36 | | 46 |
| 2016 | 32 | | | | 13 | | 45 |
| Grand Total | 32 | 156 | 7 | 77 | 49 | 1 | 322 |

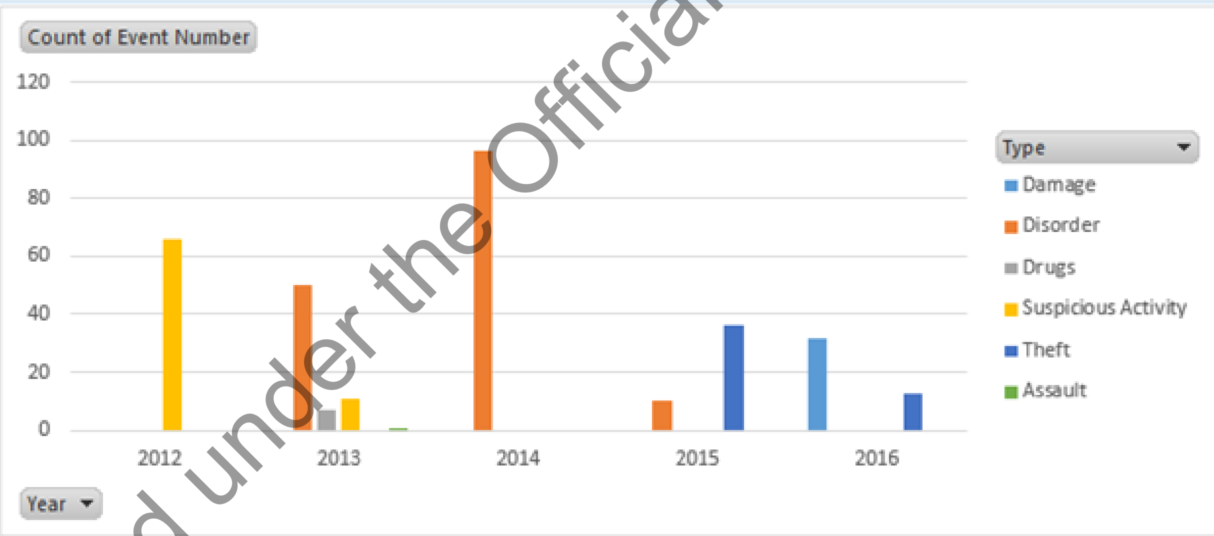


Figure 5: Calls for Service for Police attendance in and around the Bayfair underpass 2012 – 2006

Suspicious activity and disorder are identified as the two main events in years 2012 to 2014. In 2014, following installation of CCTV, the incidence of disorder dropped. The events itemized as damage that have been the main events recorded since 2014 and could either be acts on private vehicles or within the underpass i.e. graffiti. There is one incidence of assault identified as occurring in 2013 in and/or around the underpass. There has been a reduction in incidents from an average of two incidents a week to one a week in recent years although this does not factor in the perception of safety for the users.

Anecdotally, it has been relayed by Tauranga City Council that in past years there has been an issue with personal safety in regard to the underpass with intermediate students being advised not to cycle through the underpass due to bullying incidents and bike theft along with complaints about groups hanging around and intimidating people. This has been supported by TCC engaging a security firm to monitor the area.

Although CCTV has been evidenced as influencing the number of events in the existing underpass since 2014 this does not mean unsociable behavior would be prevented from occurring or increasing in this location in the future (drinking, drug dealing, assault, bullying, graffiti).

Perception of personal safety is a significant issue when there is not an alternative route available. Without a controlled crossing at-grade the current Bayfair underpass provides the only safe route in terms of getting across the number of existing traffic lanes. This is a significant factor especially at night where a pedestrian has no opportunity to be observed at-grade by passing motorists. The underpass at these times becomes a barrier as people decide to travel by car instead of walking. It is noted that this increases the dependency of those people who are under 16 and over 65 who don't drive on being transported by others because of perceived safety.

## 4.3 Underpass / At-Grade Facility Comparison

A better outcome in terms of CPTED and supporting the perception of safety is to provide access at-grade rather than by an underpass. Drivers in passing vehicles provide "eyes on the street" and are also able to see the full pedestrian/cyclist journey. Existing street lighting is also able to provide for visibility of pedestrians at night.

The user experience at-grade also has the following benefits:

- Pedestrians/cyclists can continuously see their immediate destination instead of being constrained below grade. This has the additional benefit of drivers being more aware of other transport modes and how others use the streets to move around,
- Pedestrians have an increased ability to see who is approaching and 'move to the side' in an open environment, and
- Depending on the layout there is potential to provide more than one path of travel providing the ability for pedestrians to choose to walk away from situations that they don't want to walk past.

One factor that needs to be considered, however, when pedestrian access is provided at-grade across significant intersections is that the environment is a place that pedestrians and cyclists want to pass through. This can be achieved by using materials, lighting that consider the pedestrian scale and travel speed thereby creating an environment where pedestrians and cyclists don't feel marginalised.

## 4.4 Best Practice - Underpass

A review of national and international best practice design guidance references generally accepted rules and is described in Appendix A (with the qualification that the dimensions for underpasses needs to be considered in conjunction with the specific site conditions).

### 4.4.1 Desirable width and height

A summary of international guidance outlines that the type and mix of users has a factor in determining the width of an underpass. In summary for an underpass that is reasonably long (more than 23 metres);

- To enable two opposing cyclists to comfortably pass each other, the minimum width should be at least **3.0m wide,**
- The minimum width to accommodate a pedestrian and cyclist opposing each other is **3.6m,**

- The most desirable width of an underpass is **4.2m** which enables several users to pass each other another safely,
- The recommended vertical clearance for a pedestrian and cyclist underpass is **3m**, and
- The existing underpass is 3.0m wide and 2.5m high.

As an example, a part of the SH1 Russley Road/Harewood Road project in Christchurch included a pedestrian and cyclist "Subway" approximately 100m long – suggesting that greater lengths can be accommodated with facilities of higher standard (noting that this is approximately 5m wide).

Figure 6: Photo of SH1 Russley Road/Harewood Road underpass

### 4.4.2 Other design factors

Underpass design should carefully consider the location and user safety. When the underpass is long, wider or flared openings are recommended to improve natural lighting visibility. For short underpasses or tunnels, modest lighting may be all that is required. Generally, the longer the structure, the greater the need for illumination. In certain cases, lighting may be required on a daily, 24-hour basis. For tunnels longer than 15 metres, constant illumination is recommended, with all lighting being recessed and vandal resistant. **Figure 7** presents an example of better practise underpass design.

Figure 7: Examples of Best Practice

# 5 Extending Existing Underpass

## 5.1 Existing Underpass

Access to the underpass on the east side of Maunganui Road is by either a ramp or stairs, with both located within the Bayfair Shopping Centre car park. The footpath from Matapihi Road crosses the remnants of the old ECMT rail track crossing and then descends down a ramp to the west end of the underpass.

The existing underpass is 28m long and measures 3.0m wide and 2.5m high. From Matapihi Road, the access ramp descends 2.7m over 42m, through a corner, to the lowest point at the underpass entrance. The ramp has a gradient of 8.3% and is interspersed with four flat sections. The underpass rises across Maunganui Road with a 1.5% gradient.

The eastern ramp is 30m long and contains a further corner, located where the stairs meet the ramp. This ramp also has a gradient of 8.3%, with two flat sections. Operationally, the underpass is constrained by the corners at each end which reduce the sight distance. Each corner has central barriers to separate contra-flow of pedestrians and cyclists. The existing underpass does not provide a direct connection to Girven Road. The entry of the existing underpass are at right angles as shown in **Figure 8**. The ideal practice is for straight approaches to an underpass to allow users to see through the underpass before entering.

Figure 8: Existing Underpass Arrangement

## 5.2 Existing Underpass Condition

Within the underpass itself, it is poorly lit, narrow and has extensive tagging throughout. During recent storms the underpass was also subject to flooding at times. The existing underpass has a pumped drainage system and is supposed to be sealed between the precast units, it is however subject to leaking and may need remedial works if retained. This is shown in **Figure 9**, adjacent to a more desirable underpass environment.

Figure 9: Existing Underpass Environment versus 'Best Practice'

## 5.3 Extension of Underpass

In order to accommodate the additional width of the new flyover and associated embankment, the existing underpass will need to be extended from the current length of 28m to approximately 60m long (excluding ramp approaches). This extension would ideally occur on only one side, preferably to the west based on the available width, however it is likely that at least 3 metres of additional length is needed to the east to accommodate the road widening and footpaths.

While this can be accommodated within the proposed road reserve, it will be roughly double the existing length and retain right angle bends at each end.

## 5.4 Desirable cross section

The existing underpass is 3.0m wide and 2.5m high, meeting the requirements of the *NZTA Pedestrian planning and design guide* (Chapter 15) which stipulates the minimum for an underpass as 'at least' 2.4m wide and 2.1m high. However, these figures should be considered absolute minimums, and do not account for other factors beyond the cross-sectional dimension, including;-

- The form of the underpass and approaches, including length,
- The level of passive surveillance expected to occur within the underpass,
- The alignment of the underpass,
- The surrounding environment, and
- The level of lighting.

All of these functional attributes need to be considered in conjunction with the environment in which the underpass sits in particular in relationship to best practice Crime Prevention Through Environmental Design (CPTED) as discussed in Section 3.

Taking into account the type and mix of users and the CPTED issues discussed in Section 4 and based on the underpass being used by both pedestrians and cyclists, the optimum width of an underpass with a length similar to that proposed is 5m, with a height of approximately 3.0m. The existing underpass dimensions do not achieve these requirements, nor the minimum 4m wide and 2.7m high, as recommended by CPTED guidance.

## 5.5 Constructability

### 5.5.1 Additional Structural Loads

The existing underpass is constructed using supplier designed precast units. "Issue for Construction drawings" have been obtained but no shop drawings showing details of the precast units including reinforcing have been obtained. The design required these pre cast units to be designed to HN-HO-72 loadings, which caters for normal and overweight highway loadings with a pavement of 0.5m over the precast units.

The existing underpass is located under the embankment for the MGI flyover which is approximately 7m high in this location. Without undertaking non-destructive investigations to confirm the construction detail of the precast culvert units or obtaining the shop drawings it is not possible to assess if these units would be able to accommodate the additional pressure due to the embankment above and still meet the required loadings. Preliminary discussions with suppliers has indicated it is unlikely the precast units would be able accommodate the additional embankment weight and highway loads.

The existing underpass is constructed on 150mm of granular bedding with no deep ground improvements. Based on the B2B tenderer's design we are expecting static settlement of up to 150mm in this area. This is likely to cause unacceptable differential settlement between the units immediately under the embankment.

In addition to static settlement the area is susceptible to liquefaction and seismic settlement. Deep ground improvements (approximately 9m deep) are proposed beneath the adjacent embankment to mitigate this settlement. These would not be able to be installed beneath the existing underpass and therefore in an earthquake event that causes liquefaction, the embankment above the existing underpass is likely to be subject to unacceptable settlements.

An alternate would be to extend the flyover by adding another span. This would remove the additional load on the underpass. Costs would be significantly more than extending the underpass and all other issues associated with the existing underpass would remain.

### 5.5.2 Utility Relocations

Utilities, both relocated and proposed, would restrict the alignment and of the new access ramp required at the western end of the existing underpass. There are power, ITS, gas, water, raising sewer main, drainage and communication services in the area of the new ramp, which is restricted in width, to the east by the new on-ramp and bus stop, and to the west by the driving range boundary. At the preliminary stage it is not possible to confirm whether the existing underpass could be retained, and a new western ramp constructed, due to the presence of several services. It would require additional engineering works such as retaining walls.

## 5.6 Maximum Underpass Length Considerations

Tauranga City Council has confirmed previously through discussions regarding Te Maunga Pedestrian and Cyclist Facilities, that the maximum acceptable length of an underpass was approximately 50 metres. In addition to the maximum length of 49m, any such underpass would need to be supported by long sight distances – requiring the removal of 90 degree angle accesses to the underpass.

During a follow up meeting between TCC and NZTA (11 May 2017) regarding maximum distances of underpasses indicated that while underpasses in general were undesirable from a personal safety perspective, if one were to exceed the above maximum lengths, a facility similar to Russley Road would be expected as a minimum. It was also discussed that this location in particular is expected to vary in terms of users across the day (only cyclists primarily during commuting hours, with pedestrians at other hours), which impacts on passive surveillance needs. TCC advised they would not support an underpass of this length without also having an alternative safe at grade crossing. If an underpass were combined with at-grade facilities, there may be extended periods with no users below the surface.

#### 5.6.1 Available Space

There is approximately 80m between the Bayfair and golf driving range property boundaries. Therefore additional land would need to be acquired to accommodate the underpass and approach ramps.

### 5.7 Summary of Issues

The following points summarise the issues associated with extending the existing underpass:

- CPTED concerns regarding the safety of users:
  - Poor lighting
  - Lack of passive surveillance
  - History of crime issue/personal security
  - Extensive tagging/vandalism throughout
- The previously agreed total length limitation of greater than 50m would need to be relaxed (requiring TCC agreement),
- The issue of clear sight distance would need to be revisited as 90 degree ramps to the underpass is unavoidable in this instance (also requiring TCC agreement),
- Commuter cyclists would prefer a grade separated crossing and some may choose not to cycle or choose not to take up cycling if an alternative at-grade, crossing was not considered to be safe or too inconvenient,
- The extension of the underpass is not desirable from a CPTED perspective. The extension may discourage some existing users or possible future users from using the underpass, particularly outside of peak periods,
- Current as built information is not adequate to determine if the structural capacity of the existing underpass is sufficient for the weight of the embankment. Preliminary discussions with suppliers has indicated it is unlikely the precast units would be able accommodate the additional embankment weight and highway loads,
- The existing underpass is likely to undergo unacceptable settlements:
  - Firstly due to static loading, and
  - Secondly the embankment above the above and adjacent the underpass is will undergo seismic induced settlements.
- In the event of earthquake induced liquefaction these settlements are likely to impact on the MGI overpass/bridge embankment,
- The existing structure is likely to require remedial works to address the water ingress if retained,
- Service relocations are planned for the area currently occupied by the underpass. Finding alternative locations for these services will involve additional cost and may require additional land to be purchased to accommodate these services.

In light of the above issues, and in comparing an extension of the existing underpass to the provision of an at-grade facility connecting Girven Road and Matapihi Road, it is viewed that the at-grade crossing option would encourage more pedestrian movements as it is a more direct route, maintains visual connection to destinations and provides safe crossing outside of daytime hours with surveillance provided by passing vehicles.

**The B2B project is intended to provide a high level of service to all road users for the next 50+ years. Extending the existing underpass by more than twice its current length without a corresponding**

**improvement to the structure's cross section or approach ramps, would significantly impact the underpass' already reduced performance with respect to meeting urban design and CPTED requirements.**

For these reasons, it is recommended that the option to extend the existing underpass is not pursued.

# 6 Alternative Underpass Alignment

## 6.1 Existing Constraints

As identified in the previous section, there are a number of constraints limiting the feasibility of extending the current underpass, some that can be overcome through a new alignment. Through providing best practice cross sectional dimensions, this assessment has assumed that TCC's maximum desirable length requirement of the underpass can be relaxed, therefore allowing a longer underpass to be provided in a new location.

## 6.2 Proposed Location

In order to achieve clear sight distance along the length of the underpass and accommodate desire lines, the best location is parallel to Matapihi Road / Girven Road. As this location is across the intersection approach, the underpass length would need to accommodate the geometry of the signalised roundabout. Refer to section 6.3 for further details.

With the addition of ramps down to the underpass this could require up to 200m of total length of underpass and ramps to tie in at each end.

Such an extension would have significant impacts on the property either side of the underpass, specifically Bayfair and the golf driving range. These properties were not part of the initial designation and would likely delay the project while an alteration to designation is sought and third party land is secured. Specific land impacts include:

- Approximately 20 spaces of the Bayfair carpark and one circulating lane would need to be removed to accommodate access ramps, with potential impacts on circulation and general access to the carpark. The lost car parks would likely need to be replaced somewhere else.
- Likely impacts on the golf driving range, particularly severance of the existing access, requiring relocation closer towards the rail crossing. Some mini-golf holes may also need to be redesigned or removed.

A signalised roundabout at MGI will increase the footprint of the MGI intersection. In order to provide this underpass the length would need to be a minimum of 105m, and could be up to 120m long. Due to limitations from the nearby left-in and left-out access to the Bayfair carpark, a switch back style ramp will be required. This layout will prevent clear sight/access/security concerns and is likely to result in the at-grade crossings being the preferred crossing method outside of peak times.

As noted on **Figure 10** such an alignment is likely to impact on Bayfair car parking and the golf driving range and will require consultation and land purchase.

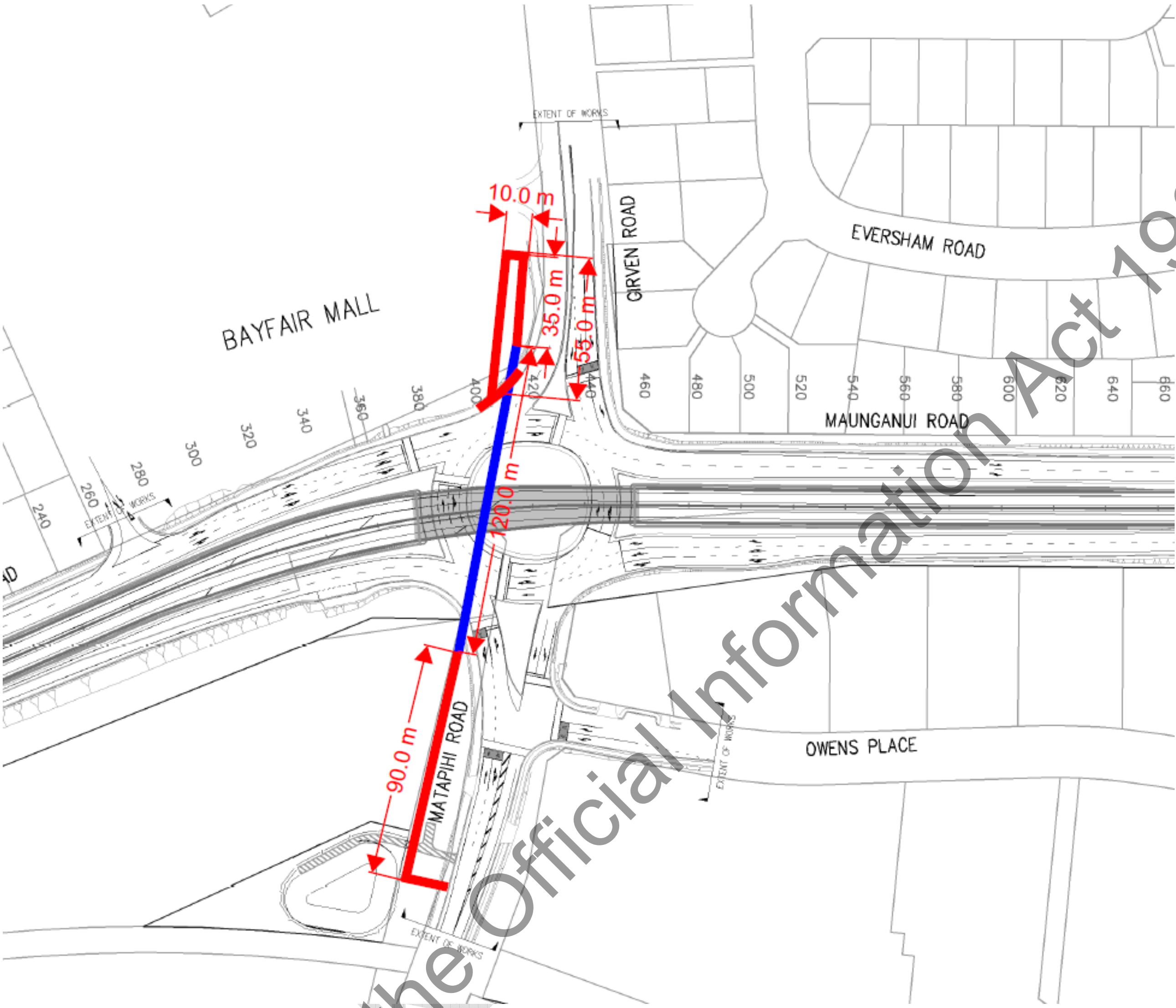


Figure 10: Indicative Underpass Alignment

## 6.3 Underpass cross section

As previously mentioned the minimum standard for a new underpass is 2.4m wide x 2.1m high. As no reference is made in New Zealand literature regarding differences in cross section dimensions to the length of the underpass, reference has been made to international standards and design guidance.

Following international guidance for an underpass longer than 25 metres that is used by pedestrians and cyclists the minimum cross section dimensions should be 4 metres wide x 3 metres high.

The context guidance from ‘Bridging the Gap’ outlines that “the underpass must be located to serve an identified desire line and it must be designed in a way that encourages people to use it; secluded locations should be avoided. There should be no additional delay in travel via the underpass compared with the equivalent at-grade crossing.”

Factors that encourage the use of an underpass include:

- Use: The number of users,

- Approach: The paths leading to the underpass must be direct and straight so that the underpass is clearly visible on the approach,[3] and
- Alignment: The underpass should offer a straight route so that one end of the underpass is visible from the other. Bends and angles in the underpass should be avoided as they create hidden places which encourage vandalism, crime and anti-social behaviour.

The above requirements would result in a much safer alternative option that is likely more suited to the maximum lengths. As an example, a part of the SH1 Russley Road/Harewood Road project in Christchurch (shown in **Figure 11**) included a pedestrian and cyclist “Subway” approximately 100m long – suggesting that greater lengths can be accommodated with facilities of higher standard (noting that this is approximately 5m wide). The layout of the Russley Road/Harewood Underpass is shown in **Figure 11**.

Similar to the Russley Road/Harewood Road underpass, it is expected that a 5m wide and 2.5m high cross section would be appropriate, given the proposed length required for a new underpass.


Figure 11: Plan of SH1 Russley Road/ Harewood Road underpass

[3] *Bridging the gap: NZTA urban design guidelines, NZTA, 2013*

## 6.4 Utility conflicts

The indicative underpass alignment passes under the northern span of the MGI overpass/bridge. This space is very congested with planned upgrades to stormwater drainage, as well as numerous other services.

The western access ramp would be located in the footpath/verge on the north side of Matapihi Road. There are numerous existing services in this area that would make construction of the western ramp almost impossible without relocating some significant services. Primarily the:

- TCC sanitary sewer - 450mm diameter main feed to the Te Maunga Treatment plant,
- 225mm diameter TCC water main,
- High Pressure Gas – Regional Pressure Reduction Station and connecting 100mm and 50 mm mains,
- TCC Stormwater –900mm diameter crossing Girven Road.

Currently there is no land available for these services to be relocated to, so additional land may be required from the driving range to accommodate these services.

## 6.5 Summary of issues

The following points summarise the issues associated with providing a new underpass:

- A new underpass would overcome the structural issues associated with extending the existing underpass,
- The height and width of the underpass would make it more inviting than extending the existing underpass, although CPTED issues would still remain as there is no passive surveillance of the underpass which may limit its use outside busy times and outside daylight hours,
- The switchback ramp layout will prevent clear sight/access/security concerns and is likely to result in the at-grade crossings being the preferred crossing method outside of peak times,
- The previously agreed maximum length of 50m agreed with TCC would need to be relaxed to the estimated new length in excess of 100m (plus ramps),
- Consultation with AMP Capital (Bayfair owner) would be necessary for to understand and mitigate property impacts , in particular the impact on car parking spaces and circulating lanes,
- Consultation with golf driving range owner and operator would be necessary for to understand and mitigate property impacts, in particular the impact on access,
- Significant service relocations and changes to the planned service relocations will be required.

# 7 Overpass/bridge Considerations

Overpass/bridge options have been considered for crossing over SH2.

An overpass/bridge would need to provide sufficient clearance over SH2 it is an Over dimensional vehicle route (requiring 6.1m of clearance above it), but pass under the Tauranga Airport flight path envelope. Therefore the overpass/bridge would need to be located where the B2B SH2 flyover approaches ground level. Options at north and south of MGI have been considered.

### 7.1.1 Ramp Gradients & Lengths

To determine the acceptable length of gradients, the Austroads' Guide to Road Design Part 6A suggests that *"Gradients steeper than 5% should not be provided unless it is unavoidable"*. Additionally, Figure 7.1 in Austroads 'Desirable uphill gradients for ease of cycling' presents maximum lengths of uphill gradients acceptable to cyclists. This indicates that in order to ascend 6.1m, a gradient of 4% is preferred. This would require the ramp to be approximately 150m long.

## 7.2 Potential Overpass/bridge Locations at MGI

The B2B SH2 flyover reaches ground level approximately 200m north and south of MGI. As identified, any ramp on either side of SH2 will require a minimum of 150m of ramps to reach a height of 6.1m.

### 7.2.1 South of MGI

When considering opportunities south of MGI, the overpass/bridge would need to be near Exeter Street, adding approximately 800m of pedestrian/cyclist trip length. As a comparison, if users were to continue down to the SH29A interchange, this would add 1.6km (and the SH29A facility is planned to be provided as part of the B2B project).

When considering potential landing areas for a 150m ramp in this location, the only potential location is where properties have been removed to support the construction of the SH29a interchange. This would result in the new bridge being very close to the new crossing point and will likely result in an option south of MGI being unnecessary.

### 7.2.2 North of MGI

With limited space available to accommodate 150m of ramp on the eastern side of SH2, any structure would need to cross above the Left-in and Left-out access to Bayfair. An example of this is shown in **Figure 12.**

An alternative consideration may be to provide a split level ramp (i.e. 2 levels of 75m), however this is likely to require land take (primarily from Bayfair) to accommodate such widths (as paths may be up to 3.5m wide). The available roadside width is measured to be approximately six metres. There are also issues with respect to having a safe location to stop, as down ramps will end at the left-turn into the Bayfair car park.

Approximately 200m of ramp and structure would effectively occupy the entire Bayfair frontage of SH2. This is likely a less than desirable situation for AMP, as the structure would effectively obscure Bayfair from the road. The structure would also cross the existing left-in and left-out access to Bayfair, which could restrict vehicle heights at this location.

Due to the high number of properties fronting on to SH2, there are no other opportunities (north or south of MGI) to provide such an overpass/bridge structure, as a 200m ramp would likely prevent access to a large number of driveways.

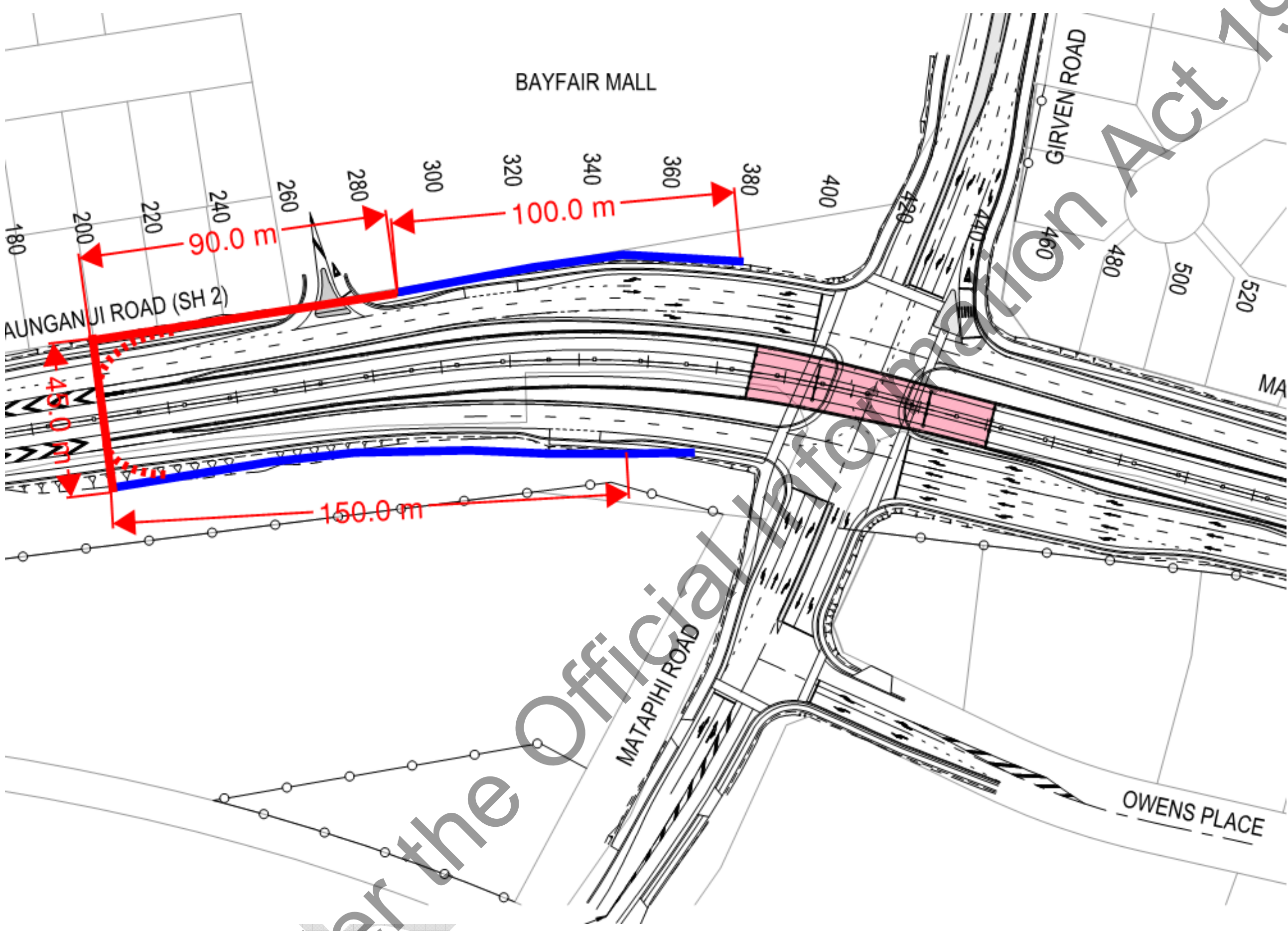


Figure 12: Potential Overpass/bridge Alignment

### 7.2.3 Summary of Issues with Overpass/bridge at MGI

The assessment identified a number of challenges with providing an overpass/bridge at MGI:

- An overpass/bridge would be offset a considerable distance from the intersection (approx. 500m extra trip length),
- Pedestrians and  cyclists are sensitivities to increases in journey length and time, therefore the at-grade facility is likely to provide a more attractive route,
- To achieve a height of 6.1m, gradients require long ramp lengths with multiple stopping/rest transitions which further increase the ramp lengths (in this case up to 150m),
- Associated visual impacts on the front entry of the Bayfair Shopping Centre, with further structures above the existing entrance.

The additional travel time required would discourage use, as users will have a pedestrian crossing available on their desire line through the intersection. The additional travel time is not expected to be faster than simply waiting at the crossing for the next green phase.

Whilst grade separation of pedestrians and cyclists from road traffic is beneficial in terms of safety, there are a number of issues created with trying to locate it near the MGI intersection which result in it unlikely to be utilised in a manner that justifies its cost. For these reasons, it is recommended the option to construct an overpass/bridge at MGI is not progressed further.

An overpass/bridge further north, connecting into a wider pedestrian/cyclist network is worth considering, as outlined below.

## 7.3 Overpass/bridge north of MGI

An alternative overpass/bridge option north of MGI, near Concord Avenue has been considered. This facility would provide a different function to the existing underpass, serving a broader purpose to improve pedestrian and cyclist connections across the wider network. The Concord Avenue location could improve usage through more direct connection to Mount Maunganui residential catchments, tieing into planned cycle/pedestrian network extensions to Links Avenue/Mount Maunganui Intermediate School, and serve future potential routes to Hewletts Road and around the airport as supported by local cycle advocacy groups.

This option also achieves the same benefits provided by the overpass/bridge at MGI options (improved personal safety). Because it is outside the zone of the B2B construction contract it could be undertaken in isolation of the contract which reduces programme and cost risks.

An overpass/bridge at this location would add approximately 1km journey from Girven Rd to Matapihi Rd which would be undesirable to many (compared to the at grade crossing that will be provided at MGI). Therefore overpass/bridge location should be considered as a connection to the wider cycle network rather than a replacement of the existing desire line across MGI.

How such a connection would integrate with the wider TCC cycle network is shown in **Figure 13**, with potential connections direct into the Links Ave Reserve, or along Concord Avenue. There are also a number of beach accesses that run parallel to Concord Avenue that would allow for safe off-road connections. A potential northern connection to Maunganui Road has been shown.


Figure 13: Wider TCC Cycle Network Connections

## 7.4 Summary of Overpass/Bridge Considerations

An overpass would provide a safe facility for pedestrians and cyclists to cross SH2 without having to interact with road traffic. However the usage of the overpass is dependent on its location and connection with the wider pedestrian and cyclist network, as well as its location in relation to alternative crossing locations. Signalised crossings will be provided at MGI, therefore an overbridge nearby is unlikely to be utilised sufficiently to justify its cost.

A grade separated crossing will be provided at the planned SH29A overbridge, therefore another crossing south of MGI is not necessary. A crossing north of MGI, in the vicinity of Links Ave Reserve, or along Concord Avenue, connecting to a wider TCC network is worth considering further.

# 8 Economic Viability

## 8.1 Preferred Option

Due to the issues associated with extending the existing underpass and overpass/bridge at MGI, cost estimates have only been prepared for a new underpass at MGI and a new overpass/bridge located adjacent to the Links Ave Reserve, or along Concord Avenue.

## 8.2 Cost Estimation

### 8.2.1 New Underpass

The indicative cost estimate for a new underpass at MGI is approximately $10.8m. It is noted that there are a number of significant risks associated with this option which could increase this cost further, such as:

- Extent of service relocations,
- Extent of ground water lowering,
- Land purchase and mitigation costs,
- Severance of the existing driving range access from Matapihi Road,
- Whole of life costs.

These risks could have a significant impact on capital cost.

### 8.2.2 New Overpass/bridge

An indicative cost for an overpass/bridge located adjacent to the Links Ave Reserve, or along Concord Avenue is approximately $5.0m. This is based on the cost of a recently constructed pedestrian/cycle overpass/bridge near the Poike Roundabout.

Similar to the construction of a new underpass, risks have been identified for an overpass/bridge, however these are expected to be less significant:

- Managing utility conflicts (primarily overhead powerlines along Maunganui Road),
- Avoiding the vehicle pull off/parking area opposite the Links Ave Reserve (or allowing for a length where this can be accommodated),
- Obtaining TCC consent to use the land within or adjacent to the Links Ave Reserve.

## 8.3 Economic Evaluation Methodology

To determine the economic benefits of providing a new grade separated pedestrian/cycle crossing of SH2, the NZTA Economic Evaluation Manual has been utilised, specifically *SP11 – Walking and Cycling Facilities*. This assessment recognises the following benefits from such facilities:

- Anticipated User Growth (specifically health and environmental benefits),
- Travel Time Savings, and
- Crash Cost Savings (if applicable).

This assessment has focused on the new underpass option. Discussion regarding each of the above components is expanded in the following sections.

## 8.4 Measured Benefits

### 8.4.1 Growth in Users/Health & Environmental Benefits

Appreciating that a facility is already present and that a signalised crossing is incorporated into the B2B project, it is expected that the provision of a new underpass is required to retain the existing number of users.

It is difficult to predict the change in total number of vulnerable road users making a change of travel mode as although removing the underpass may lead to a reduction in commuting cyclists. A CPTED review identified that a separated facility may act as a barrier to pedestrians and cyclists particularly outside of peak hours and the provision of an alternative at-grade crossing would encourage more trips by active modes.

If the provision of infrastructure Health & Environmental benefits are included, these are calculated using a composite benefit of $2.70 per new pedestrian/cyclist per kilometre. These benefits are primarily associated with users that change modes away from private vehicles to walking or cycling.

Note that these benefits do not consider users outside of a 1.6km catchment (in line with the SP11 assessment). Therefore this has been assumed to be conservative as any long distance commuter or recreational cyclist will not be captured but may benefit from this facility.

**Underpass**

The provision of a higher specification underpass may allow for further growth in users, however it is difficult to assume such growth outside of the method identified within SP11, which uses a catchment method to determine the likely number of users based on current mode share (identified as 2% cycle, 1% pedestrian – Census Data).

Assuming that the higher standard of facility contributes to a change in local user mode share, this could provide approximately $500,000 Net Present Value (NPV) of user benefits. As a sensitivity check, if the number of users were to double (i.e. to 900 users per day or a mode share of 6%) these benefits would increase by $400,000 to $900,000 (NPV).

**Overpass/Bridge**

Adopting the same methodology as the underpass (SP11) a new overpass/bridge crossing with a length of 530m is expected to generate $1.1m (NPV) in health and environmental benefits from the number of users. These benefits are focused around the benefits to the individual user (i.e. the new distance walked or cycled). These trips are calculated based on catchments around the facility (up to 1.6km around) with a slightly longer facility this reaches more potential users within the catchment which also captures more potential users.

Similar to the underpass, if mode share were to double, this benefit would increase to $2.2m (NPV).

### 8.4.2 Travel Time Savings

For the calculation of travel time savings, each facility has been measured from the Bayfair carpark (the existing crossing point) to the extent of works on Matapihi Road. These distances are as follows:

- Existing underpass (250m),
- Through Upgraded MGI intersection (240m),
- New Underpass (230m),

- Overpass/bridge at MGI (530m), and
- Overpass/bridge adjacent to the Links Ave Reserve, or along Concord Avenue has been assumed to be the same as the structure at MGI (530m). This is primarily due to the change in catchment for potential users requiring supporting assumptions. It is also likely that any benefits to some users will come at the expense of other users, effectively cancelling each other out.

To calculate time savings, speeds have been assumed to be 10km/h (2.7m/s) for cyclists and 2.7km/h (0.75m/s) for pedestrians. These times are consistent across all options except for the signalised intersection which has a more direct path but extra delays associated with waiting at the traffic signals.

Comparing the modelled pedestrian travel time of approximately 150 seconds through the at-grade crossing (average across the peak periods) an underpass is expected to yield a considerable travel time saving. A new underpass is expected to reduce travel times by approximately 30% for pedestrians and 85% for cyclists. Overall this is expected to result in approximately $550,000 (NPV) of travel time savings, primarily due to the time savings for cyclists.

When considering the benefits of a new overpass/bridge there are negligible travel time savings due to the additional distance travelled to get to/from the crossing in addition to fewer pedestrian users when compared with an underpass option.

### 8.4.3 Crash Cost Savings

Without historic crash history (as the underpass is already in place) the EEM predictive crash analysis has been used to estimate the safety impacts of implementing an at-grade crossing, then comparing that to a new grade separated facility. This assessment has focused primarily on the northern pedestrian crossing of Maunganui Road and the calculated crash costs for this are specific to this approach.

Utilising the conflicting flow model for intersections (within the EEM Crash Estimation Compendium), **Figure 14** presents the high level methodology for calculating the crash costs.

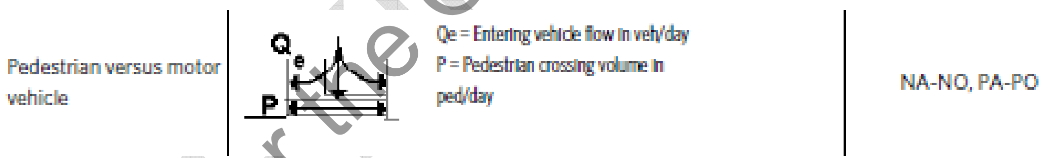


Figure 14: Pedestrian versus motor vehicle method

Without an underpass, the signalised crossing is expected to result in a 40 year crash cost of approximately $750,000 (NPV). To calculate the benefits of providing a separated crossing, an initial reduction of 70% has been adopted. However as the MGI crossing at-grade will be retained, a reduction of 35% has been used (suggesting it may be 50% effective). Applying a 35% reduction is expected to result in approximately $250,000 (NPV) of crash cost savings from the provision of an underpass. When comparing this cost against the typical value of a Death or Serious Injury (DSI) ($1.4m) this represents a saving of approximately 1/5 of a DSI.

The EEM predictive crash analysis approximation of a 40yr crash cost of $750,000 (NPV), which is the equivalent to one serious injury over 40 years, appears optimistic. Particularly when considering the high traffic volumes, speed differential of traffic and the demographic of pedestrian and cyclist users.

## 8.5 Incremental Benefit Cost Assessment

### 8.5.1 B2B Scheme Assessment Economics

As reported within the B2B SAR, the following benefits contributed towards a BCR of 2.8, based on a total NPV project cost of $92.1m (and a Do Minimum cost of $1.7m):

- Travel Time Savings – $220.3m
- Vehicle Operating Costs – $-19.9m
- Accident Cost Savings – $11.1m
- Vehicle Emissions Reductions – $-0.8m
- Agglomerations – $9.6m
- **Total Benefits – $220.4m**
- **Wider Economic Benefits – $31.8m**
- **Total Benefits (Including WEBs) – $252.2m (NPV)**

To give a rough indication of how the B2B BCR may be impacted by new grade separation options, the above values have been used as a base, with the calculated benefits, added or subtracted. Ideally this process would be fully updated to $2016 values, however the minor changes in benefits is not expected to significantly change the project BCR.

### 8.5.2 Potential Additional Benefits

**Table 1** summarises the potential additional benefits that could be expected due to an addition of grade separated crossing.

Table 1: Additional Benefits

| Option | Benefit | Value (NPV) |
|---|---|---|
| New Underpass (at MGI) | Health & Environmental Benefits | $500,000 |
| | Travel Time Savings | $550,000 |
| | Crash Cost Savings | $250,000 |
| | **Total** | **$1,300,000** |
| New Overpass/bridge (At Concord) | Health & Environmental Benefits | $1,150,000 |
| | Travel Time Savings | $0 |
| | Crash Cost Savings | $250,000 |
| | **Total** | **$1,400,000** |

### 8.5.3 BCR Assessment

**Table 2** summarises the BCR assessment for either the underpass or overpass/bridge.

Table 2: B2B SAR BCR Assessment

| Base Option | Crossing Option | Economic Benefit | Capital Cost | BCR | New B2B BCR |
|---|---|---|---|---|---|
| B2B SAR | At-grade crossing | $252,000,000 | 90,400,000 | 2.8 | N/A |
| B2B SAR | Overpass/bridge | $1,400,000 | $5,000,000 | 0.3 | 2.7 |

| Base Option | Crossing Option | Economic Benefit | Capital Cost | BCR | New B2B BCR |
|---|---|---|---|---|---|
| B2B SAR | Underpass | $1,300,000 | $10,800,000 | 0.1 | 2.5 |

To summarise the assessment of benefits, the provision of a new underpass facility is expected to contribute approximately $1-2m worth of benefits. As identified previously this project is estimated to have a capital cost of approximately $10m. Without including any ongoing maintenance or renewal costs, constructing a new underpass/overpass/bridge is expected to have a BCR of 0.1-0.4, and reduce the overall B2B project BCR from 2.8 to between 2.7 – 2.5.

The primary benefits unable to be included in this assessment are that of potential mode shift away from private vehicles. This may have a number of benefits including:

- Users who would otherwise drive between Bayfair and Home Zone (or other location), or
- For commuting to work or school.

# 9 Summary & Conclusions

## 9.1 Summary

This study considers the feasibility of extending the existing underpass, constructing a new underpass and constructing a new overpass/bridge. The assessment has considered a range of locations, to determine the best location for a new facility, rather than a like for like replacement. Various criteria have been used for the assessment including:

- Impact on the current B2B project,
- Likelihood of usage,
- CPTED/personal security,
- General option risks.

The findings are below.

### 9.1.1 Existing Underpass Extension

The existing underpass currently performs poorly with respect to CPTED and personal security issues. This would be significantly exacerbated due to effectively double the length of the structure to cater for additional road widening required as part of B2B. In addition, extending the underpass is likely to result in additional programme and cost risks associated with the delivery of the existing B2B D&C contract.

### 9.1.2 New Underpass

The provision of a new underpass is expected to retain some of the CPTED/personal security issues which relate to the existing underpass option. This would make the at-grade route more attractive to pedestrians and cyclists, particularly during off peak hours. A new underpass would also face significant challenges relating to utilities and property acquisition, requiring considerable investment (~$10.8M, excluding property). It also lacks a compelling economic benefit (representing a BCR of 0.1), and is likely to result in additional programme and cost risks associated with the delivery of the existing B2B D&C contract.

### 9.1.3 New Overpass/bridge at MGI

An overpass/bridge at MGI would mitigate the majority of personal security/CPTED and construction risks associated with the underpass options. However to fit between airport flight path and the B2B SH2 flyover requires it to be located approximately 200m north of the intersection. This would result in the bridge ramps obscuring the Bayfair frontage with SH2 and restrict access into the shopping centre. This route would add approximately 500 metres onto a trip from Girven Rd to Matapihi Rd and therefore provides an unattractive option, compared to the at-grade facility that will be provided at MGI.

### 9.1.4 New Overpass/bridge north of MGI

An alternative overpass/bridge option was identified north of MGI adjacent to Concord Avenue. This overpass/bridge would provide a different function to the existing underpass. It would serve a broader purpose by improving pedestrian and cyclist connections across SH2, linking with the wider pedestrian and cyclist network. This option achieves the improved personal safety and reduced CPTED risks compared to providing an underpass). It can also be delivered independently from the current B2B D&C contract. With an approximate cost of $5m and BCR of 0.3 over the existing B2B project, the provision of a new overpass/bridge away from the MGI intersection could be implemented with a 0.1 reduction in the project BCR.

## 9.2 Recommendation

Good walking and cycling facilities can expect to deliver the following benefits:

- Improved Accessibility – individuals who do not own a car have access to community services (work, education, shopping and public transport),
- Congestion reduction – increasing cyclist and pedestrian mode share decreases the number of people driving,
- Improved Liveability and health - if residents can easily walk or bike within their neighbourhood, it allows them to fit exercise into daily routine through active transport.

As described above, fundamental flaws and construction challenges were identified with all grade-separated options located at, or close to, the MGI intersection e.g. personal security/CPTED concerns, significant property requirements (Bayfair car park), high investment (~$5 to 10M), impacts on regionally significant utilities and adverse programme and cost risks on the existing B2B design & construct contract. Therefore it is recommended they don't get considered further.

An option to provide an overpass/bridge further north of the B2B project was identified, and warrants further investigation. The suggested location is near Concord Avenue.

This option would largely avoid those issues identified with the other options, due to it being located outside the current B2B site and away from the congested Maunganui-Girven Road Intersection, and represents an opportunity to improve overall connectivity across Tauranga for walking and cycling. The location improves connectivity to Mount Maunganui residential suburbs with a direct link over SH2 to the Matapihi Road route into the CBD. It could also connect with a potential cycle route to Hewletts Road and around the airport.

It is recommended that the Transport Agency continue to work with local stakeholders to develop cycle friendly facilities at-grade, within the signalised roundabout intersection as proposed but not limited to those raised in the Safety Audit of the B2B Tender designs.

It is also recommended that the Transport Agency continues investigating a pedestrian/cycle overpass/bridge of SH2 near Concord Ave in partnership with Tauranga City Council.

# Appendix A – CPTED Research

Table 3: Underpass Design Best Practice

| PEDESTRIAN PLANNING GUIDE (NZTA)<br>**http://www.nzta.govt.nz/assets/resources/pedestrian-planning-guide/docs/chapter-15.pdf**<br>15.14 Grade separation | |
|---|---|
| Preferred outcome | Pedestrians should ideally stay at the same grade when crossing, or have only a minor change in level – if necessary, the road should be elevated or sunk |
| Context | Both over- and underpasses usually result in longer walking journeys than at-grade crossings – and they are unlikely to be used where the walking distance is more than 50 percent greater than the at-grade distance. Even when less than this, some pedestrians will try to take the shortest route |
| Safety | Pedestrians can be concerned for their personal security at both under and overpasses [118], particularly if they are not well used [139].<br>To overcome this [13, 66, 118, 139, 146]:<br>• structures should be well lit, potentially on a continuous basis<br>• skylights should be provided in underpasses<br>• pedestrians should always be able to see their whole route without any obstructions or recesses, and (where possible) from a public place some distance away<br>• the route should include direction signs<br>• closed circuit television installations may be used<br>• each entry/exit should have 'natural surveillance' from adjacent buildings. |
| **BRIDGING THE GAP (NZTA URBAN DESIGN GUIDELINES)**<br>**http://www.nzta.govt.nz/assets/resources/bridging-the-gap/docs/bridging-the-gap.pdf**<br>**4.9 Underpass design** | |
| Preferred outcome | The issues usually associated with poor underpass design are related to personal safety, amenity (dark, uninviting and poorly maintained facilities), and the physical obstacle created by the change of level. These can be avoided by considering the underpass location and design in the early phases of a transport project. A well thought out and designed underpass can:<br>• Make it easier and safer for people to cross the road.<br>• Reduce travel time for pedestrians and cyclists if the underpass provides a direct route.<br>• Be easier to negotiate than an over-bridge due to smaller level difference.<br>• Lead to positive outcomes for pedestrians, cyclists and road users alike. |
| Context | Location: The underpass must be located to serve an identified desire line and it must be designed in a way that encourages people to use it; secluded locations should be avoided. There should be no additional delay in travel via the underpass compared with the equivalent at-grade crossing. |
| Dimensions, form, alignment | Approach: The paths leading to the underpass must be direct and straight so that the underpass is clearly visible on the approach.<br>Alignment: The underpass should offer a straight route so that one end of the underpass is visible from the other. Bends and angles in the underpass should be avoided as they create hidden places which encourage vandalism, crime and anti-social behaviour.<br>Dimensions: Underpasses should be as wide and high as possible to maximise light penetration, visibility and amenity.<br>Any tunnel effect should be minimised.<br>To provide pleasing proportions, the underpass should have a height approximately two-thirds of its width. |
| Safety | Surveillance: The design of the underpass should allow people to see activity within the underpass from the outside. Where possible the entrance of the underpass should be overlooked by adjacent buildings.<br>Crime Prevention Through Environmental Design (CPTED) principles should guide the design and location of the underpass. |

**PLANNING AND DESIGNING FOR PEDESTRIANS: GUIDELINES (AUSTRALIA)**

**9.7 Grade Separated Crossings**

| | |
|---|---|
| Dimensions, form, alignment | To encourage patronage of grade separated facilities:<br>• The maximum change in level for overpasses should be about 6.5 m<br>• The maximum change in level for underpasses should be about 3.5 m, with pedestrians able to see along the length of the underpass<br>• Overhead clearance within the structure must allow for safe pedestrian and cyclist passage:<br>• Minimum clearance of 2.5 m for routes used by pedestrians and cyclists |

**Guide for the Planning, Design, and Operation of Pedestrian Facilities (American Association of State Highway and Transportation Officials, 2004)**

Dimensions, form, alignment

Vertical clearance for long distance underpasses should be a minimum of 3m high (in order to maintain feeling of openness and security), with a minimum width of 4.8m for underpasses over 18m long. DMRB provides minimum dimensions for unsegregated underpasses for pedestrians and cyclists; these are shown in Table 3-1. The width is reduced to 3.0m at locations where space is restricted or where the total number of pedestrians and cyclists very small. In addition, access ramps or stairs should normally be the same width as the underpass.

Table 3-1 – Minimum dimensions for an unsegregated subway (DMRB)

| Subway Length (m) | Height (m) | Width (m) |
|---|---|---|
| <23 | 2.4 | 4.0 |
| ≥23 | 2.7 | 4.0 |

**ACT PLANNING AND LOCAL AUTHORITY, AUSTRALIA - CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN CODE, 2008**

Safety

| Rules | Criteria |
|---|---|
| **6.2 Pedestrian Underpasses and Overpasses** | |
| There is no rule applicable. | C29<br>The use of pedestrian underpasses is to be avoided. Where there is no practical or feasible alternative underpasses are designed:<br>a) wide enough to accommodate both pedestrian and cycle traffic<br>b) straight and without recesses<br>c) with mirrors so pedestrians can see around corners if there is a turn of 60 degrees or more<br>d) with entrances and exits that are visible from shops, homes or other areas of frequent pedestrian traffic<br>e) to ensure there is no screening of entries/exits<br>f) with signs at each end indicating where it leads and an alternative route to use at night |

**SUBWAYS FOR PEDESTRIANS AND PEDAL CYCLISTS LAYOUT AND DIMENSIONS - PART 1 TD**

THE HIGHWAYS AGENCY

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

THE WELSH OFFICE
Y SWYDDFA GYMREIG

THE DEPARTMENT OF THE ENVIRONMENT
FOR NORTHERN IRELAND

**39/63**

## Context

**General**

2.1 There are a large number of factors affecting the choice whether to provide a subway, and if so the type of cross-section. For this reason it is preferable that each case is considered on its merits having regard to the particular local situation. The following factors have been found to be significant in the consideration process:

- Volume of pedestrian traffic;
- Volume of cycle traffic;
- Whether the access route is to a school, playground or other local amenity;
- Type of road to be crossed and its total width;
- Speed of vehicles on the road and the volume of traffic including the proportion of heavy goods vehicles;
- Location, convenience and safety of alternative routes for pedestrians and cyclists;
- Use by children, elderly people, visually impaired people and disabled people including wheelchair users, and people with prams and pushchairs;
- Environmental aspects;
- Other aspects particularly relevant to the local situation;
- Cost of subway;
- Effects of changes in local land use over the next 15 years including any prospective recreational routes for pedestrians and cyclists.

## Dimensions, form, alignment

Table 4

Minimum dimensions for an unsegregated subway for pedestrians and cyclists

| SUBWAY LENGTH (m) | HEIGHT (m) | WIDTH (m) |
|---|---|---|
| < 23 | 2.4 | 4.0 |
| ≥ 23 | 2.7 | |

## Safety

**Personal Security Aspects**

2.5 Wide approaches, subway alignments with good through visibility, and good lighting, all within the view of passing pedestrians and passing traffic, will help to minimise pedestrians' fears for their personal safety. Subways and their accesses should be designed to avoid places of concealment in the interests of personal security.

# Appendix B – International Underpass Research

1. "Injury crash rates for cyclists at roundabouts are typically higher than at other intersection types. Furthermore, the safe system threshold impact speed for pedestrians, cyclists and motorcyclists is 30 km/h, which is easily exceeded at most roundabouts. Multi-lane roundabouts and roundabouts with significant speed differentials between motor vehicles and cyclists pose the greatest risks to cyclists and many people will not feel comfortable cycling in these locations." *(Source: NZTA Cycling Network Guidance)*

2. "Controlling speeds through multi-lane roundabouts is a particular challenge as, during times of low volume, some drivers will straighten their alignment through the roundabout by cutting across the lane lines. The higher speeds, increased number of conflict points and more complex operation make multi-lane roundabouts less safe and more difficult for all users to negotiate. Hence where less-confident cyclists are to be accommodated at multi-lane roundabouts, they should be able to divert to a path and to cross the entries and exits" *(Source: NZTA website – Cycle friendly roundabout)*

3. "Multi-lane roundabouts usually carry high traffic volumes and have higher entry speeds than local street roundabouts and therefore create safety problems for cyclists. It is anticipated that only experienced cyclists will use this type of roundabout and whilst they may feel reasonably comfortable in selecting a gap and turning left and travelling straight through a multi-lane roundabout in the bicycle lane, they will generally find the right-turning manoeuvre challenging. Some cyclists will therefore bypass the right turn by using local streets, shared paths at the roundabout (where provided) or by undertaking a hook turn at the exit". *(Source: Cycling Aspects of Austroads Guides, 2014)*

4. "In general terms, the larger the roundabout, the higher the number of circulating lanes and the higher the traffic flow, then the greater the problem for cyclists". *(Source: UK Guidance – Signal Controlled roundabouts)*

5. "Multi-lane roundabouts are typically viewed by cyclists as one of the most hazardous types of intersections to negotiate and police crash statistics bear this out. However, multi-lane roundabouts are more hazardous for cyclists, especially compared with traffic signalised intersections". *(Source: NZTA research - Improved Multi-lane Roundabout Designs for Cyclists* http://nzta.govt.nz/resources/research/reports/287/)

A case study from Galway, Ireland, illustrates that in some cities multi-lane roundabouts are being removed in order to improve safety and level of service for cyclists and pedestrians:

- Galway is nearing completion of a junction restructuring programme, which has been running since 2008, whereby roundabouts on major access corridors are being replaced by signalised junctions. Signalisation has resulted in improved perceived safety and the data to date indicates a lower risk of collision; with increased safety for vulnerable road users in particular. " *(*Source: Roundabouts V. Signalised Junctions: An Urban Case Study in Ireland Analysing Traffic Flow, Safety, Air Quality and Public Perception)
- The proposed works are estimated to cost €6 million and come after a survey by the Health Service Executive found that although 24 per cent of local residents live less than 2km from work, 64 per cent of them travel by car. Respondents cited roundabouts and the dangers they pose to cyclists as one of the primary reasons for driving to work (Source: Irish Times article https://www.google.co.nz/amp/s/www.irishtimes.com/news/council-to-replace-galway-roundabouts-1.581393%3fmode=amp)