

Takaanini Level Crossings Appendix B - Climate Change Assessment

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Version 1.0

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1 Introduction

New Zealand has made international commitments to reduce GHG emissions, which the Climate Change Response (Zero Carbon) Amendment Act 2019 directly respond to. These commitments (and the need for climate action) are driving changes to the social, political, and legislative environment. Transport emissions are a key focus of New Zealand's climate response and the legislation and policy on Greenhouse Gas (GHG) emissions and targets are continuing to evolve.

With a role in development of future infrastructure in Tamaki Makaurau, Te Tupu Ngātahi Supporting Growth has a role in influencing future vehicle kilometres travelled (VKT). Te Tupu Ngātahi is responding to the dual challenges of growth and VKT reduction by encouraging mode shift through each stage of its development processes.

1.1 Purpose

This report documents the climate change considerations made as a part of the preparation of the Takaanini Level Crossings Detailed Business Case (DBC). It reassesses the recommended option within the Indicative Business Case (IBC) undertaken in 2018 to respond to changes that have occurred since i.e. policy changes. It details where specific GHG reduction interventions or considerations have been made following the approach and methodology developed by Te Tupu Ngātahi. This includes:

- How the intervention framework (further detailed below) and methodology has been applied.
- Actions and recommendations identified from the initial climate change assessment.
- How the recommendations have been addressed by the DBC.
- Identification of considerations for future phases of the projects.

Following on from the DBC, Notice of Requirements (NoRs) will be lodged for route protection and a more detailed assessment of effects will be undertaken.

1.2 Scope of assessment

This DBC focuses on the level crossings identified as part of the IBC to be assessed for removal and/or replacement as shown in **Figure 1-1**. Any pedestrian level crossings within the project area, i.e. at the Takaanini Station, are outside of the scope of the business case.

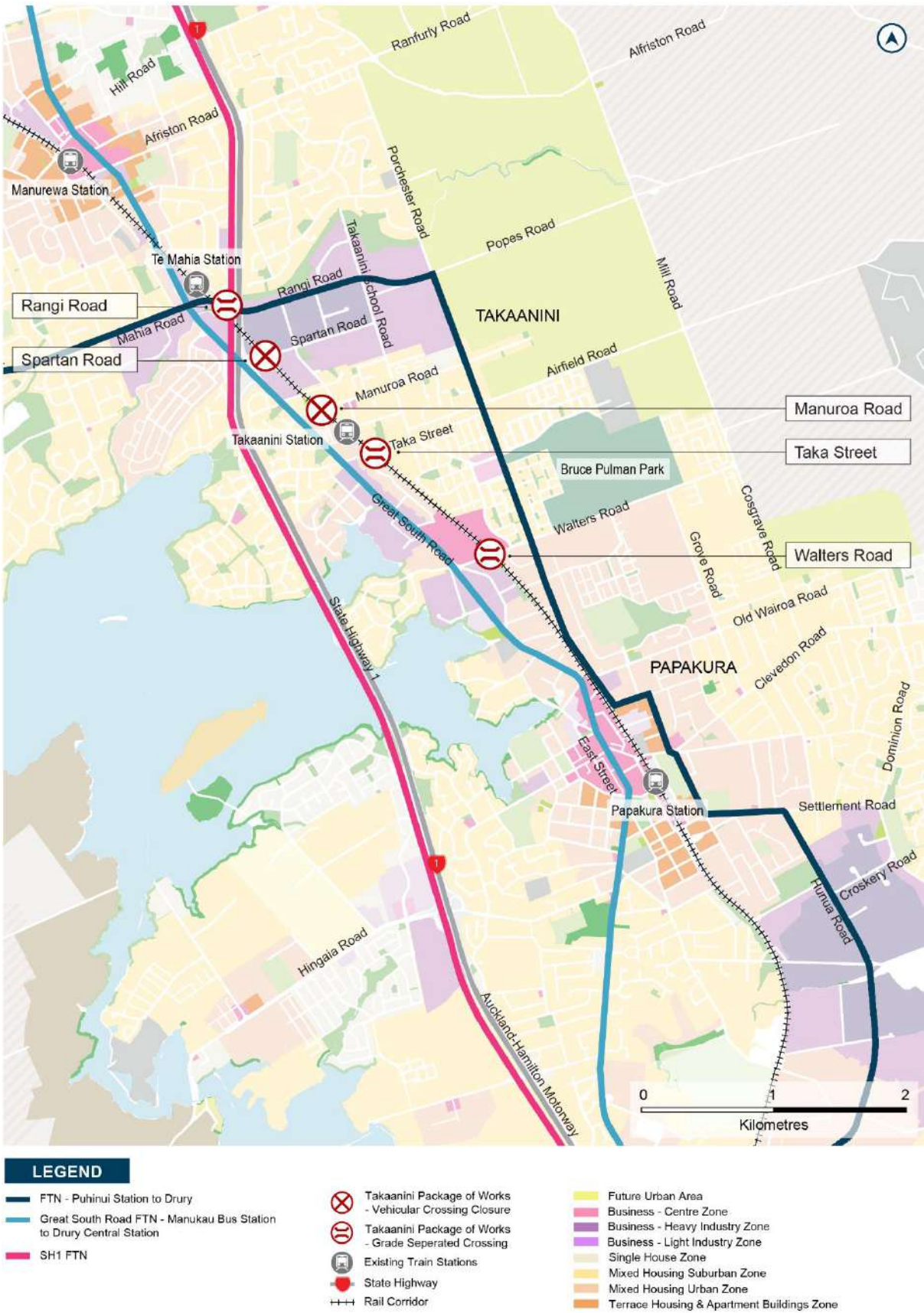
The recommendations from the IBC were:

- **Spartan Road** – closure of level crossing:
 - This corridor predominantly serves the industrial traffic within the Takaanini industrial zone.
 - It intersects with Great South Road at the Takaanini interchange with right turns out being prohibited due to the location of the intersection under the interchange.
- **Manuroa Road** – closure of level crossing:

- Corridor is situated within residential area and as such predominantly serves the surrounding residents. The corridor also provides access for industrial traffic wishing to turn right onto Great South Road, noting the right turn movement restriction at Spartan Road.
- It forms a full movement cross-intersection at Great South Road with Beaumaris Way and is close to the Takaanini train station.
- **Taka Street** – grade separation over the rail line:
 - Corridor is situated within the residential area and as such predominantly serves the surrounding residents.
 - It forms a full movement cross-intersection at Great South Road with Walter Stevens Drive and is close to the Takaanini train station.
- **Walters Road** – grade separation over the rail line:
 - Corridor predominantly serves residential traffic although noting that there is adjacent retail and nearby recreational activities.
 - It forms a five-legged roundabout at Great South Road.
- **Rangi Road** – new viaduct proposed forming part of the IBC FTN route to Mahia Road and acting as a replacement for the closure of Spartan Road and Manuroa Road level crossings:
 - Currently a cul-de-sac that serves the Takaanini industrial area

The upgrade or removal of the existing Takaanini level crossings could be considered as separate projects. However, given how closely spaced they are, the decision made at one will consequently impact the other. Thus, the climate change assessment considers the assessment from both a network level (the combination of removal and/or grade separation of the different crossings and its impact on the overall network) and individual corridors perspective (the localised climate change impacts)

Figure 1-1 : Takaanini Level Crossings IBC recommended option



2 Intervention Framework Methodology

Three broad categorisations of GHG emissions ("carbon") are being considered in this assessment:

1. **Embodied carbon:** The quantum of carbon from the creation, movement and installation of construction materials. Construction carbon emissions can be measured using emissions factors which translate material quantities into tCO₂e, e.g. tonnes of concrete used into tonnes of carbon dioxide equivalent. The Waka Kotahi Beta Preliminary Emissions Estimation Tool (PEET) is being used to consider construction (including embodied) emissions through the DBC and Notices of Requirement (NoRs) processes.
2. **Enabled carbon:** The carbon released from the ongoing operation of the asset which in this case the use of the local and strategic transport network. Te Tupu Ngātahi uses the Waka Kotahi Vehicle Emissions Prediction Model (VEPM) modelling to consider enabled emissions through Vehicle Kilometres Travelled (VKT).
3. **Land use changes:** The GHG emissions arising from land use changes that impact the ability to sequester carbon, which is the long-term storage of carbon in oceans, soils and vegetations. Te Tupu Ngātahi can influence better land use through compact urban form and minimising impacts on soils and vegetation.

2.2 Te Tupu Ngātahi Intervention Framework

Te Tupu Ngātahi has developed an intervention framework (mechanisms & tools) for considering climate change at different stages of the route protection process. The intervention framework forms the basis to interrogate and evaluate the planned networks to identify opportunities for emissions reduction – primarily at the route protection stage that is the focus of the Te Tupu Ngātahi programme. It is a best practice approach to develop confidence that opportunities have been maximised to reduce GHG emissions for whole of life emissions (which include emissions associated with the construction of the infrastructure, and with its use, and eventual disposal).

Our intervention approach for considering and responding to climate change at different stages of the business case and route protection process is focused on an **Eliminate – Reduce – Optimise** intervention framework as shown in **Figure 2-1**.

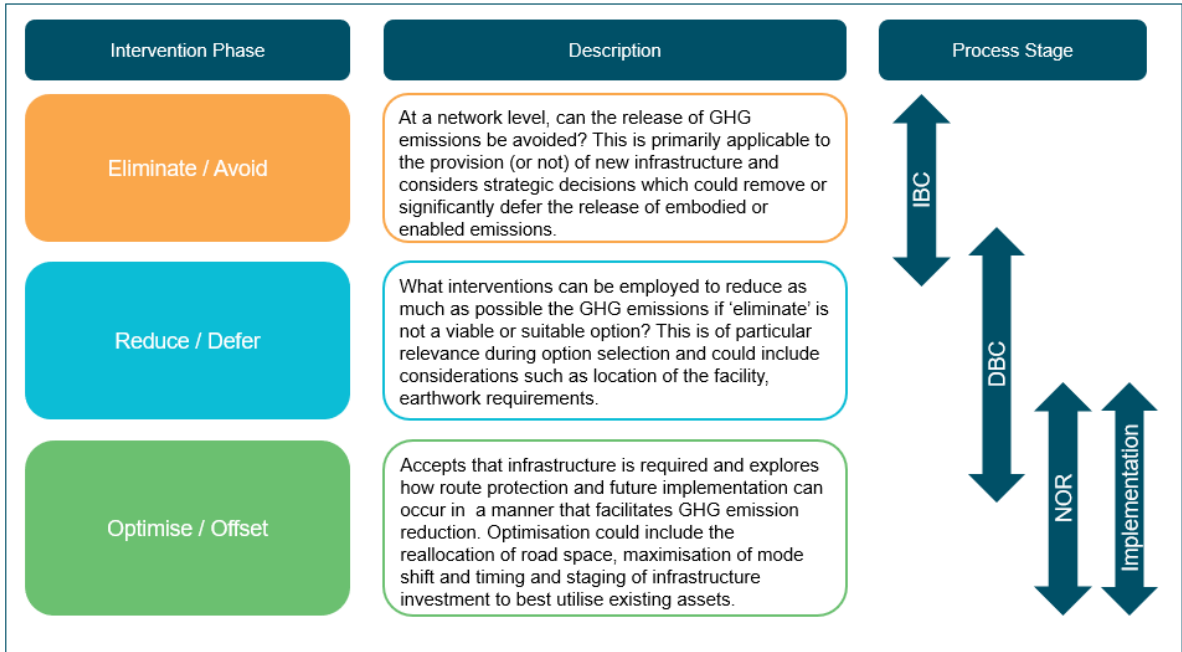
This framework is a hierarchical approach that increases in detail and focus as the programme progresses. It aligns with the Avoid – Shift – Improve (ASI) methodology regularly used in transportation planning¹ and in global carbon management specifications such as PAS 2080:2016².

The ability to influence carbon emissions changes as projects move from Indicative Business Case (IBC) to Detailed Business Case (DBC) and Notice of Requirement (NoR) or Implementation design. As such, the assessment is reconsidered at each stage to ensure climate change aspects and perspectives are covered.

¹ Example: Waka Kotahi [Whakarāpopoto a Aotearoa](#) (national summary), page 10.

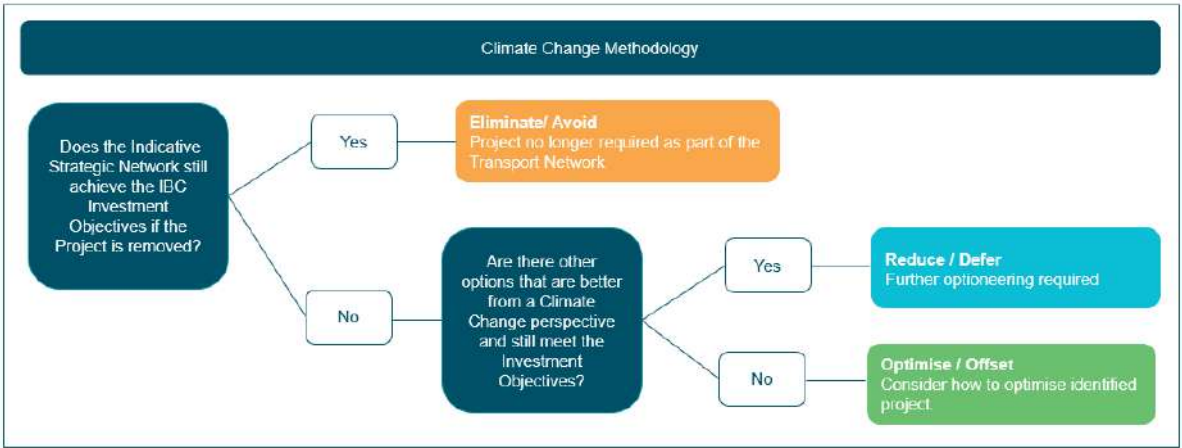
² PAS 2080:2016 Carbon Management in Infrastructure (UK).

Figure 2-1 Eliminate - Reduce - Optimise Intervention Framework



The intervention framework requires considering embodied and enabled carbon in both an integrated and sequential way. The assessment explores the practical interventions as they apply to the whole of life emissions at each stage of infrastructure development decisions from both a network and project view. The decision-making process is shown in **Figure 2-2** below.

Figure 2-2 Decision making process



The following steps have been taken to consider climate change in this DBC:

- DBC addressed the outcomes of the climate change assessment in the development of the recommended transport network.
- Identification of climate change interventions to be considered further during future implementation stages.

3 Summary of Climate Change Response

The existing Takaanini level crossings are within close proximity to each other and as such have been developed and assessed as a package to account for the network response to closures and replacements. Hereafter, they are referred to as 'the project'.

The project was considered against all three elements of the Eliminate – Reduce- Optimise framework and a summary of the resulting applicable investigations for the level crossing are shown in Error! Reference source not found..

Project	Consider Elimination?	Consider Reduction?	Consider Optimisation?
Takaanini Level Crossings		✓	✓

A full summary of climate change considerations is included in the following sections.

4 Interventions, Recommendations and Actions

The DBC considered climate change impact throughout the optioneering process which is discussed in the following sections. Refer to the DBC for more information about the detailed optioneering process.

4.1.1 Can the project be eliminated?

The South is experiencing several key growth-based challenges including, mismatched population growth, localised skill availability and local job opportunities (increasing demand for commuter travel outside of the South area), limited mode choice, strategic network resilience risks, poorly integrated land use (liveability, quality, urban environment) and limited growth potential for the area. Thus, improvements at the level crossings in the Takaanini area have been identified as part of the solution to support the south transport network in influencing mode shift and to reduce vehicle emissions.

If the level crossings remain as is:

- **Actual and perceived safety risks** will be exacerbated as growth occurs and the railway corridor is four-tracked. This may act as a deterrent for active mode users, further fuelling private vehicle use.
- **Increasing train frequency will cause increased barrier downtime**, reducing east-west connectivity and levels of service for all modes. This results in:
 1. Increased congestion and therefore increased enabled emissions with longer trip times as vehicles spend longer time idling or reroute to avoid the crossings.
 2. Increased delays cause variability in travel time creating inefficient bus services that are unreliable and unattractive. Thus, impact on the mode shift outcomes.
 3. Reduced attractiveness of walking and cycling as delays become a greater proportion of their overall trip, discouraging mode shift. This will also hinder public transport uptake with decreased accessibility to bus stops and rail stations.

- **The existing level crossings limit North-South rail capacity**, affecting access to economic and social opportunities and rail freight efficiency. This will in turn limit travel choice and impact on mode shift.

More details on the key problems are detailed in the **Strategic Case of the DBC**.

While retaining the level crossings may have a benefit from avoided embodied and construction emissions, it is considered the network would not function effectively leading to an increase in enabled carbon and the opportunity for transformational mode shift towards low carbon modes would be lost.

The embodied carbon investment anticipated with the upgrades i.e grade separation to provide east-west crossings across the rail line is for the direct benefit of achieving mode shift and in reducing enabled carbon emissions.

Therefore, the project is critical in supporting overall mode shift and climate change response and cannot be eliminated.

4.1.2 Can GHG emissions be reduced?

The main opportunities to reduce GHG emissions were identified as further considering the location (including which crossing should be removed/ grade separated) and the number of east-west crossing required, with the view to avoid:

- **Unnecessary induced traffic**, as the more road capacity provided the more traffic there will be.
- **Construction and embodied emissions** i.e., reduction of major structures, earth works and construction complexity.

These have primarily been addressed through the optioneering process in the DBC. The specific opportunities and DBC responses are included in **Table 4-1**.

Table 4-1 : Identified GHG Reduction Opportunities

Reduction opportunity	DBC Response
Is there an alternative solution?	• The IBC recommended option included a large Rangī Road viaduct structure which will have significant embodied carbon. The optioneering process therefore investigated further options for crossings that may have lesser effects for similar or greater benefits.
Number of east-west crossings required Providing the optimum number of east-west crossings to maintain network connectivity to support the growth. This means not providing more than that required as additional road capacity will induce more traffic and increased enabled carbon. In addition, additional structures results in additional embodied carbon.	• The transport assessment undertaken as part of the DBC identified that the Takaanini road network will require a minimum of four east-west crossings including that of Alfriston Road (existing). At least one was needed for the industrial area. This was accounted for during the optioneering process with Manuia Road crossing identified as the industrial access (replacing the Rangī Road option from the IBC). Taka Street and Walters Road will be grade-

Reduction opportunity	DBC Response
	separated and Manuroa Road and Spartan Road level crossings will be removed. Thus, 4 overall crossings.
Location chosen to reduce construction and embodied carbon Location attributes considered to reduce major structures, earthworks, and construction complexity.	- The MCA considered the PEET analysis to understand the magnitude of embodied and construction emissions of the different east-west crossings. It indicated Rangī Road is expected to have the greatest likely emissions. Thus, does not form the preferred option from a carbon perspective. - Assessment of the different grade separation options were undertaken and indicated rail trenching/ tunnel and road tunnel had significant construction complexities. Hence, greater embodied and construction carbon than a bridge (road over rail) option. - Additional route refinement consideration was made to minimise impacts before the preferred was selected such as minimising footprint where possible - Guidance provided in the DBC for staging considered minimising the effects on the transport network and thus, the enabled carbon associated with construction. However, it is acknowledged the Auckland Networkwide Level Crossings SSBC will determine the final staging.
Maximise walk up catchments through land use integration The Takaanini industrial area is adjacent to the Rapid Transit Network (RTN) as well as the Great South Road Frequent Transit Network (FTN). Changing its land use to the likes of residential will better integrate with the surrounding environment. This will also maximise public transport catchment therefore positively impacting enabled emissions.	As part of the DBC, meetings were held with Council to understand whether there were any opportunities or considerations in the future to change the industrial land use. However, indication is that there are no plans currently to change this.
Optimised locations to enable mode shift and minimise embodied carbon The increase in delays at the level crossings decreases accessibility to public transport facilities as well as key destinations i.e. Town Centre. As such, the location of the east-west crossings is crucial as it affects active mode catchment and accessibility thus, impacting mode share.	- Investment Objective Two of the DBC is focussed on travel choice and increasing low carbon active mode share. - Through the MCA process, assessment against this investment objective scored options more favourably if they enable a greater mode shift. This is of importance especially given Plan Change 78 which will allow greater intensification within 800m catchment of an RTN. Facilitating and increasing accessibility to and within the area will positively contribute towards mode share. - The east-west crossings provided will have dedicated pedestrian and cycling facilities.

Reduction opportunity	DBC Response
	The preferred option also proposes dedicated walking and cycling provisions at Manuroa Road and Spartan Road which will be cul-de-sacs. This will positively contribute towards mode share.

The main reduction opportunities are in realising carbon opportunities associated with the number and location of the east-west crossings. This has been addressed through the optioneering process in the DBC.

4.1.3 Can these projects be optimised?

The main opportunities identified for further optimisation were associated with maximising mode shift as detailed in **Table 4-2**.

Table 4-2 Optimisation actions identified

Optimisation action	Description and climate change outcomes
Enabling active mode uptake	Consider active mode facility designs that are attractive and easy to use to encourage its uptake. Thus, positively impact on mode share.
Timing for implementation	- Currently, the exact timing of implementation is unclear and will be determined by the Auckland Networkwide Level Crossings SSBC. However, it is recognised there could be benefits in the interventions taking place prior to the opening of City Rail Link (CRL) to minimise the carbon emissions associated with longer travel time and idling vehicles due to prolonged delays at the level crossings. - The Spartan Road active mode connection could also be delayed until such a time that it is required when and if the industrial growth is realised. This could have a positive impact on construction and embodied emissions if lower carbon materials and fuels/plant becomes available later.
Urban design	Design in greenspace and native planting in residual undevelopable land parcels. This will positively benefit amenity and provide minor sequestration benefits.

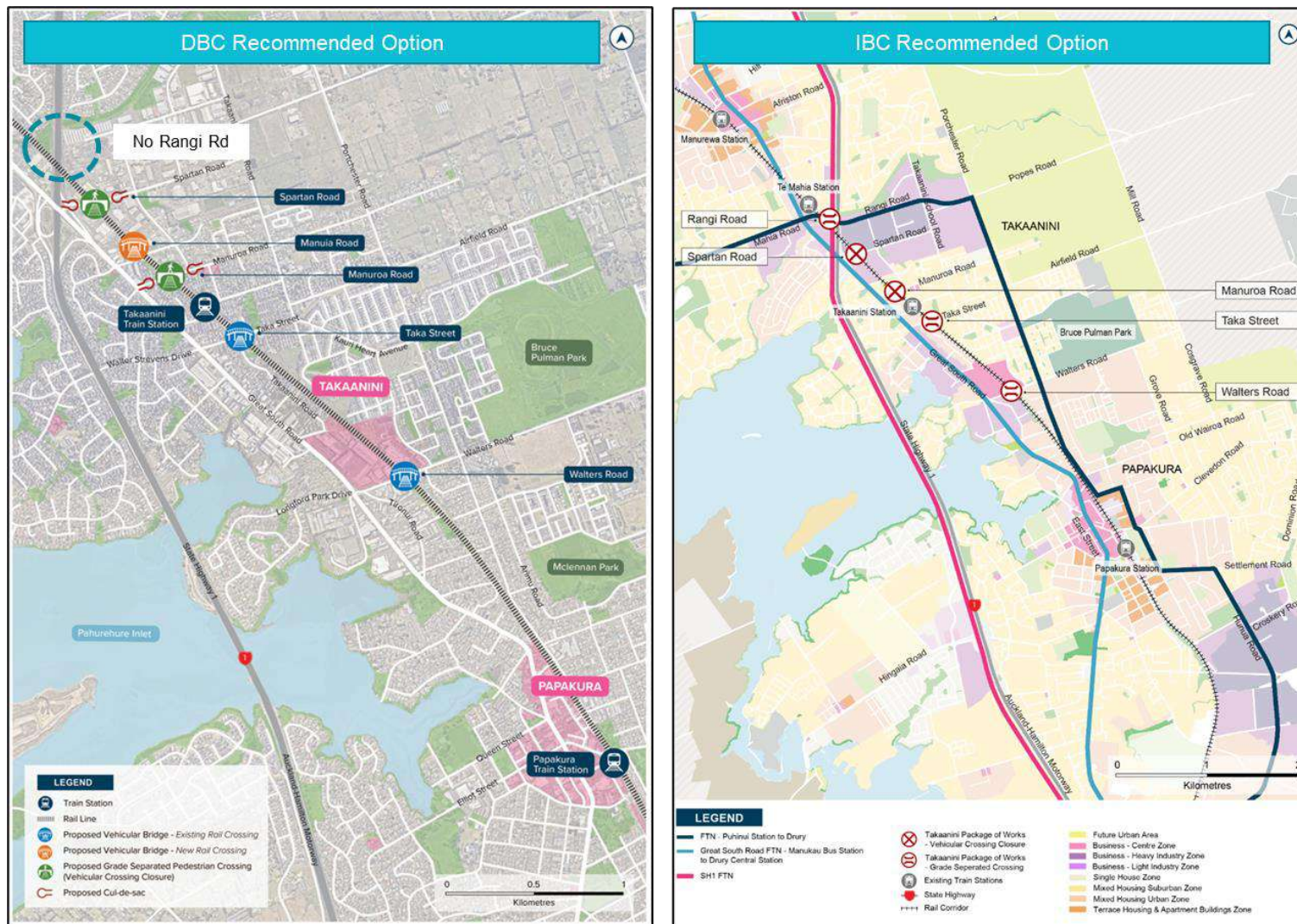
The main optimisation actions identified include the timing for implementation, further urban design and the design of attractive active mode facilities.

4.1.4 DBC response to climate change

The DBC and IBC preferred option are shown in **Figure 4-1**. This reflects the climate change responses identified above, as follows:

- Four minimum east-west crossings including Alfriston Road were identified as required to maintain network connectivity and support the growth. Additional crossings may provide additional benefits; however, this will also result in increased embodied and construction carbon.. In addition, more road capacity will induce more traffic which is counterintuitive to the climate change outcome sought.
- Active mode crossings have been provided at Manuroa Road and Spartan Road where level crossing closures have been proposed. This will enable the mode shift outcomes sought.
- All east-west crossings will have dedicated walking and cycling facilities to provide accessibility to key public transport stations i.e., the RTN and FTN on Great South Road. This will positively contribute towards mode shift to low carbon modes.
- Although the staging of the level crossings will be determined by a separate Auckland Network Level Crossings SSBC, the Takaanini Level Crossings DBC recognises the importance of the removal and/ or replacement needs to take place in a timely manner before barrier down time has significant adverse impact on the network. This will aid in maximising public transport and active mode uptake as soon as possible and ensure that traffic delays are minimised which will in turn minimise enabled emissions.
- Through the optioneering process:
 - The Rangi Road viaduct identified within the IBC was assessed to likely have the greatest embodied and construction emission intensity using the PEET tool. Thus, an alternative less carbon intense crossing at Manuia Road was identified as the preferred industrial access crossing. Other effects were also relevant to this decision, these are discussed in the Option Assessment Report in Appendix C of the DBC.
 - Additional route refinement consideration was made to minimise impacts before the preferred was selected.
 - Investment Objective Two focussed on travel choice and as such assessed options that enabled positive mode share shift towards low carbon transport modes more favourably.

Figure 4-1 : DBC and IBC Recommended Option



4.1.5 Climate change matters for further consideration

A number of additional climate change matters have been identified for future stages of the projects:

- Consider design opportunities to integrate active modes connectivity to the Takaanini Train Station as part of the Masterplan works to be undertaken in the future. This will further encourage positive mode shift.
- Optimise and redevelop residual land parcels to provide key connections to amenities and encourage active mode uptake.
- Design in greenspace and native planting around infrastructure, this will impact amenity and provide minor sequestration benefits.
- Design opportunities to reduce less material waste on site and selecting materials with fewer emissions over their cycle.
- During construction, consider using alternative fuel sources in machinery, equipment, to and travel from site. This may include electrifying construction equipment where possible.
- Consider accelerating construction where possible to reduce traffic disturbances (i.e., detours and idling) and its associated emissions.

Takaanini Level Crossings Appendix C – Options assessment report

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0.3	1 February 2023	Issue for IQA review
1.0	FINAL	FINAL

Disclaimer

This is a draft document for review by specified persons at Auckland Transport and the New Zealand Transport Agency. This draft will subsequently be updated following consideration of the comments from the persons at Auckland Transport and the New Zealand Transport Agency. This document is therefore still in a draft form and is subject to change. The document should not be disclosed in response to requests under the Official Information Act 1982 or Local Government Official Information and Meetings Act 1987 without seeking legal advice.

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Appendix

Appendix A – EAST Assessment

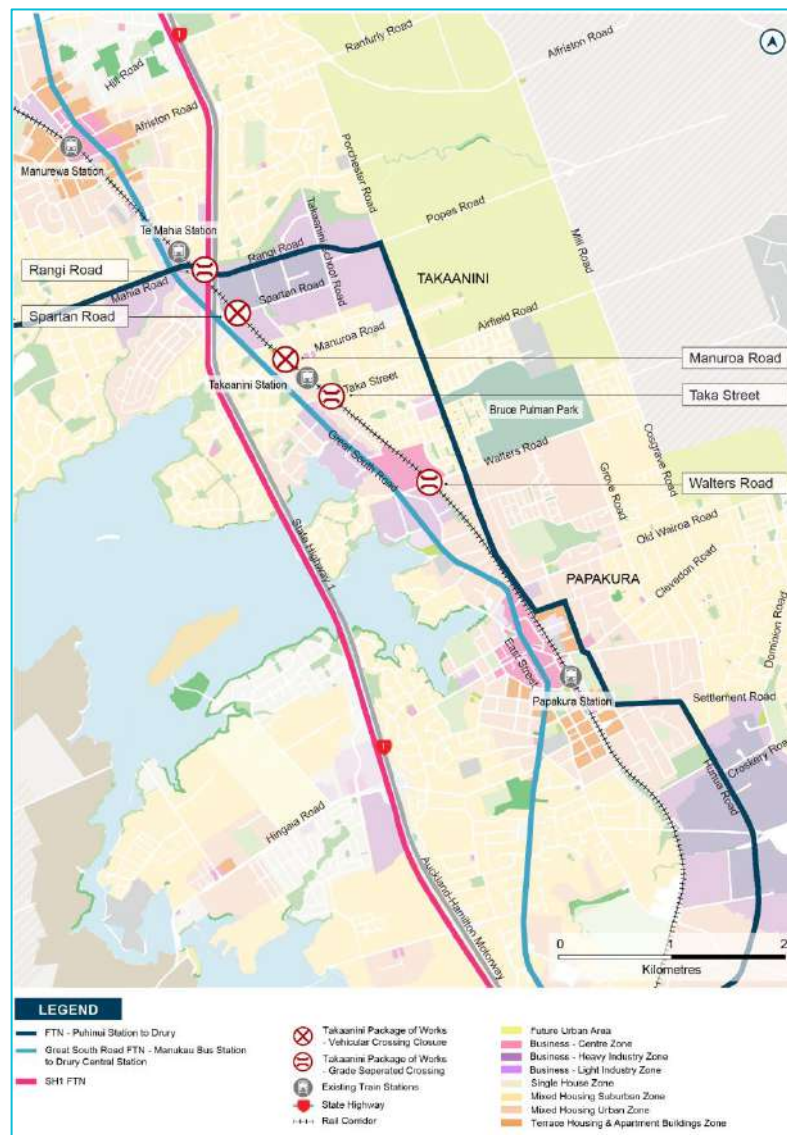
1 Introduction

1.1 Purpose

Te Tupu Ngātahi is identifying the preferred strategic transport network to support growth in south Auckland. In selecting the preferred strategic transport network, a wide range of options have been developed and evaluated at previous phases of the business case process, including transport infrastructure corridors and routes to be protected via designations (or other planning measures).

This report sets out the options development and assessment process and recommendations for the Detailed Business Case (DBC) being prepared for the Takaanini level crossings (TLC). The projects include the removal and/ or replacement of four existing level crossings at Spartan Road, Manuroa Road, Taka Street, and Walters Road in Takaanini (see **Figure 1-1**). The projects also cover associated works that may be required to support the level crossing removals and/or replacements. This includes works further along the road corridors (i.e., TLC corridors) and/or the immediate vicinity.

Figure 1-1: Takaanini level crossings (IBC recommended option)



This report provides a brief overview of the full option development and evaluation process from the Programme Business Case (PBC) for Auckland's future growth areas, through to the Indicative Business Case (IBC) for the Southern growth area. It then describes in more detail the DBC assessment process through to recommendation of a preferred transport network.

This report forms an Appendix to the main DBC.

1.2 Structure

The balance of this report is structured as follows:

- Section 2 – Option development and assessment process
- Section 3 – IBC optioneering overview
- Section 4 – DBC option development
- Section 5 – DBC option assessment, and
- Section 6 – Preferred option and next steps.

2 Option development and assessment process

2.1 Overview

In 2016, Auckland Transport (AT) and Waka Kotahi worked in partnership to complete a PBC, which identified a programme of interventions in the form of a high-level transport network for the future urban areas in Warkworth, North, Northwest, and South Auckland. In 2019, IBCs were completed for these growth areas, which culminated in the identification of an Indicative Strategic Transport Network (ISTN) for each area, including recommended transport corridors. In September 2021, the DBC commenced for the TLC projects.

2.2 Option development

Option development at each stage was informed by the previous stage of assessment (i.e., the PBC informed the options for the IBC and the IBC informed the options for the DBC). An iterative process was undertaken when developing options with an increasing level of detail and refinement occurring depending on the stage of assessment.

2.3 Option assessment methods

2.3.1 Te Tupu Ngātahi Multi-Criteria Assessment Framework

To evaluate and compare options, a programme-wide assessment framework which included a Multi-Criteria Assessment (MCA), was developed by the project team in consultation with AT, Waka Kotahi and Manawhenua.

The MCA was developed to be used throughout the Supporting Growth Programme and has been used in both the IBC and DBC option evaluation process.

The MCA framework is a common tool that is often used to assist in the decision-making process and provides an opportunity to understand how different options compare against a set of standard and grouped criteria. The MCA framework involved the following:

- **Assessment criteria:** Investment Objectives and the four well-beings: Cultural, Social, Environmental and Economic. Several sub-criteria were developed under each wellbeing grouping which were assessed by technical specialists.
- **Opportunities:** identifying opportunities that can be taken forward in developing the options. These were identified by the relevant technical specialist.
- **Additional inputs:** Partner and landowner feedback, policy analysis, value for money and resilience.

Options were assessed, and where appropriate, scored on an eleven-point scale as summarised in Table 2-2, at each stage by a multi-disciplinary team, using the MCA framework set out in Table 2-1. Constraints mapping and existing evidence from desktop research were the main sources of information to assist with scoring. In scoring the criteria, particular guidance was provided by the AUPOIP (e.g., overlays), which could place constraints on the various options identified.

The appropriateness of scoring options was determined by the project team based on the design of the options being assessed and whether scoring the options would provide a clear and beneficial differentiation between the options.

The process incorporated input from AT and Waka Kotahi, Manawhenua, feedback from the consultation and engagement process, subject-matter experts, and the project team. Manawhenua representatives have expressed views, provided specialist advice, and raised key issues through workshops and hui held throughout the process.

Table 2-1: Te Tupu Ngātahi MCA framework

#	Investment Objective		Measure	
	Investment Objectives vary for each Project as identified in the sections below		Options assessed against the investment objectives. Key themes include: • Supporting urban growth • Safety • Connectivity • Resilience	
Wellbeing	MCA topic	#	Criteria	Measure
Cultural	Heritage	1a	Heritage	Extent of effects on: • sites and places of valued heritage buildings, scheduled trees (with heritage value) and places. • sites and places of archaeological value. • sites and places of European cultural heritage value
		1b	Manawhenua	Extent of effects on sites and places of cultural heritage value to Manawhenua (including Sites and Places of Significance to Mana Whenua Schedule, Auckland Unitary Plan) Note: At the request of Manawhenua, this criterion was not scored and was replaced by a qualitative analysis within the non-scored criteria using feedback from Manawhenua at hui.

#	Investment Objective	Measure
Social	Socio – economic impacts	2a Land use futures / integration with planned land use To what extent will the option impact on the future development of land (within the corridor, adjacent to it and impacted by it – i.e., consider all 3 scales), in relation to: - Integration with the future land use scenario (including any Structure Plans or Plan Changes) - Size and shape of potential development parcels to enable appropriate building typologies - Ability to consolidate residual land - Access that does not prevent neighbouring development.
		2b Urban design To what extent does the option support a quality urban environment (both current and future planned state)? particularly relating to: - Context and planned place making considerations - An inviting, pleasant and high amenity public realm - Open space integration - Active interface between public and private realm - Scale of long-term impact on the amenity and character of the surrounding environment.
		2c Land requirement Scale of public / private land (m² / number of properties / special status of impacted property) required to deliver the option.
		2d Social cohesion Impact on, use, connectivity / accessibility for and to the existing urban areas including use and access to: - Employment - Other communities or within the same community - Shops / services / other community and cultural facilities / 'attractors' - Severance of the existing community (including consented) - Scale of effect on existing community facilities community and open space - Public access to the coast, rivers, and lakes.
		2e Human Health and Wellbeing Will the option potentially affect any sensitive land uses nearby or consented (adjacent residential, childcare centres, hospitals, rest homes, marae, and schools)? particularly relating to: - Air Quality - Contaminated land - Noise and vibration.
Environment	Natural Environment	3a Landscape / visual The extent of effects on: - The natural landscape and features such as streams, coastal edges, natural vegetation, and underlying topography – acknowledging planned changes to area considering urban land use / zoning - Natural character and outstanding natural features/landscapes including geological features (mapped and protected features).
		3b Stormwater Impact of operational stormwater (both quantity and quality) on the receiving environment, including: - Potential flooding effects of the option within the catchment - Extent and consequences of likely mitigation measures - Consideration of future climate change scenarios.
		3c Ecology Extent of effects on: Significant indigenous flora

#	Investment Objective		Measure
			- Significant habitats of indigenous fauna - Indigenous biodiversity - Stream / waterway ecology - Marine ecology.
		3d	Natural Hazards Extent of effect on adverse geology; steep slopes; seismic impacts; other resilience risks (low level infrastructure near coastlines, inundation areas).
Economic	Transport	4a	Transport system integration Extent the option achieves the following: - Connectivity / integration other transport modes (i.e., trains, buses, walking and cycling networks) - Wider transport system effects/benefits - Improve accessibility - Increase mode shift to public transport.
		4b	User safety Extent of safety effects on all transport users, including: - People in public transport - people walking or cycling - People in private vehicles.
	Construction impacts	5a	Construction impacts on utilities / infrastructure Requirements for relocation / design of existing infrastructure, including: - Consideration of safety impacts - Risk of continuity of service over construction - Opportunities for integration with other bulk infrastructure.
		5b	Construction Disruption Construction impacts on people and businesses regarding: - Traffic & noise - Earthworks related effects including dust - Quality of life and amenity - Economic impacts on businesses / community / town centres.
	Cost & Construction Risk	6a	Construction costs / risk / value capture Assessed cost for construction of options including: - Complexity and risk in construction (including consideration of constructability, earthworks cut/fill balance and material reuse) - Complexity in programme - Cost and complexity of safely undertaking works (including works on contaminated land) - Extent to which the option can utilise a value capture mechanism to offset construction costs.

Table 2-2: MCA scoring scale

Effects criteria	Scoring
Very high adverse impact	-5
High adverse impact	-4
Moderate adverse impact	-3
Low adverse impact	-2
Very low adverse impact	-1
Neutral impact	0
Very low positive impact	1
Low positive impact	2
Moderate positive impact	3
High positive impact	4
Very high positive impact	5
-	Not scored

Assessment of criteria was completed by subject matter experts and discussed at several MCA workshops. Prior to each workshop, experts were provided with a Briefing Pack, which contained the MCA framework and guidelines, a description of each of the options, a link to the Supporting Growth GIS, and an assessment template where they documented their approach and key assumptions that informed their assessment. On the day of a workshop, the assessments and recommendations were respectfully challenged in a group setting. Experts then considered the issues raised and finalised their assessment and recommendations.

In addition to the MCA framework, several additional (and important) inputs are included in the assessment framework (refer Table 2-3). For this report, this assessment focused on project partner and landowner feedback.

Table 2-3: Other inputs in MCA framework

Other criteria	Description
Project Partner and Landowner Feedback	Project partner feedback for each option identifying scale / validity of objections; identified preference/proposed changes to options etc. Feedback provided by other key partners and landowners.
Policy Analysis	Options alignment with the strategic policy framework.
Indicative Value for Money	High level indication of costs and benefits (including construction and property purchase) where it assisted in differentiating between options.
Manawhenua	Provide a qualitative assessment including: • Identification / assessment of cultural issues (Customary practice / Te Taiao (Air, Land, water, Taonga) / Māori communities and wellbeing / Māori land) associated with an option. • Options Assessment commentary including testing criterion scoring for an option. • Other matters related to an option associated with the Manawhenua position.

2.3.2 Early Assessment Sifting Tool (EAST)

The EAST tool was developed by Waka Kotahi, and is intended for the high-level assessment of longlist options in a business case process to narrow them down to a shortlist for MCA assessment (using frameworks such as the Te Tupu Ngātahi MCA Framework outlined above). By definition, the assessment undertaken through the EAST is 'coarse' and high-level, and is intended primarily to rule out fatally flawed options rather than provide a detailed assessment of viable options. The criteria assessed through the EAST tool are summarised in the table below.

Table 2-4 – Summary of EAST tool criteria

Criterion	Subcriterion	Explanation
Investment objectives		Option is scored on a 1-5 scale against the investment objectives developed through the business case, with 1 denoting a low positive benefit, and 5 denoting a high positive benefit.
Practical feasibility	Technical	Option is scored on a 1-5 traffic light scale in terms of relative ease or complexity of implementation from a technical perspective, where a 1 denotes ease/simplicity; and a 5 denotes high complexity.
	Safety and design	Option is scored on a 1-5 traffic light scale in terms of the associated health and safety risk at design, operation, and maintenance, where a 1 denotes lowest risk, and a 5 denotes highest risk.
	Consentability	Option is scored on a 1-5 traffic light scale in terms of the expected ease or complexity of consenting, where a 1 denotes ease/simplicity; and a 5 denotes high complexity.
Scheduling / programming		An estimated delivery timeframe for the option is estimated.
Cost		The broad capital cost of the option is estimated (from a range).
Key risks and uncertainties		The key risks and uncertainties of the option are identified.
Climate change	Mitigation	Option is identified as either having a reducing / increasing / neutral effect on enabled emissions / vehicle kilometres travelled.
	Adaptation ¹	Option is scored on a yes/no/uncertain scale in terms of whether the completed asset will be exposed to climate-related risks.
Environment and social responsibility	Key risks	The key environmental risks and uncertainties of the option are identified.
	Can risks be mitigated / how?	The ability to mitigate key environmental risks is assessed at a high level.
Fatal flaws		From the above assessment, a high-level assessment of whether there are any 'fatal flaws' associated with the option is completed.

¹ Scored on a yes-no-maybe scale of whether the option will be exposed to climate risk.

3 IBC optioneering overview

3.1 South IBC

To determine the most appropriate transport solution to respond to the scale and pace of growth in Auckland, AT and Waka Kotahi worked in partnership to develop business cases for each of Auckland's identified growth areas: Warkworth, North, North-west and South. To date, this process has involved the following:

- a) The completion of a Programme Business Case (PBC) in 2016, which identified a high-level Preferred Programme and Transport Network for Warkworth, North, Northwest, and South Auckland
- b) The completion of four IBCs in 2019, which identified an ISTN for Warkworth, North, Northwest, and South Auckland, and
- c) The progression of several Detailed Business Cases (DBC) for the ISTN starting from mid - 2019, which identified projects for route protection including the Recommended Strategic South Network. Note: this DBC did not commence until September 2021.

The PBC identified a draft preferred transport network for early route protection within the South. The IBC then further tested and developed the recommendations of the PBC. The purpose of the IBC process was to confirm the recommendations of the PBC were robust and to develop a recommended transport network that met the investment objectives for the region for AT Board/ Waka Kotahi Board approval.

The section to follow briefly describes the optioneering process that was undertaken during the IBC phase of works. This process resulted in the identification of the ISTN that was approved for further investigation in the DBCs.

3.2 South Indicative Strategic Transport Network

The ISTN was developed through an option assessment process during the IBC. To summarise, the optioneering process utilised a multi-criteria assessment and expert judgement to refine options from long list to short list to the final compilation of an overall recommended network. The optioneering process and associated business case resulted in the ISTN being subsequently approved by both the AT and Waka Kotahi Boards.

The IBC optioneering process began with the development of a long list of options, building on that which was developed at the PBC stage. This process focused on developing breadth and depth of possible interventions, network sections and options. As a result, several hundred options were developed for the initial longlist. The long list was subsequently filtered to exclude options that were:

- a) considered beyond the scope of the IBC (i.e., those that were outside the project area or beyond the control of AT or Waka Kotahi)
- b) land use options (such opportunities were discussed separately with Auckland Council)
- c) already part of a designated/consented/funded project
- d) considered business as usual, so would otherwise be implemented (for example: use of staging)
- e) considered unfeasible due to significant physical constraints – based on a high-level engineering assessment (for example, “new train line from South to East - Pakuranga”), and

f) duplicates of another option.

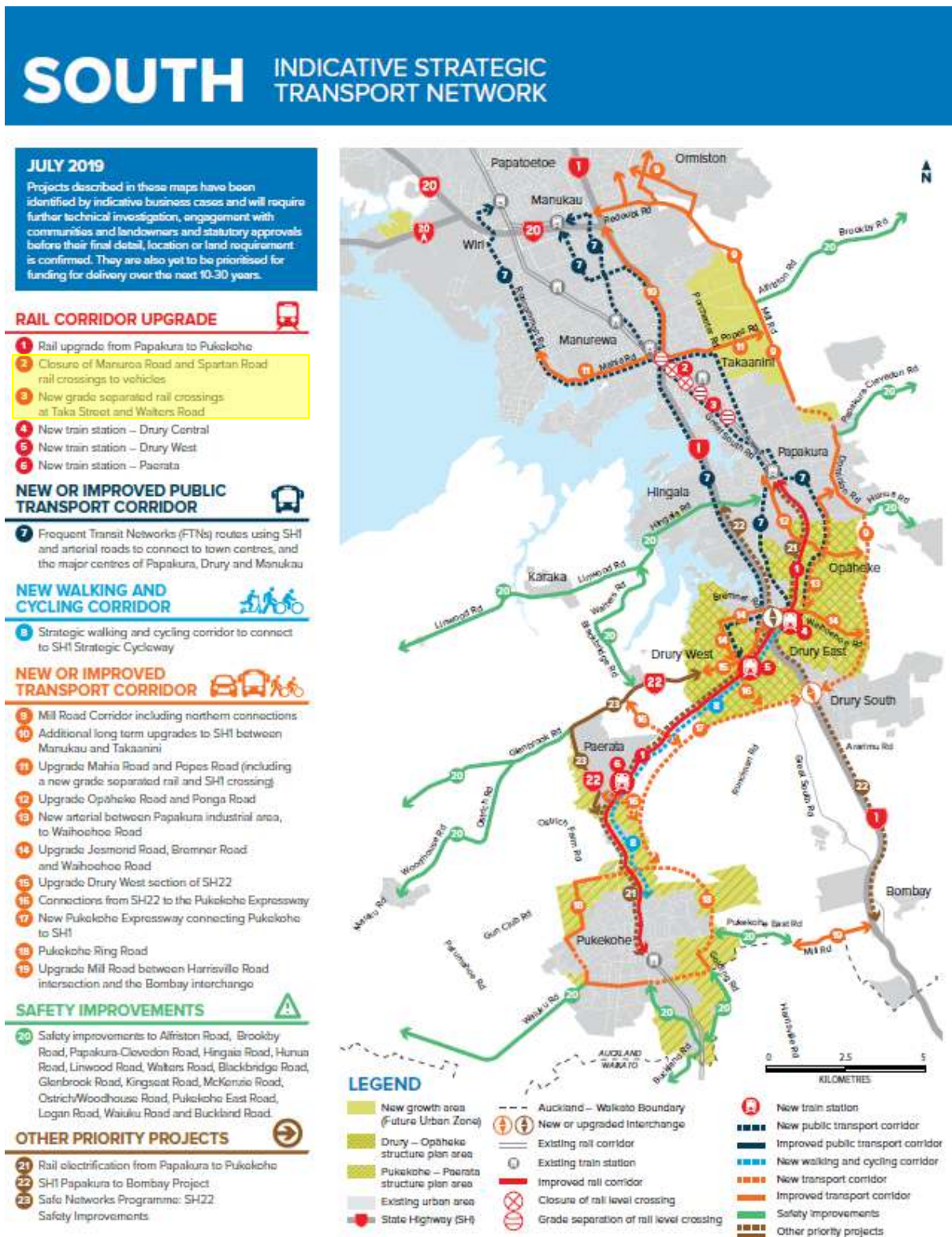
Following the filtering process, the remaining options were categorised by type, grouped by geographic extent, and then assessed against the MCA framework in a workshop setting. This process resulted in several options being recommended to proceed to a shortlist.

Following this the recommended shortlist underwent a refinement and packaging process. This included the preparation of indicative cross sections which assumed a nominal 100m wide corridor in most instances to provide a guide as to where the road and rapid transit alignments could be located, with the refined alignment to be determined as part of the DBC. This also involved packaging together individual sections and assessing competing options (or packages of options) and interdependencies between different options.

Feedback on the refined short list was also obtained through one round of external stakeholder and public engagement in June 2018. This involved public open days and a series of workshops with elected members, stakeholders and youth. The purpose of this engagement was to provide stakeholders and the public with an opportunity to review and provide input into the overall IBC recommended network and for the project team to identify matters that will inform that network.

Following the engagement period, the short list was evaluated, and the South ISTN as set out in Figure 3-1 was identified.

Figure 3-1: South Indicative Strategic Transport Network (level crossings highlighted in yellow)



3.3 Identification of NOR and DBC requirements

As part of the IBC process, consideration was given to potential route protection strategies that could reflect likely Notice of Requirement (NOR) packages for the ISTN. In undertaking this exercise, consideration was given to:

- a) Identifying sections of the components that could “stand alone” as projects
- b) The environment each section sits within, and where that environment changes
- c) The urgency for the delivery of any section of a component, and
- d) The complexity of any section of a component.

This assessment was then used to help inform the grouping of sections of the ISTN into packages to be refined through individual DBCs.

Following consideration of potential NOR packages as part of the IBC, all sections of the South ISTN were grouped into packages for the purposes of further refinement through DBCs. These groupings were based on an assessment of several criteria to ensure that the DBCs and the subsequent route protection processes were logically packaged and appropriately prioritised. Following this assessment, the South ISTN was grouped into five DBC, including the TLC DBC. The South FTN DBC being developed in parallel with the TLC DBC has interdependencies. In particular, the outcomes of the South FTN optioneering influences the optioneering process for the TLC which is discussed in the following section.

3.4 Components of the Takaanini Level Crossings DBC

The TLC DBC comprises the removal and/ or replacement of the Takaanini level crossings, namely: Spartan Road, Manuroa Road, Taka Street, and Walters Road (see Figure 1-1).

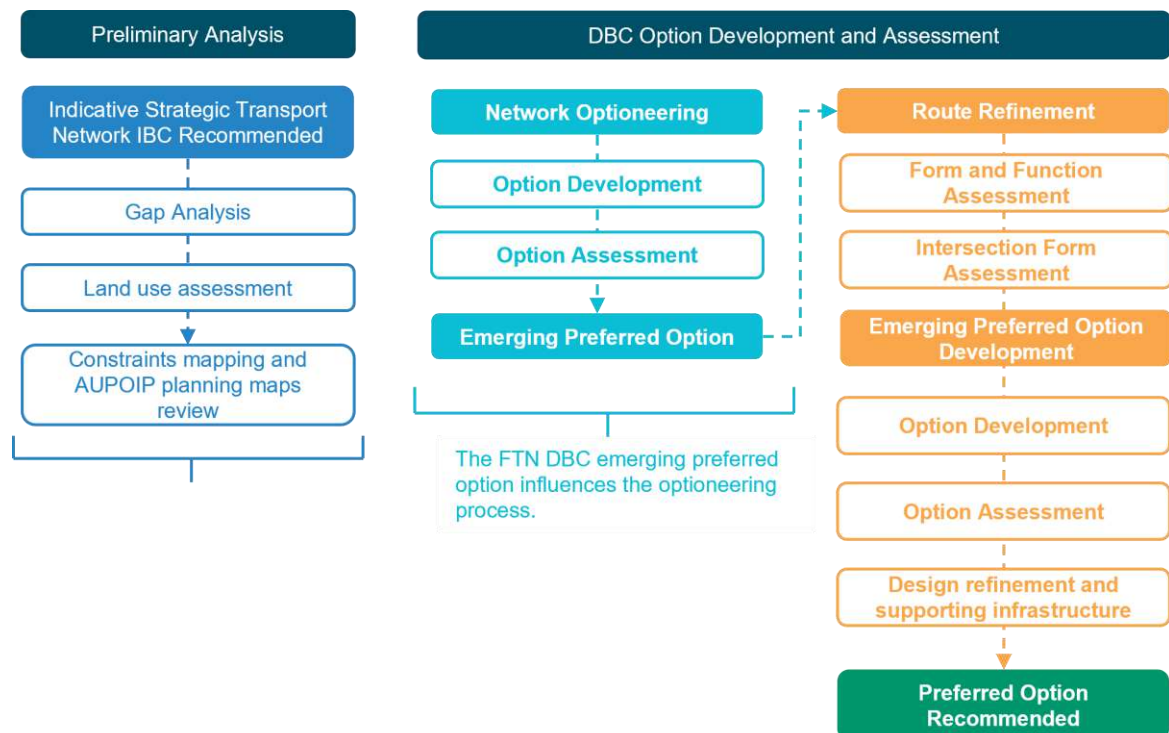
This report focuses on the development and assessment of options for the TLC.

4 DBC option development

4.1 Overview

Figure 4-1 shows an overview of the process and is explained further in the following sections of this report.

Figure 4-1: Overview of DBC optioneering process



4.2 Preliminary analysis

The preliminary analysis undertaken included both Takaanini DBCs together i.e., both the TLC and FTN as there are interdependencies between the two.

4.2.1 Gap analysis

A gap analysis was undertaken by the project team to inform the scope of further options assessment required to determine the preferred options of the DBC projects.

The gap analysis and background review were undertaken to ensure an understanding of how the ISTN was identified, to check if anything had changed since the IBC including policy direction and statutory documents (for example, plan changes), and to identify gaps or issues that require further consideration during the DBC phase.

The gap analysis included the following:

- Review of Te Tupu Ngātahi Programme Business Case (formerly Transport for Urban Growth (TFUG)) recommendations;

- Review of the South IBC options assessment, including the long list and the short list options, and the reasons why options were recommended or discounted;
- Background research, including previous project phases where this assisted in understanding previously identified issues;
- The alignment of the recommended options with relevant transport policy documents (for example, Government Policy Statement on Transport) to check for any changes since the South IBC recommendations;
- The alignment of the recommended options with relevant planning policies, plans and standards (for example, AUPOIP) and new/updated National Policy Statements (for example, National Policy Statement for Freshwater 2020 and National Policy Statement on Urban Development 2020);
- Alignment with strategic plans other statutory documents and developer aspirations that may have progressed from the IBC. For example, structure plans, plan changes (or appeals), recent Notices of Requirement and developer plans; and
- Interaction with other projects in the area.

A summary of the gap analysis undertaken is summarised under the 'IBC to DBC Gap analysis recommendations' sub-section in the option assessment section later in this report.

4.2.2 Land use review and constraint mapping

Following the gap analysis, an AUPOIP map review and constraint mapping exercise was undertaken. The purpose of this exercise was to gather information on potential constraints to inform the refinement of the DBC options or whether additional corridor options should be developed.

The project team identified a study area for each project identified in the IBC. The study area was informed by the gap analysis and an initial review of key constraints including:

- Geology
- Contours and potential earthworks requirements
- Flood areas
- Live zoning and FUZs areas, and
- Sensitive areas such as AUPOIP overlays, critical services, and special purpose zones.

Study areas were typically 100m wide, however, SMEs were advised to use their discretion if they considered there were any relevant constraints located outside of the study area.

The specialist subject matter areas of the SMEs involved in the constraint mapping exercise are identified below:

- Ecology
- Landscape and visual effects
- Archaeology and built heritage
- Stormwater and flooding
- Planning / land use / social impacts
- Urban design

- Geology, and
- Cultural values - Manawhenua had an opportunity to identify constraints and opportunities as part of the exercise.

Constraints were mapped on the Te Tupu Ngātahi GIS with comments on the constraints recorded. The identified constraints were reviewed and discussed at a workshop attended by the project team and SMEs.

4.3 Option development

This section sets out the methods and processes used to develop and assess options.

4.3.1 Investment objectives

Investment objectives were derived from the IBC objectives with a specific focus on the TLC. The investment objectives for this project are:

These objectives were used to assess options as part of the MCA process.

Investment Objectives

- **Investment Objective 1 - Safety:** Provide improvements at level crossings that contribute to a transport network that is free from deaths and serious injuries.
- **Investment Objective 2 - Travel Choice:** Support mode share by improving active mode facilities and rail capacity.
- **Investment Objective 3 - Resilience:** Support network resilience for Takaanini and improved reliability for the southern rail line.
- **Investment Objective 4 - Access:** Improve east-west connections to enable access to economic and social opportunities.

Further detail on the investment objectives, including mapping back to previous objectives, can be found in the main body of the DBC.

4.3.2 Form and function

At the IBC stage, detailed recommendations on corridor form and width were largely deferred to the DBC investigation phase. This level of detail was generally considered beyond the scope of the IBC. As such, during the DBC phase, assessments were undertaken to determine the form and function of DBC projects. Assessments were undertaken in late 2021. This section outlines the form and function assessment process.

The Corridor Form Assessment Framework² (CFAF) has been designed to provide a consistent methodology to define the desired corridor form and function requirements and ensure all modes are considered. The CFAF assessments were completed for all level crossings.

² Detailed in DBC Appendix G: Transport outcomes report.

The corridor assessment framework is a tool which informs the optioneering process and provides consistent decision-making across all corridors. It is based on AT's Roads and Streets Framework (RASf) guidance.

The CFAF output recommends either two or four lanes and other corridor elements which influence the corridor footprint. Active and road-based modes are considered in the development of the cross-section, however facilities for all modes may not necessarily be provided. The resulting cross-section forms the basis for route protection for the corridor. Te Tupu Ngātahi has developed a series of generic cross-sections³ to simplify and standardise the DBC and route protection process.

The form and function of a corridor is determined using a combination of 'place' and 'movement' significance on the individual setting:

- **Place factors** consider the existing land use, future land use plans and trip generators present in the catchment area. It also includes an assessment of the future density of residential, industrial, or mixed land use and local/regional trip attraction areas e.g., metro stations, schools, hospitals.
- **Movement factors** consider the hierarchy of the corridor in the regional road network (PT network, strategic freight network), modal priorities for the corridor and existing and future traffic volumes to determine the future typology and recommendations for a corridor function. Movement is considered at both local and network levels to ensure that duplication of facilities is avoided, and the corridors have targeted modal functions.

Figure 4-2 provides an overview of CFAF assessment and endorsement process. The iterative nature of the process allows for high stakeholder and owner engagement and an efficient design process. Note that during the development of the DBC, the CFAF was revisited when necessary to address identified constraints and design considerations. Any modifications were taken back through the endorsement process to maintain corridor alignment.

Figure 4-2: CFAF approval process



In addition to the CFAF assessments, an assessment was undertaken of existing corridors identified in the IBC. The purpose of this assessment was to compare the facilities along the corridor / land available within the corridor against that recommended as part of the CFAF assessment (and Te Tupu Ngātahi generic cross-sections). This would identify if further upgrades were required to achieve the intended outcomes sought by the owners.

This assessment considered:

- The land use adjacent to the corridor and the degree of certainty of that land use going forward

³ Refer to DBC Appendix H: Design report for generic cross-sections

- The facilities currently (or proposed) to be provided on the corridor compared to those that are recommended by the Te Tupu Ngātahi generic cross sections
- If there is sufficient width within the corridor to implement a reallocation of space to achieve the Te Tupu Ngātahi cross section or the outcomes sought by the owners.

This assessment was completed for the TLC corridors (i.e., a wider extent than just at the level crossings themselves). For example, for Walters Road, the corridor east of Arion Road was assessed to determine the tie in requirements.

The process and its outcomes are set out in detail in the Transport outcomes report at **Appendix G**.

4.3.3 Option development approach

The preliminary analysis (as discussed in section 4.2 above) identified whether the IBC option assessment had sufficiently considered all alternatives. Further consideration was then given to the nature and significance of identified constraints, gaps and the land use context at the option development and option assessment stage.

Two phases of optioneering and assessment were undertaken for the TLC which are further detailed in the sections below:

- **Network optioneering** – this refers to the location of level crossing replacements and/or closures. Optioneering is undertaken to determine what corridors will be grade separated or closed in the transport network. This was undertaken as a network approach and new corridors (i.e., corridors that do not currently have an existing level crossing) were also considered as part of the optioneering process.
- **Route refinement** – Once the network and corridor options have been confirmed. Optioneering is then the refinement of alignment to avoid identified constraints. Alignment refers to how an option connects between two points. There may be several different alignments in a single corridor.

The option assessment during both the network optioneering and route refinement stages included either a full MCA assessment with Subject Matter Experts (SME) input and/or a project team option assessment.

4.3.4 Network interdependencies

Table 4-1 provides an overview of the interdependencies and relationships between the TLC and other Te Tupu Ngātahi, AT, and Waka Kotahi projects.

Table 4-1: Network interdependencies

Project	Interdependencies
Rangi Road	• Mahia/ Roscommon Road FTN • Popes Road upgrade
Spartan Road	• Great South Road FTN (Te Tupu Ngātahi) • Connected Communities Great South Road upgrade (AT)

Project	Interdependencies
Manuroa Road	• Great South Road FTN (Te Tupu Ngātahi) • Connected Communities Great South Road upgrade (AT)
Taka Street	• Great South Road FTN (Te Tupu Ngātahi) • Connected Communities Great South Road upgrade (AT)
Walters Road	• Great South Road FTN (Te Tupu Ngātahi) • Connected Communities Great South Road upgrade (AT) • Porchester Road FTN

5 DBC option assessment

5.1 Overview

The sections that follow set out the option assessment process to date, leading to the selection of a preferred option. The process steps covered in these sections are covered in **Table 5-1** below.

Table 5-1 – Summary of optioneering steps

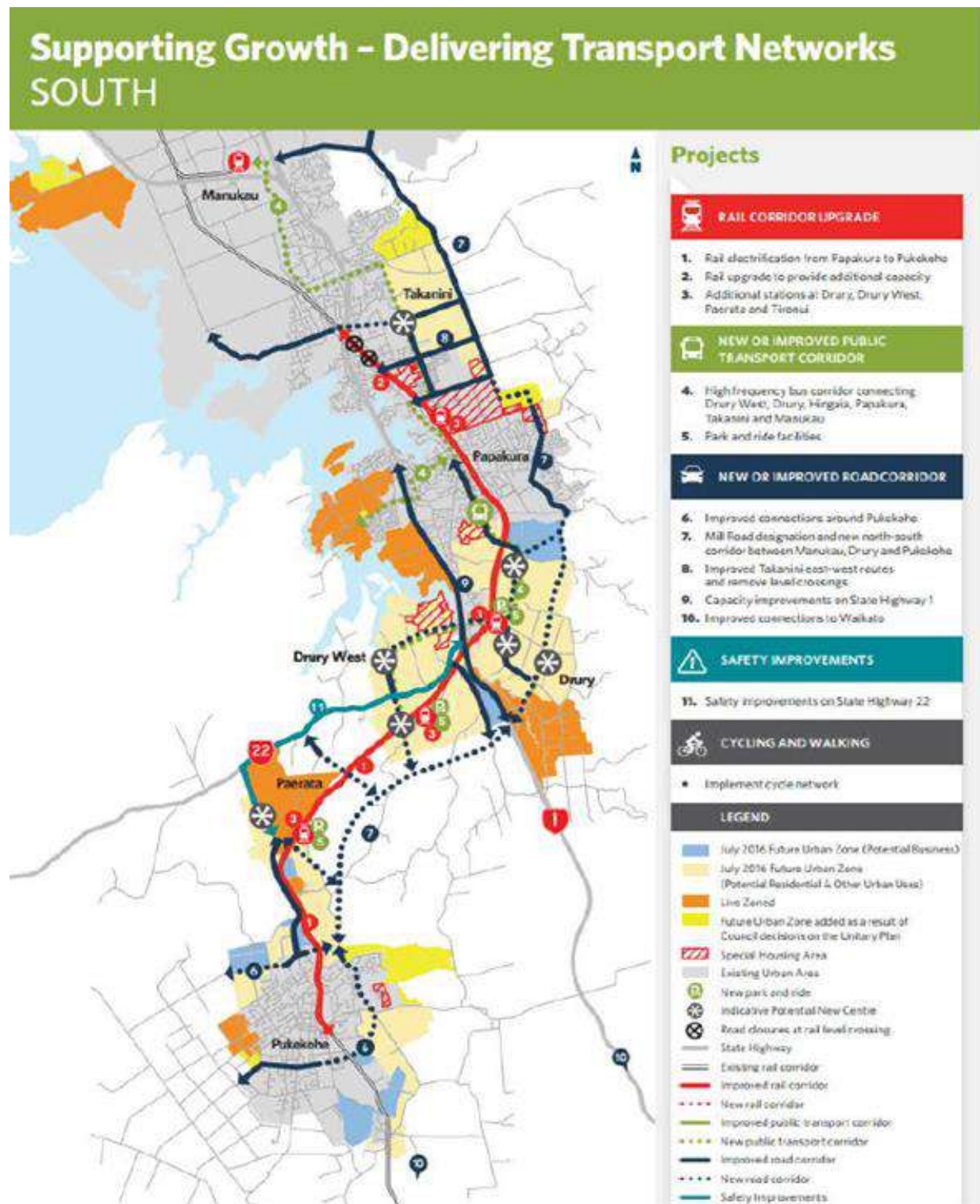
Report section	Optioneering process step	Purpose of step in optioneering chronology
5.2	Summary of previous phases	The optioneering process for this DBC builds on previous optioneering undertaken for the PBC (in 2016) and IBC (2019). Each preceding business case acts as the starting point for subsequent analysis, with analysis growing more detailed from one business case to the next. The conclusions of the IBC therefore are the starting point for this DBC. Section 5.2 therefore summarises the conclusions of the PBC and IBC to clearly establish the starting point for optioneering in this DBC.
5.3	IBC to DBC gap analysis	At the outset of this DBC, a gap analysis was undertaken to capture contextual changes that have occurred since the completion of the IBC. This process recognises that the IBC was completed in 2019, and that contextual changes that occurred in that period could change the scope of optioneering required for the DBC and/or the merits of IBC conclusions. Section 5.3 therefore summarises the key contextual changes for the TLC which have informed the scope of subsequent DBC optioneering.
5.4	Corridor form and function	Section 5.4 summarises the corridor form and function process applied to identify the cross-section for the options to be assessed in the DBC.
5.5	Network Optioneering	This section sets out optioneering undertaken in the DBC to identify an emerging preferred network. This includes the sequential consideration of: • The physical form of grade-separation to be adopted as the basis for option assessment (noting that this was subsequently retested – see section 5.8); • The number and location of grade-separated crossings required in the network through scenario-based optioneering of various combinations of crossings; and • Provision to be made for active mode connections where scenario-based optioneering recommends closure of an existing level crossing.
5.6	Route refinement	The route refinement process documented in this section summarises the consideration given to the refinement of the options comprising the emerging preferred network, including: • The corridor form and function and intersection forms for each of the proposed corridors; and • The alignment of each of the proposed corridors.
5.7	Engagement	This section summarises the engagement undertaken with owners, partners, stakeholders, and the public which has informed optioneering.
5.8	Further testing of physical form of grade-separation	Following on from the high-level consideration given to the physical form of grade-separation set out in section 5.5, this section documents the further testing undertaken to confirm the preferred physical form of grade-separation, and in particular the consideration of the relative merits of bridges and underpasses.

5.2 Summary of previous phases

The PBC recommended network for the south is shown in **Figure 5-1**. This shows the same recommended option as the IBC (Figure 3-1) for the level crossings:

- Manuroa Road – closure to vehicles
- Spartan Road – closure to vehicles
- Taka Street – grade separation
- Walters Road – grade separation
- New Rangī Road viaduct connection

Figure 5-1 : PBC recommended south network



5.3 IBC to DBC gap analysis recommendations

The key changes and recommendations identified through the gap analysis in relation to the level crossings included:

- **Optioneering carried out to date.** It was recommended to revisit the PBC/ IBC recommended option including the potential to look at level crossings independently of one another and consider property access impacts in greater detail.
- **Changes in legislation and direction with respect to climate change.** In response to this, the gap analysis recommended further consideration of the viability of the Rangi Road bridge given the embodied carbon and potential construction complexity. In addition, it is expected to induce more traffic by improving access and thus, increase in transport emissions post construction. A gap analysis of the impact of including/ excluding Rangi Road in the network was undertaken and is detailed in the following section.
- Subject to the findings of the Rangi Road gap analysis, consideration of the following issues was also recommended:
 - The implication of closing Spartan Road and Manuroa Road if Rangi Road is no longer in the network i.e., the severance of the road access to the industrial zoned land.
 - Re-consideration of the strategic importance of Popes Road in the network if Rangi Road is not progressed, especially given the Mahia Road and Roscommon Road FTN corridor will be undertaken separately by AT.

5.3.1 Rangi Road Gap Analysis

During the South Indicative Business Case (IBC), Rangi Road was recommended as a multi-modal corridor with regional significance in the future network. This corridor was the preferred Frequent Transit Network (FTN) route and a key industrial connection in the Takaanini network. Rangi Road viaduct and Popes Road arterial were also seen as one link/ arterial project, which provided a key east-west connection to the N-S Mill Road strategic arterial.

The proposed Rangi Road Viaduct was a significant structure, approximately 365m in length. It had an overall span of 520m from an eastern abutment at Rangi Road over SH1, Papakura Stream and across the NIMT 4 tracking to the western abutment. The viaduct would then follow along an embankment to an at-grade signalised intersection at Great South Road. **Figure 5-2** shows an indicative visualisation of the Rangi Road Viaduct.

While providing improved access to the Takaanini area, east of the rail line/ SH1, it was recognised that there could be adverse impacts on existing movement and place functions of Great South Road and the surrounding area, west of SH1. This is due to the potential level of impact caused by a viaduct of this scale on the receiving environment.

Figure 5-2 : South IBC Rangi Road Viaduct Recommendation



A high-level assessment against key transport outcomes was undertaken to assess the need for Rangi Road in the future transport network. The outcomes are summarised in **Table 5-2**.

Table 5-2 : Rangi Road Gap Analysis Transport Assessment

Criteria	With Rangi Road viaduct	Without Rangi Road viaduct	Can outcomes be met without the viaduct?
Supporting Growth	• Able to support growth in Takaanini future urban areas • Able to support employment growth expected in the Takaanini industrial area • Adverse impact on movement and place on Great South Road, Manurewa East	• Potential reduced uptake of industrial land • Unable to support employment growth expected in the Takaanini industrial area	No – alternative needed to provide access for the Takaanini industrial area . Further optioneering required.
Access	• Less traffic pressure on other east-west connections such as Alfriston Road	• Increased traffic on Alfriston Road and Taka Street • Potential to reduce PT reliability • An increase in overall VKTs due to rerouting of industrial trips	No - unless an alternative option can achieve this outcome. Further optioneering required.
Mode Shift	• No significant change in mode shift expected as improved PT accessibility is offset by improved access for general traffic. • Misalignment with Auckland RTN Study to improve access to Te Mahia Station – reduced opportunity to achieve mode shift outcomes.	• No significant change in mode shift expected.	Yes
Safety	• Separates industrial traffic (heavy freight) away from	• Safety impacts on vulnerable road users in	No – alternative need to provide access for the

Criteria	With Rangi Road viaduct	Without Rangi Road viaduct	Can outcomes be met without the viaduct?
	residential routes, reducing impact on vulnerable road users in residential/ local areas. There will be increased traffic near Mahia Road and GSR as this is where the viaduct is expected to land (western side). This will result in increased conflict.	residential/ local areas, due to heavy traffic routing around residential streets.	Takaanini industrial area to separate industrial traffic and residential traffic. Further optioneering required.
Freight	Provides a separate industrial connection	- Reduced access to industrial area - Increased heavy vehicle movements on future bus routes and the local network	No - unless an alternative option can achieve this outcome. Further optioneering required.
Resilience	Alternative access to industrial area reducing pressure on other key east-west routes and future bus routes	Increase pressure on the remaining east-west routes	No - unless an alternative option can achieve this outcome. Further optioneering required.

As part of this assessment, a test was undertaken to understand the impact of reducing the number of east-west connections from three (the number of crossings proposed under the IBC recommended) to two in the network south of Papakura Stream and north of Walters Road. This resulted in increased queuing and traffic pressures on other parts of the network. Thus, it was established that at least three east-west connections should be provided in the Takaanini network to achieve east-west connectivity and access.

The assessment concluded that:

- A **direct industrial connection is needed** to provide for access and transport resilience in the Takaanini network.
- A **minimum of three east-west connections are needed south of Papakura Stream** and north of Subway Road to serve the Takaanini area.
- **Further optioneering can be undertaken to identify alternatives to Rangi Road viaduct which can achieve transport outcomes** whilst reducing adverse effects on the surrounding built environment.
- Future corridor optioneering should take a network approach to determine different combinations of replacement or closure at the level crossings in order to fully understand the optimal level of infrastructure that would support adjacent land uses and access to the PT network.

5.4 Corridor form and function recommendations

The Corridor Form and Function (CFAF) process (as per that detailed in Section 4.3.2) was used for the purpose of defining a desired cross-section for the identified east-west cross sections. The CFAF has been designed by Te Tupu Ngātahi to provide a consistent methodology to define the desired corridor form and function requirement and ensure all modes are considered.

An initial high-level CFAF assessment was undertaken based on the IBC recommended network to inform the option development and assessment. This assessment indicated a two-lane corridor of 24m width active mode facilities.

Noting that any change in the recommended option will alter the traffic flows on the different corridors, the assessment was undertaken again following identification of the recommended option to confirm the cross sections. This is further detailed in **Section 5.7.1**.

Details of the RSAF and CFAF assessment can be found in **Appendix G: Transport Outcomes Report**.

5.5 Network Optioneering

5.5.1.1 Scope of optioneering

As set out in section 5.3, the gap analysis identified clear prerequisites for the future Takaanini network. These are repeated below, and have informed the necessary scope of DBC optioneering for the TLC.

- A **direct industrial connection** is needed to provide for access and transport resilience in the Takaanini network.
- A **minimum of three east-west connections** are needed south of Papakura Stream and north of Subway Road to serve the Takaanini area.
- Further optioneering can be undertaken to identify **alternatives to Rangi Road viaduct** which can achieve transport outcomes whilst reducing adverse effects on the surrounding built environment.
- Future corridor optioneering should take a **network approach** to determine different combinations of replacement or closure at the level crossings in order to fully understand the optimal level of infrastructure that would support adjacent land uses and access to the PT network.

The scope of optioneering for the TLC has also been cognisant of concurrent optioneering on the South FTN Project, and in particular whether any TLC option within the above defined project area (south of the Papakura Stream and north of Subway Road) would form the east-west component of an FTN route to connect from Porchester Road to a Southern Line rail station. This analysis identified Alfriston Road as the logical east-west route between Porchester Road and Manurewa Station. Given that Alfriston Road is located to the north of the TLC project area, options being assessed as part of the TLC Project **have not been considered as part of an FTN route**.

Figure 5-3 shows this decision point within the wider context of the network optioneering methodology.

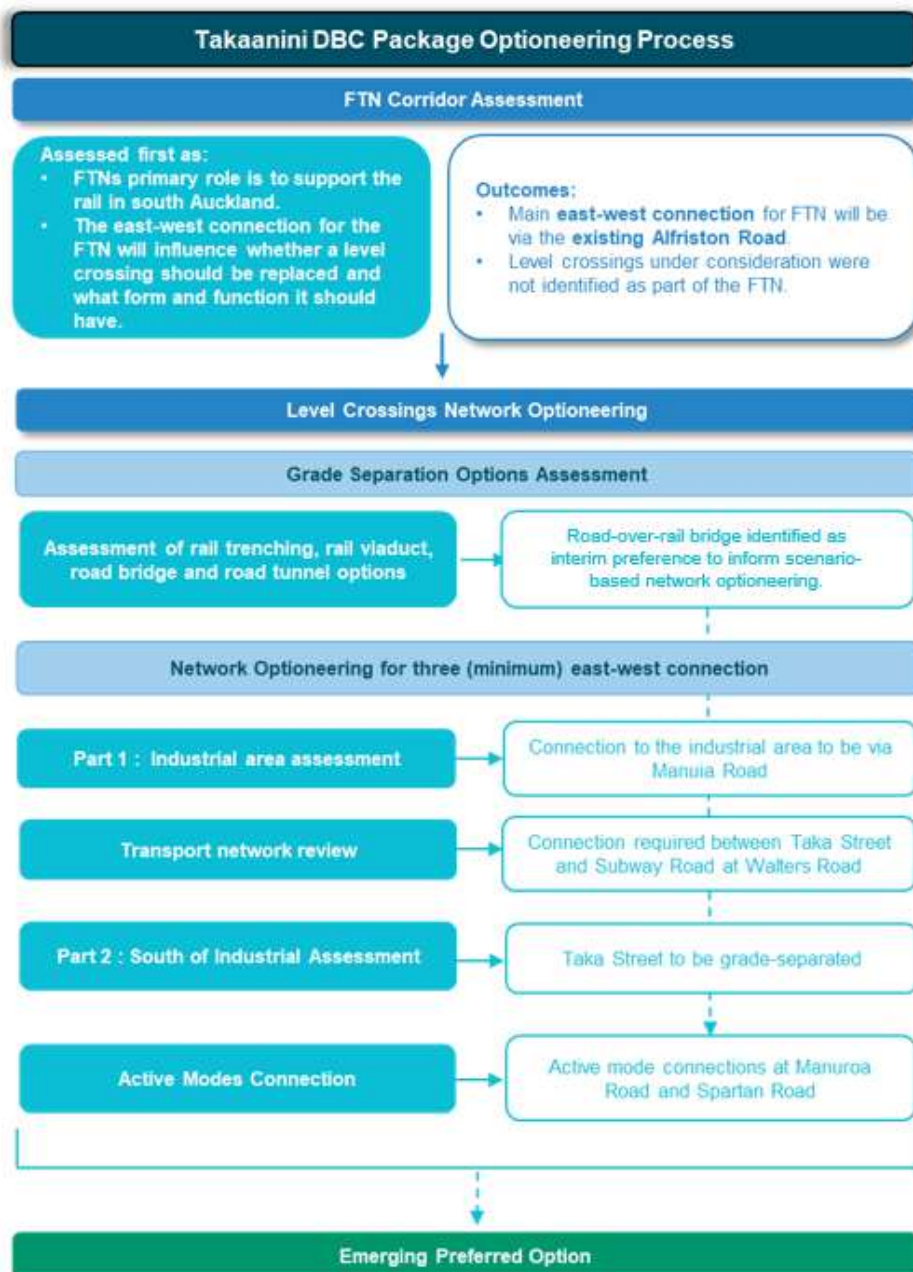


Figure 5-3 – DBC Network Optioneering Process

5.5.1.2 Network Optioneering Methodology

Physical form of grade separation

Network optioneering commenced with a high-level assessment of **the physical form of grade separation** to be assumed for scenario-based network optioneering (see **Figure 5-3**). This broadly considered four means of achieving grade separation of road and rail:

- Raising the railway – i.e. rail-over-road;
- Lowering the railway – i.e. rail-under-road;
- Raising the road – i.e. road-over-rail; or
- Lowering the road – i.e. road-under-rail.

The purpose of this analysis was to set out the ways in which grade separation could be physically achieved, and to identify an interim preference for the physical form of grade separation to determine the scope of subsequent scenario-based network optioneering (noting that grade separation through rail grade changes will generate fundamentally different interventions than road grade changes). The preferred physical form of grade separation was then retested in greater detail and confirmed following the scenario-based network optioneering assessment and public engagement process (see section 5.8 of this report).

This analysis considered a range of information in identifying an interim form preference, including:

- Recommendations of studies undertaken prior to the DBC for level crossing grade-separation in Takaanini; and
- High-level DBC option development derived from basic engineering design parameters, and assessment using Waka Kotahi's EAST tool (see section 2.3.2).

Scenario-based network optioneering

In light of the scope/parameters for optioneering noted at 5.5.1.1 above, the preferred number and location of grade-separated crossings was identified using an optioneering process which compared different combinations of crossings as network scenarios. This process ensured that the cumulative effects of the different combinations of crossing treatments were assessed as a whole. This scenario-based network optioneering was undertaken in two main parts (see **Figure 5-3**):

- **Part One: Industrial area assessment** – focussed on identifying the east-west connection for the Takaanini industrial area; and
- **Part Two: South of industrial area assessment** – identified the remaining east-west connections required to serve the area south of the industrial area.

The Te Tupu Ngātahi Multi-Criteria Assessment (MCA) framework was used as the main tool for comparing the various network options for each of these assessments.

5.5.2 Physical form of grade separation

5.5.2.1 Consideration of rail grade changes

As noted in the methodology outlined above, rail grade changes – raising or lowering the railway – were considered as methods for achieving grade separation. In considering the merits of rail grade changes, both previous (pre-DBC) studies and assessment undertaken through the DBC process were considered.

Recommendations of previous (pre-DBC) studies

The Project Team identified four previous studies which have considered or discussed rail grade changes as a means of achieving road-rail grade separation in Takaanini dating back to 2014. These are summarised in **Table 5-3**.

Table 5-3 – Previous (pre-DBC) studies considering rail grade changes

Study	Relevant options considered	Conclusions
<i>Takaanini / Opaheke / Drury / Karaka Integrated Transport</i>	None	Study did not consider a rail grade change option on the basis it would be “unviable”

Study	Relevant options considered	Conclusions
<i>and Land Use Strategy</i> (Urbanism Plus, 2014)		due to significant cost, disruption of train services, and potential constraints on future capacity” (p. 22).
<i>Rail Crossing Grade-Separation Feasibility Study</i> (Aurecon, 2014)	Three options were assessed at a high level for Walters Road, Taka Street, and Manuroa Road: • Road-over-rail; • Rail-under-road; and • Combination of road-over-rail and rail-under-road.	Options were assessed using a range of criteria including online impacts (for road and rail), impacts on surrounding areas and properties, and a range of construction impacts including complexity and disruption, costs, and construction duration. For all three locations, rail grade changes were not favoured and were scored less favourably on all construction-related criteria. The study also scored rail grade changes poorly on impacts on rail and rail-adjacent areas due to risks/impacts associated with poor ground conditions in Takanini. However rail grade changes were identified as being less impactful on surrounding properties. The study also noted that the interdependencies between each site needed to be considered for rail grade options given their proximity, and that the implications of additional rail tracks would need to be considered in future work.
<i>Level Crossing Removal Options Investigation – Walters Road</i> (RIC, 2016)	The following options pertained to grade-separating the Walters Road level crossing only: • 2A – Rail-over-road • 2B – Rail-under-road • 2C – Rail offline (under or over) • 3A / 3B – Combination options (i.e. lower rail/raise road; or raise rail/lower road).	Options 2A and 2B both not preferred on basis of construction complexity/disruption to rail operations (12-18 month block-of-line), higher costs associated with ~1km-long / 7m high/deep structures, and visual effects. Option 2C not preferred on the basis of very high land costs and business disruption effects. Options 3A / 3B not preferred on basis that they combine negative aspects of other options.
<i>South Indicative Business Case</i> (Te Tupu Ngātahi, 2019)	The following options pertained to grade-separating all Takaanini level crossings: • MT14 – Rail-under-road trench • MT14A – Rail-over-road viaduct	Both options MT14 and MT14A were discarded at the longlist stage and not advanced to the shortlist on the basis that they provided only localised transport benefits and would result in very high construction costs and complexity. MT14A was identified as having significant visual effects and requiring a costly relocation of overhead line equipment. MT14 was identified as having lower visual effects but very high costs due to groundwater and settlement effects and peat soils.

From the above summary, it can be seen that none of the reviewed studies favour rail grade changes as a means of achieving road-rail grade separation in Takaanini. However, further work on rail grade

change options was undertaken through the DBC process given that these earlier studies were all relatively high-level exercises.

For completeness, resource consents for large developments near the level crossings were reviewed. Through this review, it was noted that the resource conditions for Stage One of the Takanini Town Centre at 30 Walters Road (issued in 2012) contain a condition requiring the closure and reinstatement of the proposed access from Walters Road “in the event that the rail over bridge along Walters Road is constructed”. While not a piece of analysis in and of itself, the condition does signal that the possibility of grade-separating the Walters Road level crossings was raised through that consenting process, and that the form of grade-separation at that time was expected to be a road-over-rail bridge.

Further assessment undertaken through DBC

The design parameters for the development of options for rail grade changes in the DBC were derived from KiwiRail Standard T-ST-DE-5200 Track Design, and are summarised in **Table 5-4**. These parameters are applicable to both rail-over-road and rail-under-road options.

Table 5-4 – Rail grade change design parameters

Parameter	Value
Design Speed	100km/h
Vertical curve radius (for 100km/h)	3500m (K=35)
Desirable maximum gradient	1:80 (1.25%)
Absolute maximum gradient without operational restrictions	1:32 (3.125%)
Maximum gradient for yards, sidings, and station platforms	1:200 (0.5%)
Vertical clearance (taking account of structure depth)	7.6m

These design parameters indicate that:

- The average horizontal length required to ramp up or down to the required vertical clearance is approximately 1000m. The four Takaanini level crossings fall within a 3400m section of the NIMT, with an average distance of 850m between them. Accordingly, there is insufficient length between level crossings for the NIMT to be raised over each road individually. This was demonstrated through a design test assessing the requirement to grade-separate Walters Road in isolation, which showed the 1200m distance to the next level crossing northwards (Taka Street) is not sufficient for the rail to both return to grade and ramp up again to clear Taka Street. This finding holds for all four level crossings given that the remaining level crossings are closer to each other. Accordingly, it is assumed that the NIMT would need to be raised over/lowered under all crossings in the area on/in a single structure (other than Walters Road which could be grade-separated in isolation with a rail grade change).
- It is not possible for a rail-over-road viaduct structure to clear the Spartan Road level crossing due to its proximity to the SH1 rail underpass which is a hard constraint approximately 250m to the north of Spartan Road. Similarly, it is not possible for a rail-under-road trench to clear the Spartan

Road level crossing due to its proximity to the Papakura Stream which crosses the NIMT approximately 400m north of Spartan Road; and

- Having regard to the above, the resultant structure would comprise a rail viaduct or trench of approximately 3700m in length and generally 7.6m in height between the SH1 rail underpass in the north and returning to grade approximately 900m north of Papakura Station (see **Error! Reference source not found.**). The viaduct would clear three of the four Takaanini level crossings (Manuroa Road, Taka Street, and Walters Road), and the existing site of Takaanini Station. Spartan Road would need to be closed.

The resultant options – a rail viaduct (rail-over-road) and rail trench (rail-under-road) were assessed using Waka Kotahi's EAST tool. As noted in section 2.3.2, the EAST tool is intended for the high-level assessment of broad ranges of options to narrow from a longlist down to a shortlist for MCA assessment. The results of the EAST assessment for the rail grade change options are set out below (the full details are included in **Appendix A**).

Table 5-5 – Summary of EAST assessment for rail grade change options

Criterion	Subcriterion	Rail-over-road viaduct	Rail-under-road trench
Investment objectives		4 (positive)	4 (positive)
Practical feasibility	Technical	5 (complex)	5 (complex)
	Safety and design	2	2
	Consentability	5 (complex)	5 (complex)
Scheduling / programming		5+ years	5+ years
Cost		>\$50m	>\$50m
Key risks and uncertainties		For both options – high construction cost and complexity anticipated, particularly given ground conditions. Uncertainty as to how these options will interact with KiwiRail plans, particularly four-tracking.	
Climate change	Mitigation	Reduce (i.e. anticipated to result in fewer enabled emissions / VKT)	
	Adaptation	Uncertain – not yet assessed.	
Environment and social responsibility	Key risks	Large construction disruption and landscape/visual impact.	Groundwater, settlement risk, large construction disruption.
	Can risks be mitigated / how?	Yes – bridge height may be commensurate with surroundings in the future environment given NPS-UD and MDRS; construction method will need to minimise disruption as much as possible.	Yes – groundwater treatment needed; construction method will need to minimise disruption as much as possible.
Fatal flaws		Both options were discarded at the IBC stage (see Table 5-2) given the risk and reward ratio was assessed as not worth pursuing further.	
Summary of recommendation		Discard – do not progress either option given scale, complexity, cost, construction disruption, and risk. Likely limited benefits relative to costs. Both options also discarded in IBC.	

In addition to the EAST assessment, the Project Team assessed the rail grade options from first principles and similarly recommended that these options are discarded prior to detailed options assessment (i.e. an MCA) for the following reasons:

- The rail viaduct was discarded on the basis that it would be highly disruptive to rail operations, costly and complex to construct relative to alternatives, and would result in significant visual effects and land requirements over a lengthy section of the NIMT; and
- While perhaps the best outcome in terms of visual effects, the rail trench was discarded on the basis that it would be highly disruptive to rail operations, and correspondingly more costly and complex to construct compared with the rail viaduct given the groundwater effects and risk associated with a 3.7km underpass in peat.

The same general conclusions hold with the option of a rail viaduct or trench to grade-separate Walters Road in isolation.

While less costly than the above options by virtue of shorter length, rail grade change options associated with Walters Road in isolation remain highly disruptive to rail operations, costly and complex to construct, and will still impose significant visual effects (in the case of a viaduct) and/or groundwater effects and risk (in the case of a trench).

Conclusion

The implications of the above analysis are that rail grade changes were ruled out as a means of achieving grade-separation. Accordingly, this analysis has ruled out two of the four general methods for achieving grade-separation.

5.5.2.2 Consideration of road grade changes

As noted in the methodology outlined above, road grade changes – raising or lowering the road – were considered as methods for achieving grade separation. In considering the merits of road grade changes, both previous (pre-DBC) studies and assessment undertaken through the DBC process were considered.

Recommendations of previous studies

The Project Team identified seven previous studies which have considered or discussed road grade changes as a means of achieving road-rail grade separation in Takaanini dating back to 2006. These are summarised in **Table 5-6**.

Table 5-6 – Previous (pre-DBC) studies considering road grade changes

Study	Relevant options considered	Conclusions
<i>Takanini Grade Separation Feasibility Study – Manuroa and Walters Road</i> (Beca, 2006)	Bridge (road-over-rail) option only	Feasibility study only – concluded that a road-over-rail bridge is feasible and would have immediate benefits. Identified a need for further geological assessment given likelihood of settlement and stability issues.
<i>Takanini Road/Rail Grade-Separation Investigation Traffic Report</i> (Beca, 2007)	Bridge (road-over-rail) option only	Focus of these reports was on identifying the combination of crossings which should be grade-separated rather than the form of

Study	Relevant options considered	Conclusions
<i>Takanini / Opaheke / Drury / Karaka Integrated Transport and Land Use Strategy</i> (Urbanism Plus, 2014)	Bridge (road-over-rail) option only	options – both assumed road-over-rail bridges.
<i>Rail Crossing Grade-Separation Feasibility Study</i> (Aurecon, 2014)	Three options were assessed at a high level for Walters Road, Taka Street, and Manuroa Road: • Road-over-rail; • Rail-under-road; and • Combination of road-over-rail and rail-under-road.	Options were assessed using a range of criteria including online impacts (for road and rail), impacts on surrounding areas and properties, and a range of construction impacts including complexity and disruption, costs, and construction duration. For all three locations, the road-over-rail option was favoured, and were scored more favourably on all construction-related criteria; as well as on rail impacts. However they were scored less favourably for road impacts and for impacts on surrounding properties. The study also noted that in the Walters Road location, access to the town centre needed to be considered for a road-over-rail option in future work.
<i>Transport for Future Urban Growth</i> (Urbanism Plus, 2016)	Bridge (road-over-rail) option only	Focus of this report was on identifying the combination of crossings which should be grade-separated rather than the form of options – both assumed road-over-rail bridges.
<i>Level Crossing Removal Options Investigation – Walters Road</i> (Rail Infrastructure Consultants, 2016)	1A – Road-over-rail bridge 1B – Road-under-rail bridge 1C-1F – Road offline alternatives	Option 1A considered relatively straightforward from an engineering perspective – main concerns relate to property impacts and visual effects. Option 1B not preferred on basis that it had difficult challenges related to underground structure and drainage from an engineering perspective, property impacts, but reduced visual effects. Various offline options not preferred on basis of increased property impacts.
<i>South Indicative Business Case</i> (Te Tupu Ngātahi, 2019)	Bridge (road-over-rail) option only	Focus of the IBC was on identifying the combination of crossings which should be grade-separated rather than the form of options – assumed road-over-rail bridges.

From the above summary, it can be seen that two of the seven studies directly compared road-over-rail bridges with road-under-rail underpasses and both identified preferences for bridges. Of the remaining studies, bridges were assumed as a basis for either feasibility assessment or scenario-based network optioneering seeking to identify the number and location of crossings rather than their physical form. Given these limitations, further work on road grade change options was undertaken through the DBC process.

Further assessment undertaken through DBC

The design parameters for the development of options for road grade changes in the DBC are summarised in **Table 5-7**. These parameters are applicable to both road-over-rail and road-under-rail options.

Table 5-7 – Road grade change design parameters

Parameter	Value
Typical road cross-section (derived from corridor form and function assessment summarised in 5.4 above)	24m mainline; 18m for bridge or underpass sections
Horizontal clearance envelope	28.8m minimum (for NIMT four-tracking)
Maximum span (bridge only)	35m
Vertical clearance	Bridge – 7.8m from ground level to road surface (incorporating 5.5m rail vertical clearance) Underpass – 7.5m from underpass centreline to rail track (incorporating 6m road vertical clearance)
Design speed	50km/h
Vertical grades	Desirable maximum grade of 8%; minimum of 0.5%
Minimum crest curve	K = 6.8
Minimum sag curve	K = 6

Road-over-rail bridge and road-under-rail underpass options were developed based on these parameters. As with the rail grade change options, the road bridge and underpass options were assessed at a high level using Waka Kotahi's EAST assessment tool. The results of this assessment are summarised in **Table 5-8** (the full details are included in **Appendix A**).

Table 5-8 – Summary of EAST assessment for road grade change options

Criterion	Subcriterion	Road-over-rail bridge	Road-under-rail underpass
Investment objectives		4 (positive)	4 (positive)
Practical feasibility	Technical	4 (complex)	5 (complex)
	Safety and design	2	2
	Consentability	3	4 (complex)
Scheduling / programming		0-2 years	2-5 years
Cost		>\$50m	>\$50m
Key risks and uncertainties		High construction cost and complexity expected, although the least costly and complex of the four forms of grade-separation.	High construction cost and complexity expected – less than rail grade change options but more than a road-over-rail bridges.
Climate change	Mitigation	Reduce – (i.e. anticipated to result in fewer enabled emissions / VKT)	
	Adaptation	Uncertain – not yet assessed.	

Criterion	Subcriterion	Road-over-rail bridge	Road-under-rail underpass
Environment and social responsibility	Key risks	Landscape and visual impacts on surrounding environment, construction disruption.	Groundwater settlement risk, significant construction disruption, and CPTED concerns.
	Can risks be mitigated / how?	Yes – bridge height may be commensurate with surroundings in the future environment given NPS-UD and MDRS, construction method will need to minimise disruption as much as possible.	Yes – groundwater treatment required careful design to ensure safety for active modes (passive surveillance), construction method will need to minimise disruption as much as possible.
Fatal flaws		None identified	None identified
Summary of recommendation		Progress as interim preferred form for purpose of scenario-based network optioneering.	Not preferred but not yet discarded – no fatal flaw identified, but option not preferred given greater cost and construction disruption anticipated compared with a bridge.

Conclusion

Based on the above assessment, a road-over-rail bridge was identified as the interim preferred form option for the purpose of informing subsequent scenario-based network optioneering (covered in section 5.5.3 below).

5.5.2.3 Conclusion – interim preferred physical form of grade separation

This interim assessment of options for the physical form of grade separation documented through section 5.5.2 considered all four broad options for how road-rail grade-separation can be achieved – raising and lowering of the rail, and raising and lowering of the road. The results of the assessment are summarised below.

Table 5-9 – Interim preferred physical form of grade separation – summary of assessment outputs

Option	Recommendation	Summary of commentary
Rail-over-road viaduct	Discard	Rail gradients require 1km of ramping to achieve required vertical clearances.
Rail-under-road trench	Discard	- Not possible to grade-separate at Spartan Road given proximity of SH1 interchange and Papakura Stream. 3.7km structure needed to clear three level crossings – only Walters could be done in isolation. - Highest construction disruption, visual effects (in the case of a viaduct), and costs – hence discarded prior to further assessment.
Road-over-rail bridge	Preferred / progress as interim preferred form	- Key geometric parameters – gradients, clearances over rail, bridge deck width, ability to future-proof for four-tracking. - Need to maintain access to adjacent properties via access lanes. - Achieves investment objectives and is anticipated to have the least construction complexity, costs, risks, and impacts.

Option	Recommendation	Summary of commentary
		• Preferred through this assessment / progressed as the interim preferred form for the purpose of scenario-based network optioneering – to be retested through MCA.
Road-under-rail underpass	Not preferred / not discarded	• Similar geometric parameters to a bridge. • Higher costs, complexity, risk, resilience concerns compared with a bridge. • Likely greater construction disruption compared with a bridge. • Not preferred / not discarded in this assessment – to be retested through MCA.

Two important caveats are noted at this point in the process:

- The road-over-rail bridge option preferred through this assessment was adopted as the basis for scenario-based network optioneering – in other words, the options for different combinations and locations of grade-separations are assumed in subsequent optioneering (see section 5.5.3) to be road-over-rail bridges. However, it is noted that locational choices for road crossings in this subsequent optioneering are not dictated by whether the physical form of the crossing is a bridge or underpass. The only form options that have been discarded at this point are rail grade changes, meaning that all subsequent optioneering looks at east-west road grade changes, and not north-south rail grade changes; and
- As noted in the methodology set out at 5.5.1.2 above, this interim preference for the physical form of grade-separation will be retested in greater detail following the scenario-based network optioneering assessment and public engagement process (see section 5.8 of this report). In other words, the number and location of grade-separations will be confirmed before the form is confirmed.

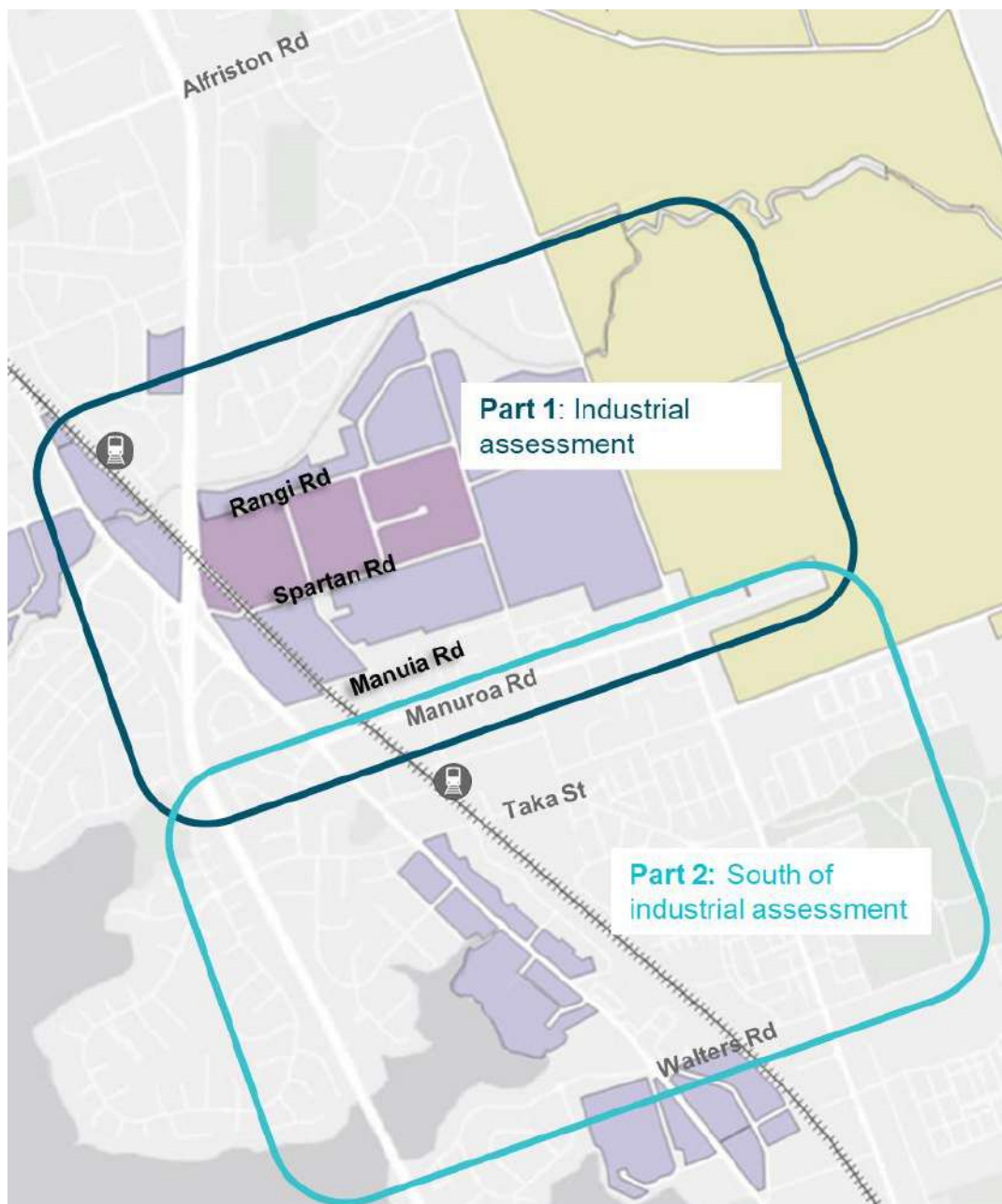
5.5.3 Network Optioneering

The network optioneering process was undertaken as a network approach to provide a more holistic understanding of the cumulative effects of the different combinations of replacement or closure at the level crossings. 'Scenario' options of the different combinations, representative of the potential final network, were developed for assessment with the IBC recommended option as the starting point. This approach formed the basis of the option assessment undertaken.

The assessment was undertaken in two parts with Part One focussed on providing an access for the Takaanini industrial area, whilst Part two was the focus for everything south of the industrial area.

Figure 5-3 shows the assessment extents for the Part One and Part Two assessments.

Figure 5-3 : Assessment Extents



5.5.3.1 Part One: Industrial area assessment

Initial assessment

Part One of the assessment focussed on providing access to and from the Takaanini industrial area. It considered the area bound by Manuroa Road (southernmost east-west access to the industrial area) and the northern extent of the industrial area (Figure 5-3).

With the IBC recommended option forming the basis of the scenarios and only one east-west connection required to serve the industrial area, both Taka Street and Walters Road remained unchanged from the IBC recommendation for all scenarios. Thus, the assessment focussed on Rangī Road, Spartan Road and Manuroa Road as the access to the Takaanini industrial area. Conducting the assessment in this way helped to isolate the key decision around the industrial area connection and re-test the IBC scenario and the Rangī Road viaduct following the IBC recommendations. As the gap analysis had indicated only one industrial access is required, 'Scenario' options did not consider having multiple grade separations i.e. having both Rangī Road and Spartan Road at this stage. However, this may be considered later if the assessment indicated none of the Scenarios were preferred.

Three scenarios were assessed and are shown in **Table 5-3** with the following design parameters:

- 24m corridor (2 lanes) with walking and cycling facilities
- Maximum vertical grade of 8%
- Vertical clearance of 7.6m including structure and pavement depth
- Posted speed limit of 50 kph (design vertical checks of 60kph)
- Approximate bridge lengths:
 - Rangī Road – 365m
 - Spartan Road – 60m (two standalone bridges of 30m each)
 - Manuroa Road – 30m
 - Taka Street – 30m
 - Walters Road – 30m

Table 5-3 : Part One industrial assessment scenarios

East-West Crossings	Scenarios		
	Scenario 1: IBC Recommended	Scenario 2: Spartan Road	Scenario 3: Manuroa Road
Alfriston Road (Existing)	Open	Open	Open
Rangī Road	Open	N/A	N/A
Spartan Road	Closed	Open	Closed
Manuroa Road	Closed	Closed	Open
Taka Street	Open	Open	Open

East-West Crossings	Scenarios		
	Scenario 1: IBC Recommended	Scenario 2: Spartan Road	Scenario 3: Manuroa Road
Walters Road	Open	Open	Open

Open – new or existing crossing / bridge for vehicular traffic with active mode facilities.

Closed – existing level crossing removed and existing corridor to be cul-de-sac

N/A – not applicable as Rangī Road is currently a cul-de-sac.

The assessment criteria and scores for each scenario are summarised in **Table 5-4**.

Key outcomes from the assessment:

- **Scenario 1** with the Rangī Road viaduct performs well against the investment objectives, transport system integration and user safety criteria. However, it scores moderate to highly adverse for landscape/ visual, urban design, stormwater, and construction. It is also anticipated to have the highest capital and embodied carbon cost of all scenarios.
- **Scenario 2** with Spartan Road does not perform as well as the other scenarios against investment objective two in providing travel choice due to the surrounding land use. It also scored highly adverse for human health and wellbeing due to the diversion anticipated for heavy vehicles impacting residents due to the restriction on right turn from Spartan Road to Great South Road. In addition, this option is not preferred due to operational impacts given its proximity to the Takaanini interchange and would require a complimentary solution such as having Manuroa Road open and/or change the design of Spartan Road to allow a full-movement intersection with Great South Road. Further, a novel structure (i.e. such as a spiral bridge so as not to interfere with the Takaanini interchange) would be required to avoid reconstruction of the SH1 off-ramp. Thus, this presents construction challenges and complexities.
- **Scenario 3** with Manuroa Road performs better overall but is anticipated to have highly adverse impact on human health and wellbeing like Scenario 2. In addition, more industrial traffic will be diverted to use this largely residential corridor, which is expected to be negatively received by the community and stakeholders. Hence, like Scenario 2, this scenario is not preferred in isolation and would require a complementary solution such as having an additional industrial connection to separate the residential and industrial traffic.

Table 5-4 : Summary of Part 1 MCA Assessment

Criteria	Scoring		
	Scenario 1: IBC Recommended (Rangī Road)	Scenario 2: Spartan Road	Scenario 3: Manuroa Road
Investment Objective 1: Safety			
Investment Objective 2: Travel Choice			
Investment Objective 3: Resilience			

Criteria	Scoring		
	Scenario 1: IBC Recommended (Rangi Road)	Scenario 2: Spartan Road	Scenario 3: Manuroa Road
Investment Objective 4: Access			
Land Use Futures			
Urban Design			
Land Requirement			
Social Cohesion / effects			
Human Health and Wellbeing			
Transport system integration			
User safety			
Ecology			
Historic Heritage			
Landscape / Visual			
Stormwater			
Natural Hazards			
Construction impacts on utilities / infrastructure			
Construction disruption			
Construction costs / risk / value capture			

It is important to note that this assessment is focussed around providing access to the industrial area with Spartan Road currently providing this function. However, its proximity to the Takaanini interchange and associated banning of right turns out from Spartan Road onto Great South Road means northbound industrial traffic is diverted through existing residential areas. In the long-term, even if Spartan Road was grade separated, this restriction on right turning would remain. This means any solution at Spartan Road would either need a complementary solution, i.e. a second access to the industrial area that allows right turning out to Great South Road, or an acceptance that industrial traffic would use residential routes.

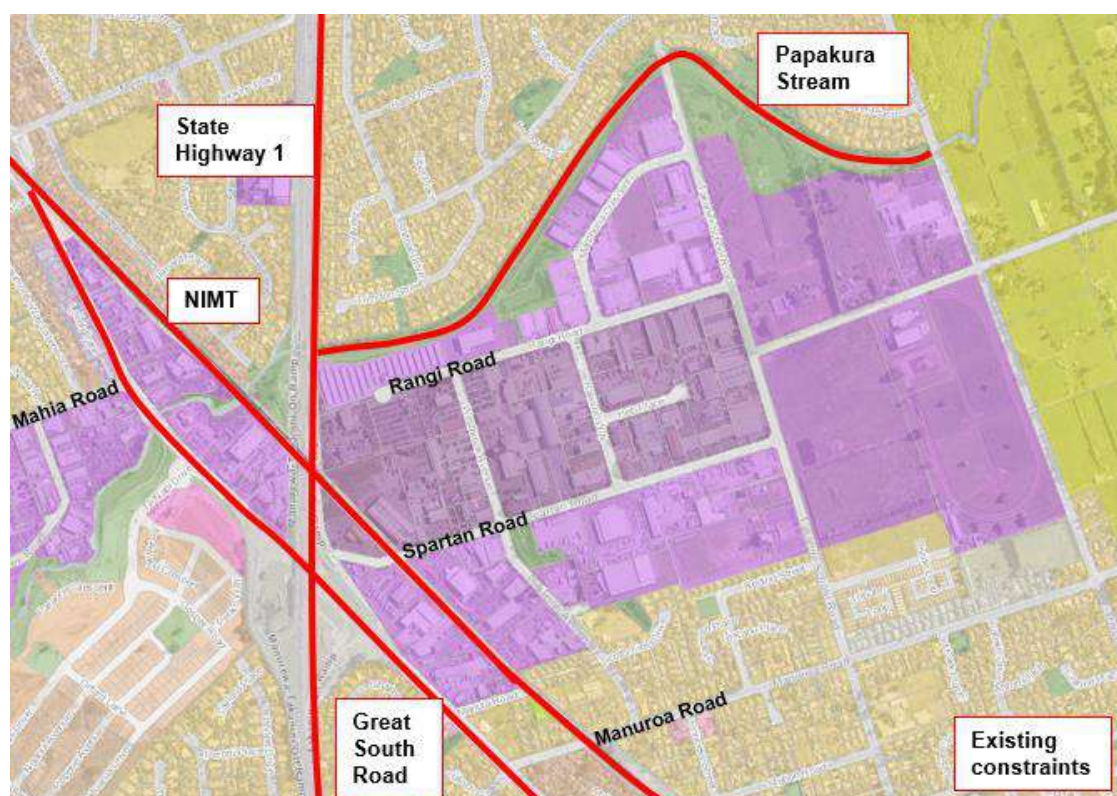
Rangi Road and Manuroa Road as possible alternatives have highly adverse effects that should be avoided as demonstrated through the MCA. **Thus, with no clear preferred option, it was considered alternative option/s should be explored** before complimentary options to the above scenarios are considered.

All three scenarios have undesirable effects, thus there was no clear preferred option and alternative option/s needed to be explored.

Alternative options

Possible viable alternative options bound between the Papakura Stream and Manuroa Road were explored (see **Figure 5-4**).

Figure 5-4 : Option development extent



Noting that there are potentially infinite possible options, to limit the options to be assessed, options that do not resolve the effects identified previously were not considered. These included any connection:

- Over the SH1 as this will have similar anticipated effects as the Rangl Road scenario.
- To Great South Road (GSR) via the existing Spartan Road as this will have little difference to the Spartan Road scenario.
- From Manuroa Road onto Great South Road via a different alignment. These could be route refinement options and will still result in industrial traffic diverting through the residential area.

Figure 5-5 illustrates the options assessed and descriptions provided in **Table 5-5**. The following design parameters apply to all options:

- 24m corridor (2 lanes) with walking and cycling facilities

- Design speed of 50km/hr
- Structure clearance road to rail of 7.8m
- Max vertical grade up to 8%
- Horizontal curve minimum radii of 120m

Figure 5-5 : Industrial Access Alternative Options

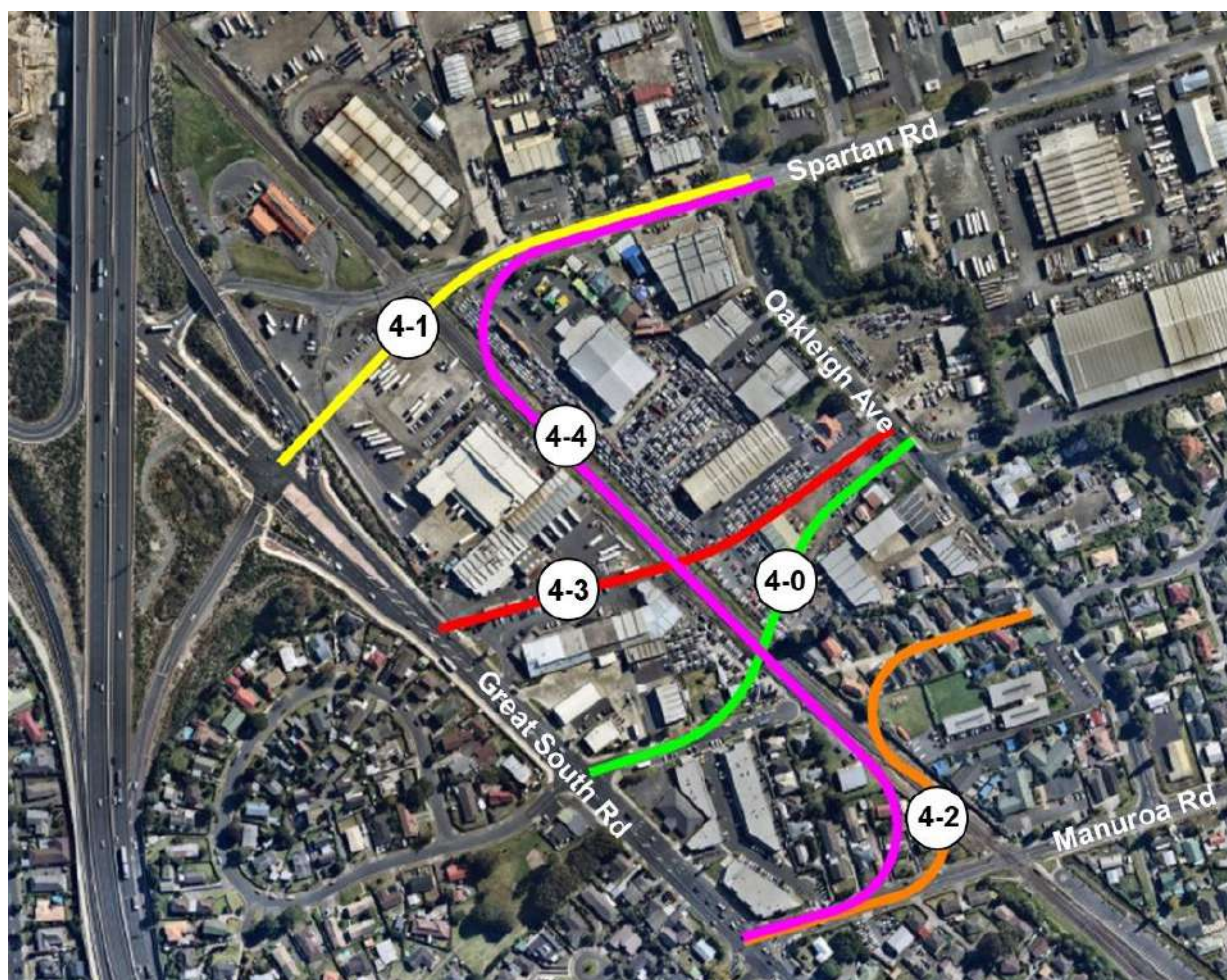


Table 5-5 : Alternative option descriptions

No.	Option	Description
4-0	Connection using Manuia Road	Connection from Oakleigh Ave through to Manuia Road and onto GSR to reduce industrial/ heavy traffic through residential area. Bridge length of 60m.
4-1	Option to connect to SH1 off-ramp intersection	Spartan Road alternative to resolve turn restriction issue with existing intersection with GSR. Intersection with GSR is moved and consolidated with SH1 SB offramp (exact arrangement to be determined during route refinement). Bridge length of 30m.
4-2	Manuroa Road to Portrush Lane	Portrush Lane to Manuroa Road (west) to reduce industrial/heavy traffic through residential zoning. Involves a lengthened structure located over the

No.	Option	Description
		NIMT corridor. Maintains existing intersection with GSR and Oakleigh Ave. Bridge length of ~180m.
4-3	Connection from Hitchcock Road to Great South Road	New road alignment through industrial zone at interface with SH1 interchange. New intersection with GSR and Oakleigh Ave. Bridge length of 30m.
4-4	Manuroa Road to Spartan Road	Spartan Road to Manuroa Road (west) to maintain Spartan Road as industrial/heavy traffic through route. Maintains existing intersection with GSR and Spartan Road alignment. Involves a lengthened structure located over the NIMT corridor. Maintains existing intersection with GSR and Oakleigh Ave. Bridge length of ~580m

The assessment of the options focused on finding an alternative that would provide the outcomes sought with lesser effects than those identified within the previous scenarios. Thus, the assumptions for the previous scenarios remain i.e Taka Street and Walters Road will be grade separated with the options in **Table 5-5** forming new scenarios. These were assessed in a similar fashion using the MCA framework.

The assessment criteria and scores are summarised in **Table 5-6**. Key outcomes from the assessment:

- **Scenario 4-0**, connection using Manuia Road performs the best against the investment objectives. It also performs the best for the transport criteria, transport system integration and user safety. Also, the scenario is anticipated to have only low to very low adverse impacts.
- **Scenario 4-3**, connection from Hitchcock Road to Great South Road performs similarly well against the investment objectives as Scenario 4-0 though scoring slightly less for Investment Objective 3. This is due to Scenario 4-3 being within a closer proximity to the interchange, thus increasing the likelihood of vehicles queuing back to the interchange and consequently impacting the state highway. It is anticipated to have only low to very low adverse impacts.
- **Scenarios 4-1, 4-2 and 4-4** scores highly adverse in at least one criteria. Scenario 4-1 is anticipated to have high construction disruptions due to the connection to the state highway off-ramp. Scenario 4-2 restricts and impacts the potential for future rail expansion due to it running parallel to the railway line, thus scores poorly for construction impacts on utilities/infrastructure. This is also applicable for Scenario 4-4 which in addition scores highly adverse for stormwater due to the extensive new pavement required generating large water quality effects.

Table 5-6 : Summary of Part 1 Alternative Options MCA Assessment

Criteria	Scoring				
	4-0	4-1	4-2	4-3	4-4
Investment Objective 1: Safety					
Investment Objective 2: Travel Choice					
Investment Objective 3: Resilience					
Investment Objective 4: Access					
Land Use Futures					
Urban Design					
Land Requirement					
Social Cohesion / effects					
Human Health and Wellbeing					
Transport system integration					
User safety					
Ecology					
Historic Heritage					
Landscape / Visual					
Stormwater					
Natural Hazards					
Construction impacts on utilities / infrastructure					
Construction disruption					
Construction costs / risk / value capture					

The assessment identified **Scenario 4-0** and **Scenario 4-3** will deliver the outcomes sought in providing for industrial traffic without diversion through the residential area. Both also do not have any anticipated highly adverse effects like the other scenarios or the previous scenarios. However, **Scenario 4-0**, connection to Manuia Road being further away from the Takaanini interchange will

provide greater network resilience and have greater traffic benefits. **Thus, Scenario 4-0 is the preferred scenario.**

Scenario 4 - 0, a new connection from Oakleigh Ave to Great South Road using the existing Manuia Road was the preferred alternative option.

Summary of Part One assessment

The initial Part One assessment identified that grade separating at the existing east-west crossing locations as a primary access to the industrial access had undesirable effects that should be avoided. Hence, alternative locations were explored and the preferred option was a new connection via or around Manuia Road.

Table 5-7 shows the MCA outcomes for the initial scenarios assessed and for the preferred alternative option, Manuia Road (henceforth, referred to as Scenario 4 for simplicity). The MCA assessment findings summary is shown in Table 5-8.

Key outcomes from the assessment:

- Scenario 4 performs equally as well as Scenario 1 against the investment objectives and only slightly less in Transport criteria.
- Scenario 4 had no criteria scoring in the moderate to high adverse effects unlike Scenarios 1 to 3. This has mainly been attributed to the smaller structure required than say Scenario 1 and being able to provide for a full movement intersection with Great South Road (GSR) which removes the industrial traffic away from the residential areas.
- Any adverse scores for Scenario 4, such as landscape/visual have the opportunity to be improved through mitigations which can be explored in the route refinement stage.

The assessment of all four scenarios were presented to Manawhenua and they had concerns around the visual effects of the new bridges and the treatment of Manuroa Road is of interest. However, they have also indicated a level of comfort with the Manuia Road crossing (Scenario 4) as long as there are ways to make incremental improvements as the design develops.

Based on the assessment and feedback, the **emerging preferred is Scenario 4, Manuia Road.**

Table 5-7 : Summary of Part 1 MCA including Manuia Road

Criteria	Scoring			
	Scenario 1: IBC Recommended	Scenario 2: No Rangi, No Manuroa	Scenario 3: No Rangi, No Spartan	Scenario 4: Manuia Road
Investment Objective 1: Safety				
Investment Objective 2: Travel Choice				
Investment Objective 3: Resilience				

Criteria	Scoring			
	Scenario 1: IBC Recommended	Scenario 2: No Rangi, No Manuroa	Scenario 3: No Rangi, No Spartan	Scenario 4: Manuia Road
Investment Objective 4: Access				
Land Use Futures				
Urban Design				
Land Requirement				
Social Cohesion / effects				
Human Health and Wellbeing				
Transport system integration				
User safety				
Ecology				
Historic Heritage				
Landscape / Visual				
Stormwater				
Natural Hazards				
Construction impacts on utilities / infrastructure				
Construction disruption				
Construction costs / risk / value capture				

Table 5-8 : Part 1 MCA assessment findings summary

Criteria	Summary
Performance against investment objectives	Safety: All scenarios will remove the safety risk posed by the existing level crossings. It is noted that there is a possibility of risky behaviours being introduced at Manuroa Road if the level crossing is closed. However, this can be mitigated. Travel Choice: All scenarios will increase rail capacity through level crossing closure and as such contributes positively to this objective. Scenario 3 scores the highest as it is seen to provide the greatest mode shift given its surrounding land use being residential. Resilience: All scenarios will improve the southern rail line with the removal of level crossings. However, Scenario 1 will provide the greatest resilience through accommodating traffic away from the Takaanini Interchange. Though Scenario 4 is seen to provide similar benefits. Access: All scenarios will enable greater access for the community through improved network as delays are reduced. Scenarios 1 and 4 will provide greater access for the industrial area. Overall, all scenarios score positively against the investment objectives with Scenario 1 and 4 scoring more favourably than the other options.
Cultural	Heritage

Criteria	Summary
	There is no differentiation between Scenarios 2,3 and 4 as there are no identified archaeological or heritage sites. Scenario 1 scores less favourably as it crosses the Papakura Stream which is of archaeological interest.
Social	Land Use All scenarios scores as low positive impact with the exception of Scenario 3 as they all support intensification though there are some loss of development opportunities. However, overall there are more opportunities. Scenario 3 scores less favourably as the overall opportunities do not outweigh the losses.
	Urban Design Scenarios 2 and 4 are preferred as it provides an overall low positive contribution to the urban environment. Scenario 1 scores moderately adverse and is least preferred due to the scale of impact anticipated.
	Land Requirement All scenarios scored negatively given the potential land requirements. However, Scenario 2 and 4 are preferred as less complex acquisition anticipated.
	Social Cohesion Scenarios 3 and 4 are preferred. There are benefits in reducing severance for the community however, there are also potential impacts on existing facilities. Thus, an overall low positive.
	Human Health and Wellbeing Scenario 1 is preferred. There are potential noise and vibration effects however, the closure of Manuroa Road will likely have a positive effect on nearby sensitive receivers such as the residential activities. Both Scenarios 2 and 3 scores highly adverse as industrial traffic is diverted through the residential area.
Natural Environment	Landscape/Visual All scenarios score negatively due to the large bridge structures required. However, Scenario 1 scores the most adverse due to the larger structure required for Scenario 1 (Rangi Road viaduct). Scenario 2 is preferred due to the surrounding environment being industrial.
	Stormwater Scenario 3 is preferred with the less impact on the stormwater operations of all scenarios. Scenario 1 is the less preferred as it crosses the Papakura Stream and careful design is required to minimise effects on flooding.
	Ecology All scenarios score the same as there are some losses of mature and native trees along the corridors. Noting that Scenario 1 is the less preferred option as it crosses the Papakura Stream.
	Natural Hazards No differentiation between Scenarios 1,2 and 4. However, Scenario 3 scores moderately adverse as significant settlements and effects on nearby properties anticipated.
Transport	Transport System Scenario 1 is preferred as it provides the most direct east-west connection for industrial traffic. Scenario 3 will still require industrial traffic to be rerouted and thus not preferred. Scenario 2 will require the industrial traffic to route through the residential area. Hence, similar scoring to Scenario 2. Scenario 4 scores slightly less than Scenario 1 as it isn't as direct as Scenario 1.
	User Safety Scenario 1 is preferred as it fully separates the industrial traffic thus is considered the safest option. Scenario 4 will also provide some separation however given its proximity to the residential area; some residential traffic will still use this connection. Scenarios 2 and 3 will require industrial traffic to route through the residential area.
	Construction Impacts on Utilities

Criteria	Summary
Construction Impacts, Costs and Risks	No differentiation between Scenarios 2,3 and 4 as it is anticipated to only have impact on the local utilities network. However, Scenario 1 is anticipated to impact on a number of major utilities including the Transpower line and Wastewater main.
	Construction Disruption Scenario 4 is the preferred with targeted disruption on existing commercial buildings. Scenario 1 is anticipated to have the greatest disruption including SH1, thus high adverse impact.
	Construction Costs/risks Scenario 4 is the preferred option. Anticipated to have business as usual construction though transformational works are expected on Manuia Road. Significant works are required for Scenario 1, thus high adverse impact.

A new connection from Oakleigh Ave to Great South Road using the existing Manuia Road was the preferred east-west connection for the industrial area.

5.5.3.2 Transport Network Review

Network Review

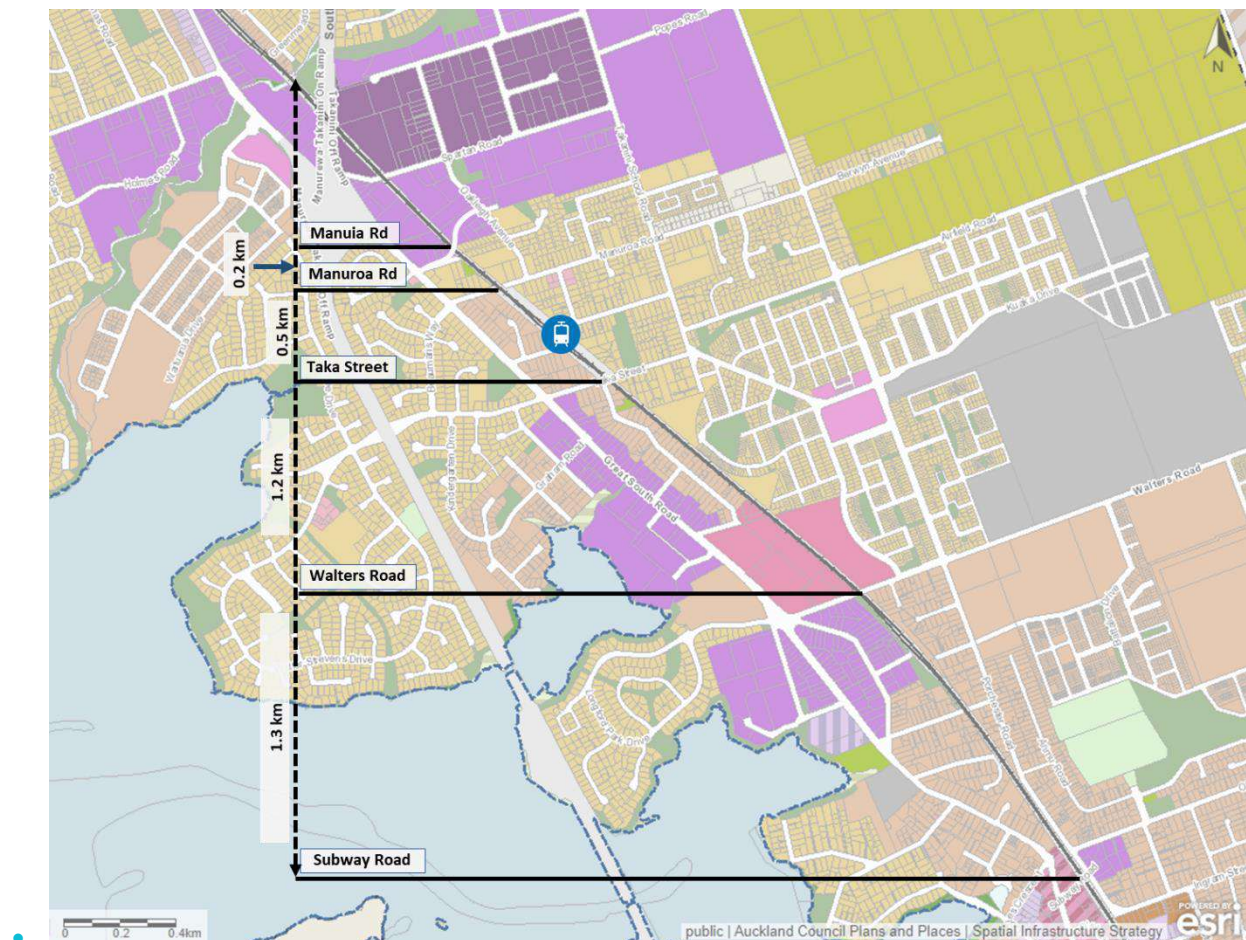
The Part One assessment identified Manuia Road as the preferred connection for the industrial area which differs from the IBC recommended network, i.e. Rangī Road viaduct has been replaced by Manuia Road as the preferred connection to the industrial area. Hence, to understand the effect of this, especially in relation to the transport network south of the industrial area, a transport network review was completed. This revisited the remainder of the IBC recommended option to understand whether closing Manuroa Road and keeping both Walters Road and Taka Street were still relevant in providing for the required east-west connectivity.

The transport network review identified:

- The distance between Walters Road and the adjacent east-west crossing across the NIMT is 1.3km to the south at Subway Road and 1.2km to the north at Taka Street. Removing Walters Road from the network will result in a significant gap in the east-west connectivity (refer to **Figure 5-6**).
- Tironui Road pedestrian level crossing located approximately 300m south of Walters Road will be removed as part of AT's pedestrian level crossing programme. Walters Road is planned to be the alternative route for active mode users.

Thus, it was established that an east-west crossing between Taka Street and Subway Road is required for optimum east-west accessibility for the community. Though if the connection is too close to Taka Street or Subway Road then there will still be a significant gap. Hence, a connection will be required between Taukari Road/Beach Street and Waterview Road for optimum connectivity.

Figure 5-6 : East-west crossings on the network



An east-west crossing will be required between Taukari Road/Beach Street and Waterview Road.

Assessment of Options

Possible viable options bound between Taukari Road/ Beach Street and Waterview Road were explored as shown on **Figure 5-7**. In developing these options, the following was considered:

- Preference to cross NIMT perpendicular to reduce required structure length/width (although noting that structure may be longer than required for NIMT due to geotechnical concerns).
- Preference for retaining an existing intersection with GSR due to significant number of existing intersection clutter.
- Preference to provide connection within business town centre zone (AUP) to improve connectivity.
- Preference to limit impact on property, existing structures and existing accesses.

Figure 5-7 : Options between Taukari Road/ Beach Street and Waterview Road

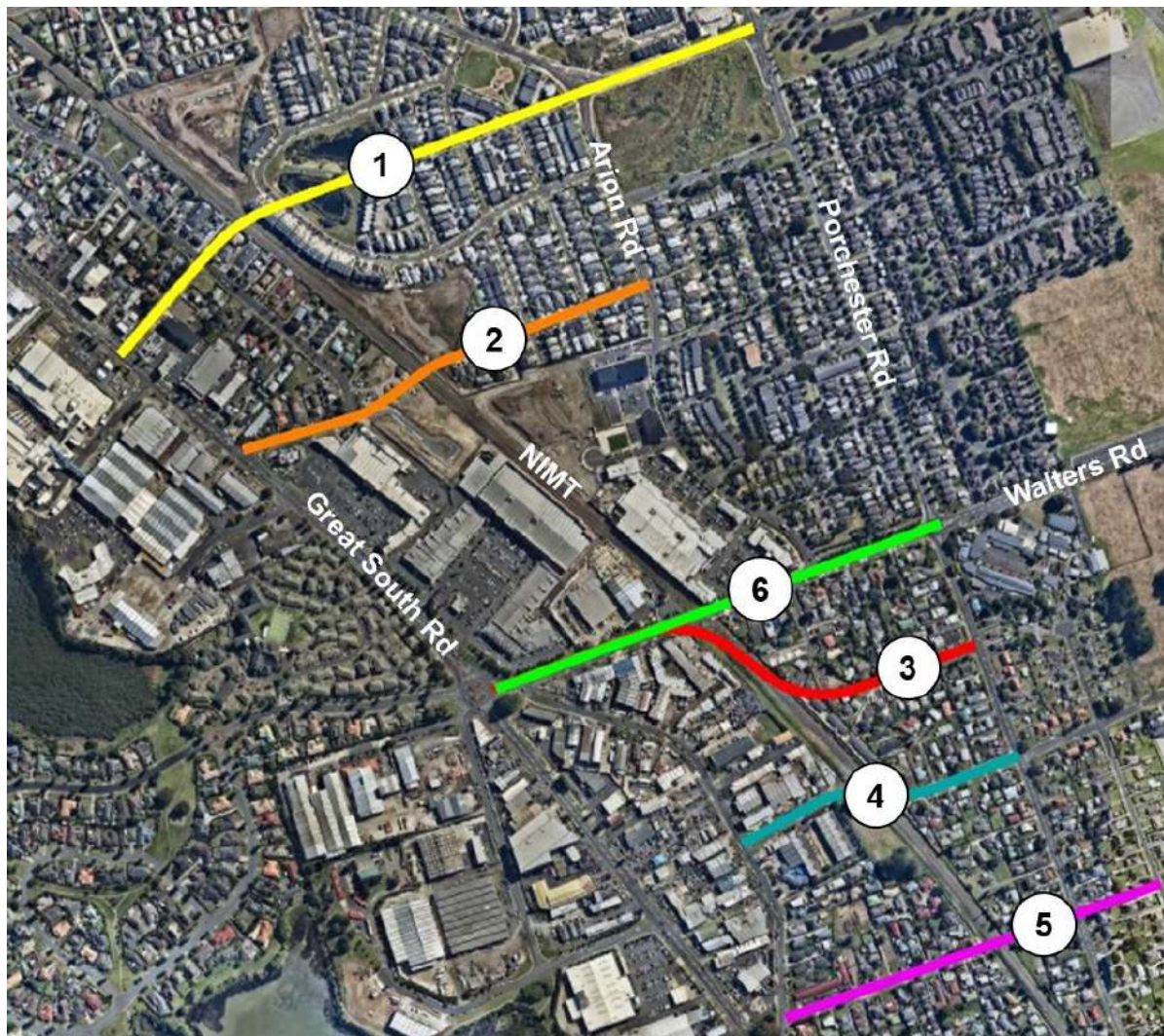


Table 5-9 : Option Descriptions

No.	Option	Description
1	Connects Porchester Road to GSR via Kauri Heart Ave, Taukari Rd and Beach Rd	Requires crossing local roads Soaring Bird Dr and Takanini Rd. Local road crossings may require closure or works along the road to raise levels to tie into rail crossing, or reduction in vertical level to allow grade separation. Signalisation of GSR and Beach Rd intersection. Bridge length ~30m.
2	Connect Arion Road to GSR via Kapia Dr and Glenora Rd.	Requires closure of Takanini Rd with Glenora Rd. Bridge length ~30m.
3	Connection to Porchester Road via Glenburn Place	Connection through to GSR via Glenburn place and Walters Road. Bridge length ~160m.

No.	Option	Description
4	Grade separation of Tironui Station Road.	Connection through to GSR via Tironui Road. Tironui Rd intersections to be improved with Walters, GSR and Tironui Station Rd. Intersection to be improved with Porchester Road. High skew structure crossing of NIMT. Bridge length ~35m.
5	Grade separation of Waterview Road.	Intersection with Tironui Road to be realigned and improved to give priority to east-west traffic directly to GSR. Intersection to be improved with Arimu Road, and Arimu Rd intersections to be improved to suit increased traffic flows. Porchester Road crossing to require closure or works to raise levels to tie into rail crossing, or reduction in vertical level to allow grade separation. Bridge length ~30m.
6	Grade separation of Walters Road	Utilises the existing Walters Road. Intersection improvements at Arion Road and Braeburn Place. Bridge length ~ 30m.

The options were assessed using the MCA framework and are as summarised in **Table 5-10**. Key outcomes from the assessment:

- **All options** perform well against the investment objectives as grade separation will improve safety, provide travel choice benefits through dedicated walking and cycling facilities and increased network resilience. **Option 3 and 6** performs best against the access investment objective as all other options reduces the connectivity to the Town Centre on Walters Road severing neighbourhood connectivity.
- **All options** are anticipated to have high adverse impact for construction costs/risk / value capture due to the potential construction complexity. However, it is anticipated the effect can be mitigated through further design refinements.
- Similarly, **all options** are anticipated to have high adverse impact for natural hazards due to the peat ground conditions and anticipated settlement. However, this is also anticipated to be able to be mitigated.
- **Option 1** is anticipated to have very high adverse impact against stormwater as it will pass through two newly constructed wetlands that are designed to manage the runoff from nearby residential dwellings. This is the only option anticipated to have such significant impact and is discarded on this basis.
- **Option 2, 4 and 5** are not preferred as options are anticipated to have high adverse effect on human health and wellbeing due to additional traffic being diverted through residential areas. This can be avoided with Options 3 and 6.
- **Options 3 and 6** are anticipated to have similar benefits and effects due to both providing access to the Town Centre on Walters Road and minimises diversion through residential areas. However, Option 6 will better integrate with the transport system being an existing road and thus less human health and wellbeing effects and stormwater impact due to less new pavement required. It is also preferred from an urban design perspective as it is better aligned with the surrounding land use and potentially provides a stronger and legible east-west link.

Thus, on balance, Option 6, using the existing Walters Road alignment was the preferred option.

Table 5-10 : Summary of Options MCA Assessment

Criteria	Scoring					
	1	2	3	4	5	6
Investment Objective 1: Safety						
Investment Objective 2: Travel Choice						
Investment Objective 3: Resilience						
Investment Objective 4: Access						
Land Use Futures						
Urban Design						
Land Requirement						
Social Cohesion / effects						
Human Health and Wellbeing						
Transport system integration						
User safety						
Ecology						
Historic Heritage						
Landscape / Visual						
Stormwater						
Natural Hazards						
Construction impacts on utilities / infrastructure						
Construction disruption						
Construction costs / risk / value capture						

Option 6, using the existing Walters Road alignment part of the east-west connections for the Takaanini area was the preferred option.

5.5.3.3 Part Two: Area south of the industrial area

The Part One assessment and the transport review assessment has identified Manuia Road and Walters Road as two of the three east-west connections required. Manuia Road will serve the Takaanini Industrial area and Walters Road forms the southernmost crossing (within the scope of this project). Hence, a crossing in between the two that also services the area south of the industrial area forms the basis of the Part Two assessment.

Taking the same approach as the Part One assessment, Scenario options were developed for the combination of replacement and/or closure of Manuroa Road and Taka Street (**Table 5-11**). The assumptions noted for the Part One assessment are applicable for this assessment.

Table 5-11 : Scenarios for Part Two assessment

East-West Crossings	Scenarios		
	Scenario 5: Manuroa Road Only	Scenario 6: Taka Street Only	Scenario 7: both Manuroa and Taka
Alfriston Road (Existing)	Open	Open	Open
Rangi Road	N/A	N/A	N/A
Spartan Road	Closed	Closed	Closed
Manuia Road	Open	Open	Open
Manuroa Road	Open	Closed	Open
Taka Street	Closed	Open	Open
Walters Road	Open	Open	Open

The assessment criteria and scores for each scenario are summarised in **Table 5-12**. The MCA assessment findings summary is shown in **Table 5-13**.

Key outcomes from the assessment:

- **Scenario 7** scores the best in the Transport criteria and well in the investment objectives. However, it is also anticipated to have the greatest adverse effect given two bridge structures will be required. This includes enabled and embodied carbon as with more road capacity provided, the more traffic is induced.
- **Scenario 5** is the least preferred from an investment objective perspective especially around resilience due to its proximity to the Manuia Road intersection. This could impact intersection operations with the potential of impacting the Takaanini interchange.
- **Scenario 6** scores more favourably than Scenario 5 against the investment objectives and is the preferred scenario for Land Use Futures and Social Cohesion criteria. This is anticipated to have less land requirements and the least adverse effects of all three scenarios.

The scenarios were presented to Manawhenua for feedback, and it is noted that none of the options were preferred due to the anticipated impacts. However, Ngā Manawhenua acknowledged that Scenario 6 would be the most sensible to be further explored.

Thus, **Scenario 6** of having Taka Street open forms the emerging preferred option.

Table 5-12 : Summary of Assessment for Part Two assessment

Criteria	Scoring		
	Scenario 5: Manuroa Road Only	Scenario 6: Taka Street Only	Scenario 7: both Manuroa and Taka
Investment Objective 1: Safety			
Investment Objective 2: Travel Choice			
Investment Objective 3: Resilience			
Investment Objective 4: Access			
Land Use Futures			
Urban Design			
Land Requirement			
Social Cohesion / effects			
Human Health and Wellbeing			
Transport system integration			
User safety			
Ecology			
Historic Heritage			
Landscape / Visual			
Stormwater			
Natural Hazards			
Construction impacts on utilities / infrastructure			
Construction disruption			
Construction costs / risk / value capture			

Table 5-13 : Part 2 MCA assessment findings summary

Criteria	Summary
Performance against investment objectives	Safety: All scenarios will remove the safety risk posed by the existing level crossings. It is noted that there is a possibility of risky behaviours being introduced at Taka Street if the level crossing is closed. However, this can be mitigated. Travel Choice: All scenarios will increase rail capacity through level crossing closure and as such contributes positively. Scenario 7 scores the highest as there is an additional crossing. Resilience: All scenarios will improve the southern rail line with the removal of level crossings. Scenario 7 is preferred as there is an additional crossing increasing network resilience. Access: All scenarios will enable greater access for the community through improved network as delays are reduced. Scenario 7 is preferred as the additional crossing enables greater access. Overall, all scenarios score positively against the investment objectives. Scenario 7 is preferred given the additional crossing provides additional benefits.
Cultural	Heritage There is no differentiation between scenarios as there are no identified archaeological or heritage sites.
Social	Land Use All scenarios scores the same with Scenario 6 being the preferred option due it having the least impacts on the land use. Urban Design All scenarios score the same with Scenario 6 being slightly more preferred as there are opportunities with this scenario that Scenario 5 does not offer. Scenario 7 has additional benefits, however the impact on the community is greater. Land Requirement Scenario 6 is preferred as less complex acquisition anticipated. Scenario 7 will have the greatest land requirement. Social Cohesion Scenario 6 is preferred as the impact it would have could be mitigated by the Manuia Road bridge as opposed to Scenario 5. Although Scenario 7 is anticipated to have the greatest benefits, it however also will have the greatest impact on community facilities. Human Health and Wellbeing All scenarios are anticipated to have adverse impacts due to sensitive receiver type activities in the area and adverse quality, noise and vibration effects from vehicle movements on the bridge. Scenarios 5 and 6 scores equally, with no differentiation between the two. Scenario 7 scores the worst as it is anticipated to affect more sensitive receivers than the other scenarios.
	Landscape/Visual

Criteria	Summary
Natural Environment	All scenarios score negatively due to the large bridge structures required. There is no differentiation between Scenarios 5 and 6. Scenario scores the lowest as two bridges will be required.
	Stormwater No differentiation between the scenarios, all scoring the same due to overland flow path needs to be diverted,
	Ecology All scenarios scored low adverse impact as there are some losses of mature and native trees along the corridors. No real differentiation between the scenarios.
	Natural Hazards Scenario 5 and 6 both score moderately adverse due to the peat ground conditions. Construction is anticipated to have significant settlements and impact nearby properties. Scenario 7 is less preferred due to two structures required instead of one.
Transport	Transport System Scenario 7 is preferred, as the additional crossing provides more capacity on the network overall. Scenarios 5 and 6 scores similarly with no differentiation.
	User Safety Scenario 7 is preferred, with the additional crossing, less conflict between the different modes on the corridors is expected. Scenarios 5 and 6 scores similarly with no differentiation.
Construction Impacts, Costs and Risks	Construction Impacts on Utilities Impacts on local utilities network anticipated for all scenarios. No real differentiator.
	Construction Disruption Higher disruption anticipated with Scenario 7 given two crossings are required as opposed to one. No differentiation between Scenario 6 and 7.
	Construction Costs/risks Highest construction costs and risks anticipated with Scenario 7. No differentiation between Scenario 6 and 7.

The outcome of the Part Two assessment has Taka Street being grade separated, forming part of the preferred network.

5.5.4 Active mode connections

The emerging preferred option from the assessments is Scenario 6. With this, Spartan Road and Manuroa Road would be fully closed with no connection for any mode. It was considered that there may be merit in exploring whether active mode connections should be provided at these locations given the investment objective includes both travel choice and accessibility.

A transport assessment was undertaken which explored several factors to understand the need for the connections. This included an understanding of the spacing between the east-west active mode connections with both Spartan Road and Manuroa Road included and excluded as per that shown in **Figure 5-8**.

Table 5-14 summarises the key findings from the assessment.

Figure 5-8 : East-west active mode connections with both Spartan Road and Manuroa Road included and excluded

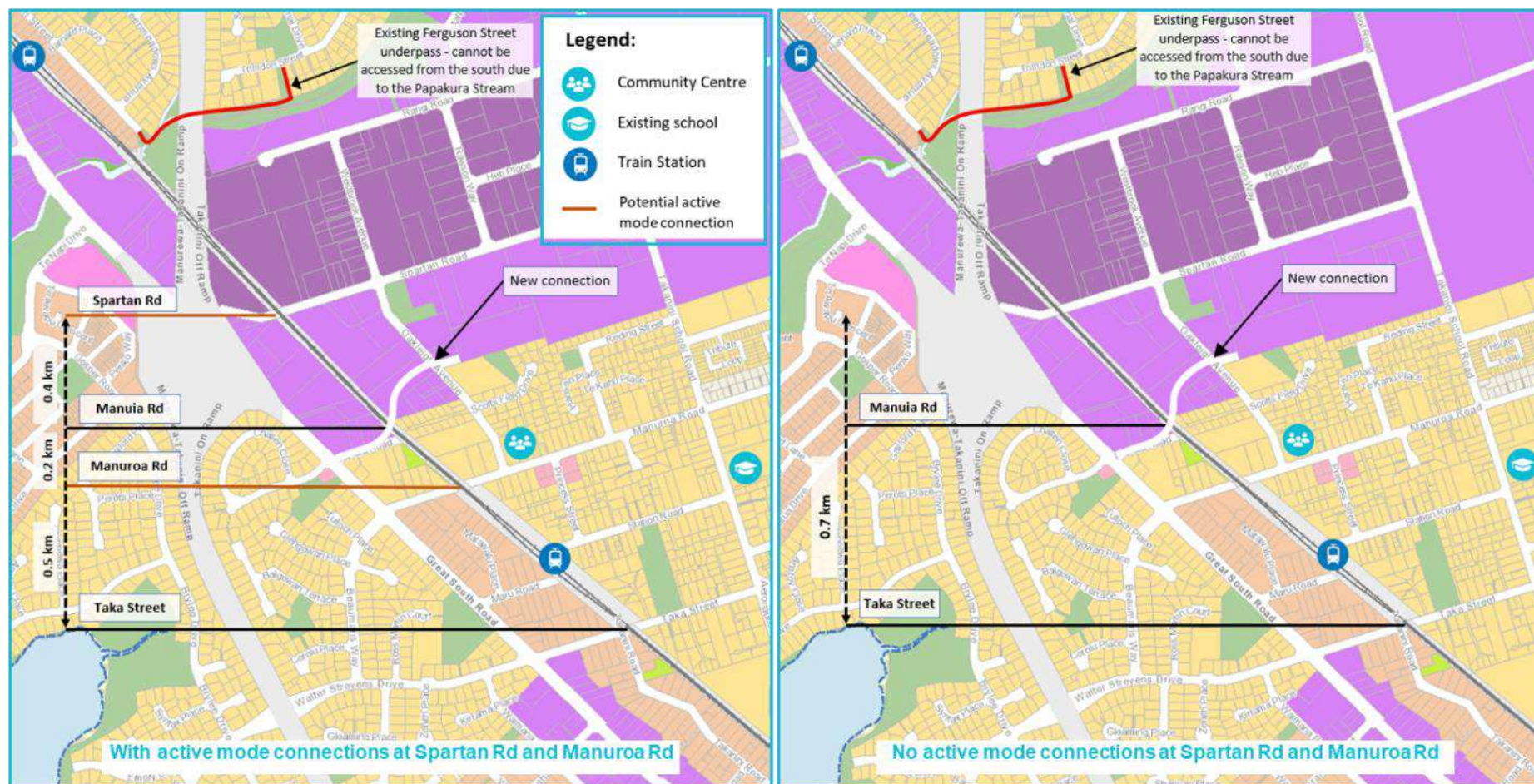


Table 5-14 : Summary of assessment findings

Factors explored in the assessment	Spartan Road	Manuroa Road
Land use	Business – Heavy Industry or Business – Light Industry Zone Expected to remain industrial with the potential to intensify in the future. This would indicate an increase in walking and cycling demand for this east-west connection in the future.	Residential – Mixed Housing Suburban or Residential – Mixed Housing Urban Zone A childcare centre, neighbourhood centre, community centre, Takaanini School and Takaanini Train Station are in the vicinity of the existing level crossing. This indicates a need for a walking and cycling connection at this location so people can easily access the community centre and facilities within the vicinity. It is also expected that the land use surrounding the Takaanini Station may intensify due to emerging policies around the National Policy Statement for Urban Development (NPS:UD) and the Medium Density Residential Standards (MDRS). This would further increase the need for an active mode connection at Manuroa Road in the future.
Connectivity	<u>Current facilities</u>: Footpaths on both sides of the corridor. No existing cycling facilities. <u>Future facilities</u>: Western section of Spartan Road connects with Great South Road (GSR) which is expected to have separated walking and cycling facilities on both sides of the corridor. A Spartan Road active modes bridge would enable connectivity to the Southern Path access point, located at the SH1 northbound off ramp at the Takaanini interchange.	<u>Current facilities</u>: Footpaths on both sides of the corridor. No existing cycling facilities. <u>Future facilities</u>: Western section of Manuroa Road connects with GSR which is expected to have separated walking and cycling facilities on both sides of the corridor. In the future, it is expected that a potential east-west active mode connection at Manuroa Road will enable access to the Takaanini Train Station. Takaanini Train Station master planning is currently underway and there will be future opportunities to integrate an

Factors explored in the assessment	Spartan Road	Manuroa Road
		east-west active mode connection at Manuroa Road with the station.
Forecast pedestrian and cyclist counts Note these are modelled numbers based on the planned development. Thus, actual numbers will be dependent on if and when development happens.	<u>2018:</u> 80 pedestrians and 40 cyclists per day <u>2028:</u> 240 pedestrians and 130 cyclists per day <u>2048+:</u> 410 pedestrians and 250 cyclists per day The walking and cycling demand is expected to increase over the next 30 years. Hence, an active mode connection at Spartan Road will accommodate the expected demand and increase east-west connectivity in the network.	<u>2018:</u> 180 pedestrians and 10 cyclists per day <u>2028:</u> 200 pedestrians and 30 cyclists per day <u>2048+:</u> 540 pedestrians and 60 cyclists per day The walking and cycling demand is expected to increase over the next 30 years. Hence, an active mode connection at Manuroa Road will accommodate the expected demand and increase east-west connectivity in the network.
Diversion routes – additional distance if closed	Without an active mode connection at Spartan Road, pedestrians and cyclists wishing to travel between Te Mahia and the Takaanini industrial area are expected to travel an additional 600m. This is equivalent to approximately 7 minutes of additional walk time. This diversion distance and additional journey time is undesirable/ inconvenient and may reduce the number of people shifting towards active modes.	Without an active mode connection at Manuroa Road, pedestrians and cyclists wishing to travel between GSR near Challen CI and east the rail line, are expected to travel an additional 300m (walk time of approximately 4 minutes). This is further exacerbated if through movement via the Takaanini Train Station is not permitted in the future. Pedestrians and cyclists are expected to travel an additional 450m (walk time of approximately 5.5 minutes) to St Aidans Reserve. These diversion distances and additional journey duration are considered undesirable/ inconvenient and may reduce the number of people shifting towards active modes.

The assessment concluded that there is a strong case for **providing east-west active modes connection at both Spartan Road and Manuroa Road** for the following reasons.

At Spartan Road given:

- It is expected that walking and cycling demand will increase on Spartan Road, contingent on the development of the industrial zone surrounding Spartan Road. The active modes connection will provide access to jobs in the future, given the expected increase in jobs in the Takaanini industrial area.
- The policy context regarding climate change, provides clear indication for the provision of active modes where possible. This east-west connection will accommodate the anticipated uptake of active modes and/or encourage people to shift to active modes.
- Route distances are impacted for those travelling north from the industrial area when Spartan Road is closed in the network. Diverted routes are approximately 600m longer for those travelling north. There are no other active mode connections north of Spartan Road in the industrial area, and south of the Papakura Stream. Hence, the Papakura Stream acts as a barrier for active modes users travelling to and from the north. This emphasises the importance of the need for an east-west connection at Spartan Road to access places such as Te Mahia Station.
- Providing a connection at Spartan Road will increase active mode permeability across the southern rail line in the Takaanini network. This connection is also in between Te Mahia and Takaanini train station, hence, has the opportunity to increase commuter trips to rail.
- An active mode bridge replacement is needed to mitigate the effects of level crossing closures at this location.

At Manuroa Road given:

- This connection will increase active mode permeability across the southern rail line in the Takaanini network. Manuroa Road is also in proximity to local and key destinations in the vicinity such as:
 - Takaanini School
 - Takaanini Train Station
 - Neighbourhood centre: post shop, dairy, local supermarket, laundromats etc
 - Community centre/ church
- The policy context regarding climate change, provides clear indication for the provision of active modes where possible. This east-west connection will accommodate the anticipated uptake of active modes and/or encourage people to shift to active modes.
- In the likely instance where there is no east-west through connection via Takaanini Station, there is expected to be longer diversion routes for pedestrians and cyclists travelling north and south from Manuroa Road if there is no east-west connection provided here. These diversion routes are 300m – 500m longer.
- Current pedestrian and cyclist data show that people are using the existing Manuroa Road east-west connection to cross over the rail line. It is expected that walking and cycling demand will increase in the future, especially given evolving land use decisions on intensification around stations with the NPS:UD and MDRS. Hence this east-west connection plays a critical role for access in the future network.

- An active mode bridge replacement is needed at this location to mitigate the effects of level crossing closures at this location.

Active modes connections to be provided at Spartan Road and Manuroa Road to increase active mode connectivity and encourage active mode uptake.

5.5.4.1 Emerging preferred network

The emerging preferred network which was confirmed with owners and stakeholders is shown in **Figure 5-9**. The main difference between this and the IBC recommended option is Rangi Road is no longer part of the network. Manuia Road will instead provide access to the Takaanini Industrial area.

Figure 5-9 : Emerging Preferred network



5.6 Route Refinement

5.6.1 Form and Function Refinement

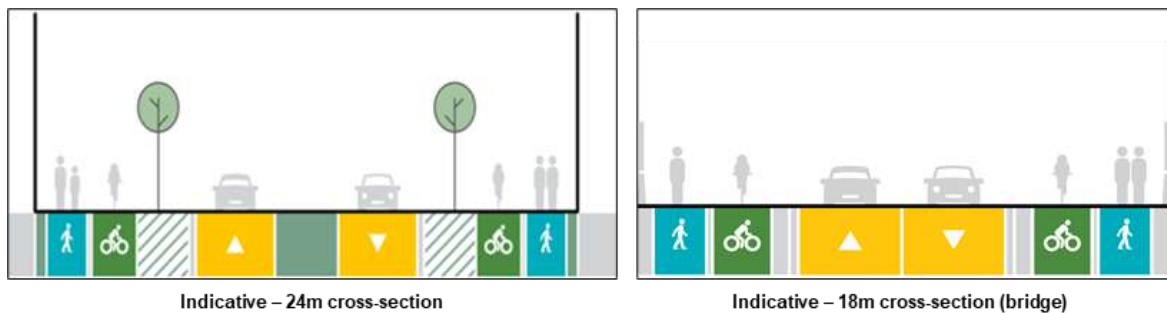
The following sections details the route refinement process undertaken for the emerging preferred option. Route refinement considers the alignment variations to avoid identified constraints where possible. As part of the route refinement process, corridor and intersection assessments were undertaken which are detailed below.

5.6.1.1 Corridor Assessment

The Corridor Form and Function (CFAF) process was used for the purpose of defining a desired cross-section for the identified east-west cross sections. As part of this process SMEs were consulted for endorsement allowing for high engagement and design efficiency.

The assessment has indicated a two-lane corridor with the following proposed future cross-sections for all corridors as shown in Figure 5-10.

Figure 5-10 : Indicative Cross-Sections



Details of the RSAF and CFAF assessment may be found in **Appendix G: Transport Outcomes Report** of the DBC.

5.6.1.2 Intersection Assessment

In parallel to the CFAF, a process was undertaken to identify the likely future intersection form and function of intersections for the emerging preferred. The purpose of this process was to identify the indicative intersection controls and subsequent footprint implications. It is noted that the final decision on the form and control of the intersections could be modified when further land use certainties are known at time of implementation.

Table 5-15 shows the intersections analysed as part of this DBC. Note that as Great South Road is part of the FTN route within the FTN DBC, intersections such as Great South Road and Manuroa Road will be captured there instead as the works required will be mostly related to the FTN.

Further details of the assessment may be found in **Appendix G: Transport Outcomes Report** of the DBC.

Table 5-15 : Takaanini Level Crossings Indicative Intersection Forms

Intersection	Recommendation	Comment
Manuia Road (new connection)		
Great South Road/ Manuia Road	Signalised intersection	Connected Communities is proposing to signalise this intersection.
Manuia Road/ Oakleigh Avenue/ Hitchcock Road	Single lane roundabout	New intersection with Hitchcock Road.
Walters Road		
Walters Road/ Arion Road	Retain existing signalised intersection	Adjacent commercial and residential land use
Walters Road/ Great South Road	Will remain as a roundabout and will be assessed as part of the FTN DBC given bus priority measures are required.	
Tironui Road/ Walters Road	Left in left out	Located approximately 40m from the Walters Road roundabout. Provides access to the industrial/ commercial area.
Taka Street		
Taka Street/ Great South Road	Will remain as a signalised intersection and will be assessed as part of the FTN DBC given bus priority measures are required.	
Taka Street/ Kauri Heart Ave	Retain existing single lane roundabout	This is a recently upgraded intersection and physical works for the level crossings will end prior to the intersection.
Manuroa Road		
Manuroa Road/ Great South Road	Will remain as a signalised intersection and will be assessed as part of the FTN DBC given bus priority measures are required.	
Manuroa Road/ Oakleigh Ave	Retain priority intersection	The cul-de-sac works of Manuroa Road will mean less traffic will use this intersection, as such no works are proposed at this intersection.
Spartan Road		
Spartan Road/ Great South Road	Will remain as a signalised intersection and will be assessed as part of the FTN DBC given this will be more impacted by FTN works.	
Spartan Road/ Westbrook Ave	Retain priority intersection	The cul-de-sac works will mean less traffic will use this intersection, as such no works are proposed at this intersection.

5.6.2 Alignment Refinement

The corridor and intersection form and function specifies the requirements for the emerging preferred options to be further designed. The design for the three grade separated bridges (Manuia Road, Walters Road and Taka Street) and the active mode connections (Manuroa Road and Spartan Road) included the consideration of:

- Vertical alignment
- Horizontal alignment
- Property access – in particular driveway access for existing corridors

Full details of the design process, assumptions and decisions are detailed in **Appendix H: Design Report** of the DBC.

Options for each corridor were explored and assessed by the Project Team and specialists where required. The same MCA framework was adopted for assessment with details provided in the following sections.

5.6.2.1 Manuia Road

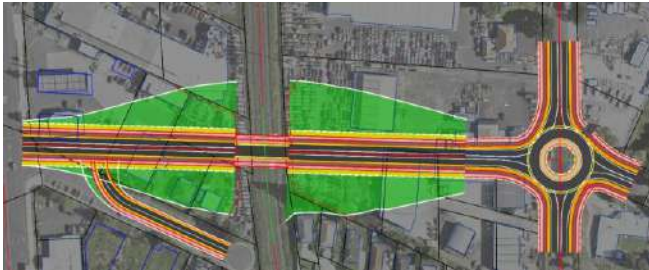
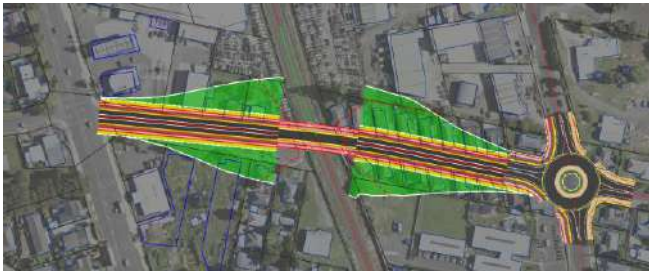
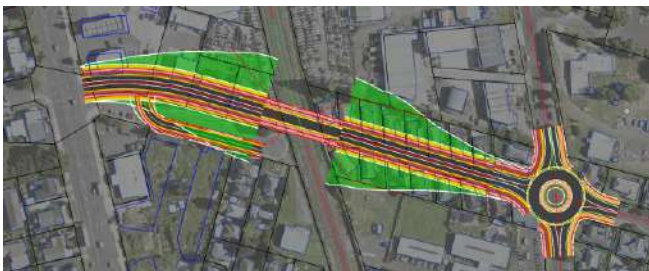
With Manuia Road being a new connection between Great South Road and Oakleigh Avenue, a number of different alignments were explored that had differing impacts. All options have the following assumptions:

- 24m corridor (2 lanes) with walking and cycling facilities
- Design speed of 50km/hr
- Structure clearance road to rail of 7.8m
- Max vertical grade up to 8%
- Horizontal curve minimum radii of 120m

The options and descriptions are shown in **Table 5-16**.

Table 5-16 : Manuia Road Route Refinement Options

Option	Design	Description
1		Maximise use of existing Manuia Road and intersection form with GSR. High skew structure crossing of NIMT. Bridge length of approximately 35m.

Option	Design	Description
2		Realigns intersection with GSR to safer form. Tie in with existing intersection with Hitchcock Road (to be changed to roundabout). Access provided to existing properties on southern side of Manuia Road. Bridge length of approximately 30m.
3		Maximise use of existing Manuia Road and intersection form with GSR. Tie in with Portrush Lane and existing intersection with Scotts Field Dr (to be changed to roundabout). Removes access to all existing properties on Manuia Road. High skew structure crossing of NIMT. Bridge length of approximately 35m.
4		High skew structure crossing of NIMT. Realigns intersection with GSR to safer form. Tie in with Portrush Lane and existing intersection with Scotts Field Dr (to be changed to roundabout). Access provided to existing properties on southern side of Manuia Road. Bridge length of approximately 35m.
5		Transport oriented alignment prioritising industrial movement to/from NE. Realigns intersection with GSR to safer form. Access provided to existing properties on southern side of Manuia Road. Bridge length of approximately 30m.

These were assessed using the MCA framework and the findings are shown in **Table 5-17**.

The key outcomes from the assessment are:

- All options score favourably against the investment objectives as they are expected to provide similar outcome and there are no real differentiating factors.

- **Option 2** is anticipated to provide the greatest benefit. It scores the best for urban design and user safety due to it being the most direct and legible option. It will also provide a clear delineation between industrial and residential land use. The option scores -2 for construction costs/risk/value capture as opposed to -3 for all other options.
- **Options 3 and 4** are anticipated to have the greatest land requirements with no real additional benefits when compared with the other options.
- **Option 5** is expected to have the worst urban design outcomes due to its lack of legibility, severance of industrial land and large residual parcels. It is also anticipated to have the greatest ecological effect as it could impact the ecological features adjacent to Oakleigh Ave and Hitchcock Road.

Table 5-17 : Summary of Manuia Road route refinement MCA assessment

Criteria	Scoring				
	1	2	3	4	5
Investment Objective 1: Safety					
Investment Objective 2: Travel Choice					
Investment Objective 3: Resilience					
Investment Objective 4: Access					
Land Use Futures					
Urban Design					
Land Requirement					
Social Cohesion / effects					
Human Health and Wellbeing					
Transport system integration					
User safety					
Ecology					
Historic Heritage					
Landscape / Visual					
Stormwater					
Natural Hazards					
Construction impacts on utilities / infrastructure					
Construction disruption					
Construction costs / risk / value capture					

Thus, Option 2 is identified as the preferred option/alignment for Manuia Road as it is anticipated to provide the greatest benefits with the least impacts.

Option 2, alignment between the existing Hitchcock Road intersection and realigned intersection with Great South Road is identified as the preferred option for Manuia Road.

5.6.2.2 Taka Street and Walters Road

Identification of constraints was undertaken prior to exploring potential alignment variations for the grade separation of Taka Street and Walters Road.

This identified for Walters Road (as shown in **Figure 5-11**):

- **Eastern side of the rail line** – The southern side is predominantly residential whereas the northern side has a large shopping complex. This shopping complex should be avoided where possible to minimise the associated property risks and impact on community amenity. The existing intersections of Arion Road and Braeburn Place need to be carefully considered to ensure adequate access is maintained.
- **Western side of the rail line** – both sides of Walters Road are commercial land uses including a childcare centre, Carters, and car service centres. Thus, there is no strong argument to avoid a specific commercial business over another but noting that adequate access will need to be provided if impacted.

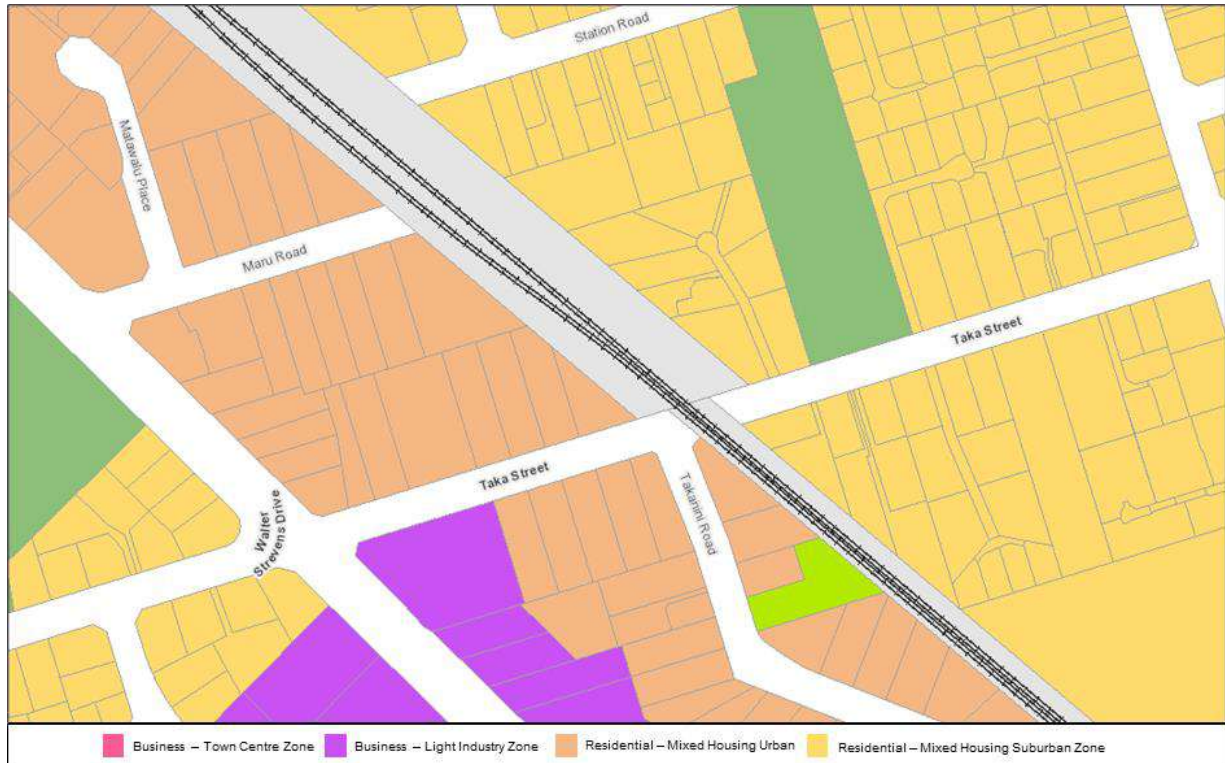
Figure 5-11 : Walters Road surrounding land uses



For Taka Street (as shown in Figure 5-18):

- **Eastern side of the rail line** – Predominantly residential with a number of long driveways that services a group of properties. There is the Takanini Reserve on the northern side adjacent to Cathy Lane. Access to properties needs to be considered.
- **Western side of the rail line** – Mixed residential and commercial properties including a care centre and childcare centre on opposite sides. Access to properties needs to be considered. Takaanini Road needs to be carefully considered to ensure adequate access is maintained.

Figure 5-12 : Taka Street surrounding land uses



Following on from the constraints analysis, alignment variations to gain enough clearance for the bridge to cross the rail line were considered between the following locations:

- Walters Road – Great South Road and Porchester Road
- Taka Street – Great South Road and Takaanini School Road

The project team considered that there was no strong evidence to develop ‘off-line’ variations i.e. shifting the existing road alignment north or south as:

- An ‘on-line’ option using the existing road alignment could avoid/ mitigate some of the constraints identified.
- Deviation from the existing road alignment would be more disruptive especially from a property perspective.
- Deviation from the existing road alignment would be more complex to construct as it would require a non-linear alignment to tie back into the existing straight road.

Thus, ‘on-line’ options were developed for Taka Street and Walters Road as shown in Figure 5-11 and Figure 5-14, respectively.

Figure 5-13 : Taka Street 'online' option



Figure 5-14: Walters Road 'online' option



5.6.2.3 Manuroa Road and Spartan Road

The closure of the level crossings at Manuroa Road and Spartan Road will require cul-de-sacs on either side of the rail line. In addition, active mode bridge connections are proposed at both locations.

The cul-de-sacs are designed as per the AT TDM standards and design of the active mode connections allow the flexibility of either a bridge or underpass to be implemented at a future date at Spartan Road, and a bridge with stairs or lifts at Manuroa Road. An underpass would not be suitable at Manuroa Road due to it being in a flood plain and in poor ground conditions (peat soils). The location and flexibility requirements in the design of these crossings have been discussed and agreed with AT.

The location for the cul-de-sac and active mode connection at Spartan Road considered where there may be less property impacts such as avoiding buildings where possible. For Manuroa Road, consideration was given to integrating with the Takaanini Train Station which sits on the southern side.

Figure 5-15 and **Figure 5-16** below shows the designations at Spartan Road and Manuroa Road, respectively. It is worth noting that, there is flexibility in the designation shown and future design phase of the project, the area shown may be minimised through value engineering.

Figure 5-15 : Spartan Road designation for cul-de-sac and active mode connection

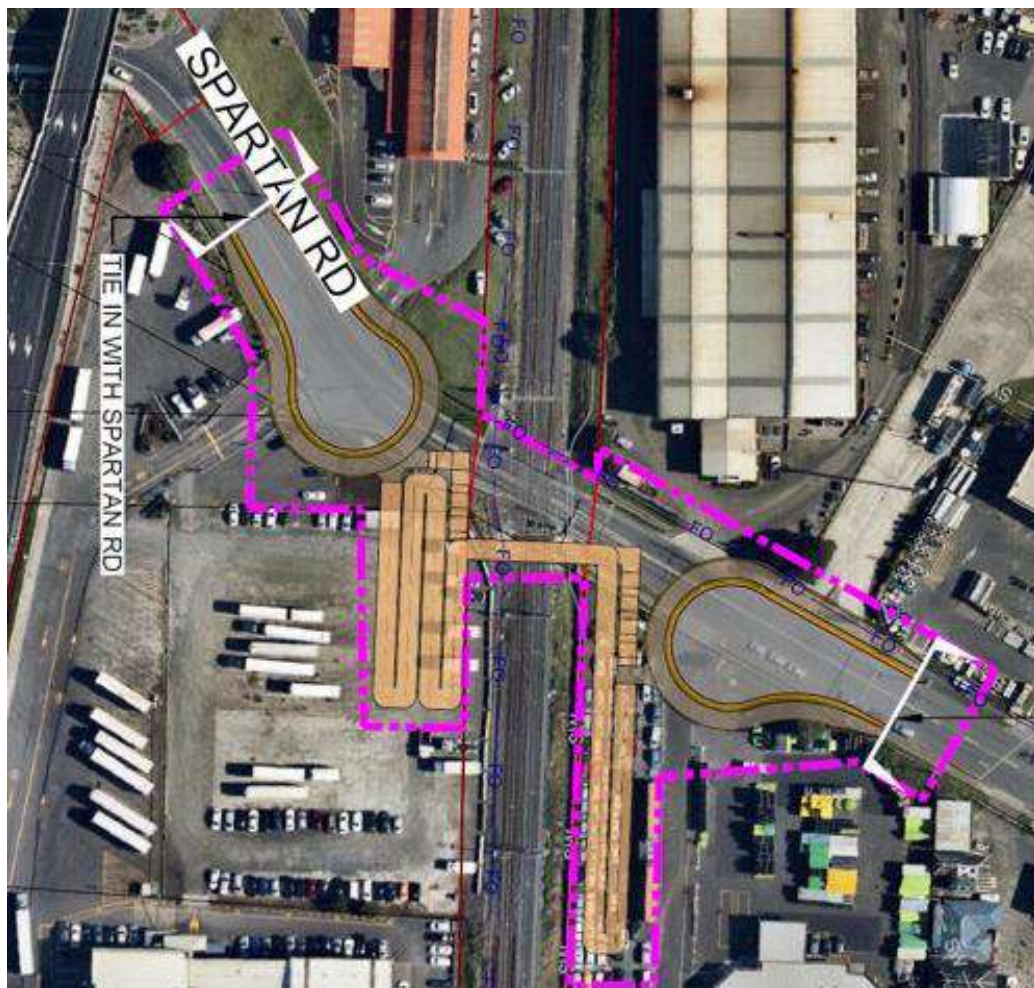
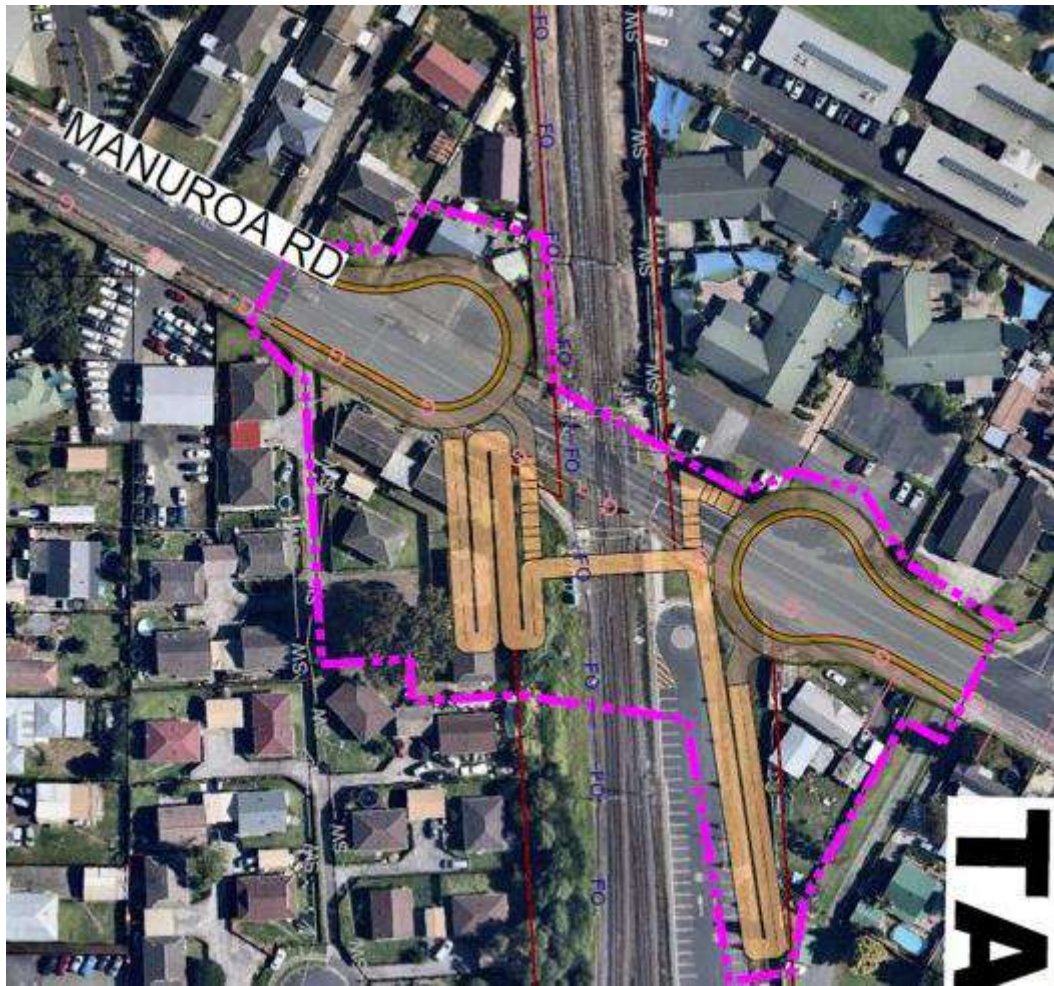


Figure 5-16: Manuroa Road designation for cul-de-sac and active mode connection



5.7 Owner, project partner, stakeholder, community, and landowner engagement

This section summarises the engagement undertaken with owners, project partners, stakeholders, and the public. More details may be found in **Appendix E: Engagement Summary Report** of the DBC.

5.7.1 Owner engagement

Te Tupu Ngātahi has ongoing engagement with Waka Kotahi and Auckland Transport throughout the development of the DBC. Led by Owner Interface Managers, the project team has regularly collaborated with subject matter experts from the organisation to ensure technical and strategic alignment of the DBC. Forums have included:

- Regular technical sessions and workshops to discuss corridor and intersection form and function, design standards, and emerging options.
- Specific sessions to discuss design assumptions, key principles, or specific design issues.

Of particular note, a workshop was held on the 24th August to present the Rev A design of the preferred level crossings option designation. This allowed Subject Matter Experts (SMEs) from both organisations to ask questions and provide feedback. Subsequent meetings were also held with relevant SMEs to close out any outstanding comments.

Key themes of feedback received:

- There needs to be integration with the Takaanini Station Masterplan at Manuroa Street. The masterplan study has yet to commence, and any integration will need to be considered when the study starts.
- Allowance for four-tracking – the design caters for four-tracking based off the latest four-tracking plans available and the designation allows for some degree of flexibility.
- Design refinements including design for safe system and pedestrian crossings. The current designation would not preclude any safe system design or further design refinements later.

5.7.2 Project partner engagement

5.7.2.1 Manawhenua

Te Tupu Ngātahi recognises the responsibilities and commitments of engagement with Manawhenua as a Treaty Partner. We maintain a Manawhenua forum (for operational and kaitiaki level interaction) and enable linkages with the wider governance level relationships of Waka Kotahi and AT via the Tāmaki Transport Table and Auckland Council Kaitiaki Governance Table. The focus of this group is Programme-wide delivery, particularly seeking consistency across projects.

Between late 2021 and 2022, Te Tupu Ngātahi attended a number of Manawhenua hui and site visits. These provided insights on aspirations and issues of Manawhenua. The discussions included:

- Overview and updates on the Takaanini Level Crossings project
- Opportunities to provide input on the Options Assessment process
- Importance of ecological and environmental areas

Feedback obtained from Manawhenua was incorporated in the development of options and to confirm the emerging preferred option.

5.7.2.2 KiwiRail

Te Tupu Ngātahi has engaged with KiwiRail throughout the development of the DBC. This included meetings to share and discuss information including:

- Understanding the plan for 4-tracking through the area
- Design assumptions being made by Te Tupu Ngātahi
- Feedback on the preferred option design

Participants from KiwiRail also attended the Rev A design workshop held on the 24th August with other SMEs.

5.7.3 Community and landowner engagement

Engagement with the wider community occurred between 12th August and 26th September 2022. Online engagement tool 'The Hive' was used to gather feedback. In addition, 380 letters were sent to affected landowners in early August 2022. Individual meetings were also held with key stakeholders including NZ Heavy Haulage Association, and Kāinga Ora Homes and Communities.

Overall, respondents generally agreed with the removal of level crossings as a good safety initiative. However, feedback received included:

- Opposition to the closure of Spartan Road and Manuroa Road and the decision to replace these crossings with a new offline structure at Manuia Road, and
- Consideration should be given to other grade separation forms instead of a bridge especially at Walters Road. Various community feedback suggested an underpass instead.

5.8 Confirmation of physical form of grade-separation

5.8.1 Context

As set out in the optioneering methodology at section 5.5.1 above, the preferred physical form of grade separation was retested in greater detail following the scenario-based network optioneering and engagement process. Given the conclusions reached through the interim assessment of physical form options (see section 5.5.2.3), this retesting was limited to an assessment of the merits of a road-over-rail bridge compared with a road-under-rail underpass. The Te Tupu Ngātahi MCA Framework was used as the main tool for comparing these two grade separation form options.

Walters Road was used as the first case study for this assessment given that much of the feedback on the form of grade separation received through the engagement process pertained specifically to the Walters Road location.

5.8.2 Options assessed

Options were developed for both a bridge and underpass based on the design parameters summarised in Table 5-7 above (see section 5.5.2.2).

5.8.2.1 Road-over-rail bridge option

In following the design parameters and clearance requirements summarised in Table 5-7, the bridge option assessed for Walters Road was proposed as a 250m multi-span structure over the NIMT.

Vertical grades of up to 8% were considered, and at-grade access lanes were proposed to main access to existing/remaining properties. The concept design which formed the basis of assessment is illustrated in the figure below.



Figure 5-17 – Walters Road bridge option – concept design

5.8.2.2 Road-under-rail underpass option

Concept design

In following the design parameters and clearance requirements summarised in Table 5-7, a road-under-rail underpass option has been developed. This would comprise a road underpass (tunnel) of approximately 90m in length and with around 100m of approaching road retained in cut. The vertical grade is steepened to 8% to the east of the rail, to approach ground level near Arion Road. The intersection with Arion Road is required to be reconstructed to a lower vertical level to provide acceptable road geometry. At-grade access lanes are proposed to maintain access to existing properties. The concept design which formed the basis of assessment is illustrated in the figure below.



Figure 5-18 – Walters Road underpass option – concept design

Assumed ground conditions and implications for concept design

The form of the trench structure for the underpass option assessed in the MCA was based on a conceptual arrangement accounting for known ground conditions. The ground conditions adopted as the basis for MCA assessment were based on review of publicly available site investigation data from the New Zealand Geotechnical Database, and recent project experience in similar ground conditions. Due to the absence of site-specific data, a single geological profile was adopted for the purposes of MCA assessment, and is summarised as follows:

- 0-2m below ground level (bgl) – Fill;
- 2-12m bgl – Peat [Ardmore Member];
- 12-18m bgl – Soft Clay [Takaanini Formation];
- 18-30m bgl – Stiff Alluvium [Takaanini Formation];
- Unknown depth to the top of Waitematā Group rock; and
- An assumed groundwater level of 2m bgl.

These assumed ground conditions informed the key features of the trench structure concept design adopted for the purposes of MCA assessment as follows:

- For the section of trench with a total excavation depth ranging from 5-9m bgl:
 - 900mm diameter soft/hard reinforced concrete bored pile secant walls to support the excavation at a depth of 21m bgl, with every fourth (hard) pile extended to 28m bgl for vertical support;
 - Temporary props at 2.5m vertical centres to support the excavation;
 - A floor slab of 1.2m thick reinforced concrete, with the deepest road level being approximately 7.5m bgl;
 - Steel screw piles at 5m centres beneath the road centre line to a depth of 23m bgl;
 - A permanent prop at the top of the wall or reinforced concrete bridge deck slab to support the NIMT.

- For the section of trench with a total excavation depth of up to 5m bgl:
 - Temporary excavation to 2m depth along the trench alignment;
 - 13m deep temporary sheet pile wall for excavation support and construction groundwater cut-off;
 - A temporary prop to support the excavation;
 - Permanent reinforced concrete floor (0.8m thick) and cantilever walls (0.6m thick); and
 - Steel screw piles under the flood on a 5m grid to a depth of 23m.
- Steel screw piles beneath the road centre line to a depth of 23m bgl.

These concept design assumptions were considered to be suitable for the purposes of route protection option assessment.

5.8.3 Option assessment

The MCA scoring from the assessment of the bridge and underpass options is summarised in **Table 5-18** below.

Table 5-18 – Walters Road options – MCA scoring

Criteria	Scoring	
	Bridge	Underpass
Investment Objective 1: Safety		
Investment Objective 2: Travel Choice		
Investment Objective 3: Resilience		
Investment Objective 4: Access		
Historic heritage		
Land Use Futures		
Urban Design		
Land Requirement		
Social Cohesion / effects		
Human Health and Wellbeing		
Landscape / Visual		
Stormwater		
Ecology		
Natural Hazards		
Transport system integration		
User safety		

Criteria	Scoring	
	Bridge	Underpass
Construction impacts on utilities / infrastructure		
Construction disruption		
Construction costs / risk		

From the above MCA assessment and accompanying commentary, the following key differentiators between the options were identified (in the order assessed):

- **Investment objectives** – Both options scored the same against three of the four investment objectives relating to safety, travel choice, and accessibility defined in the DBC – both options were scored as positive for these objectives. Under the resilience objective, the bridge option was preferred over an underpass given that an underpass is more susceptible to flooding;
- **Urban design** – The bridge option was scored as a neutral impact – the scale and interface impacts of a bridge were assessed as being balanced out by the positive effects of east-west connectivity and reduced community severance. The underpass was not preferred. While the same positive effects as a bridge were identified in terms of promoting east-west connectivity, the underpass option was assessed as being a poorer outcome in terms of Crime Prevention through Environmental Design (CPTED) given the personal safety risks associated with the underpass as a movement predictor, entrapment zone, isolated area; and the relatively poorer outcomes in terms of lighting, sightlines, surveillance, perceived safety, potential for vandalism/graffiti, and noise/air quality. Moreover, the underpass was assessed as a poorer outcome for active modes given the noise and air quality issues for active mode users associated with enclosed spaces;
- **Land requirements** – Both options were scored the same against the land requirement criterion given the broadly similar third-party land requirements. Notwithstanding this, the underpass will require some additional land not otherwise required for a bridge related to the temporary rail diversion assumed as part of the construction methodology for an underpass (see construction disruption below), and to allow for sufficient space for settlement mitigation allowances for potential ground settlement effects (e.g. separation between adjacent buildings and trench excavations);
- **Landscape and visual** – The underpass option was preferred on this criterion given that it would have lower visual impacts compared with a bridge. The underpass will still have localised visual effects and will represent a new feature in the environment. The bridge was less preferred on this criterion given the visual impacts (without mitigation) of a bridge structure in the context of commercial, industrial, and residential surroundings;
- **Stormwater** – The bridge option was preferred under this criterion on the basis that an underpass would require groundwater management (seepage pumping) and flood pumping in all events exceeding the capacity of existing stormwater infrastructure. The bridge was also noted as potentially affecting existing overland flow paths;
- **Natural Hazards** – The bridge option was preferred under this criterion on the basis that the high groundwater table and deep soft ground conditions (key assumptions documented at 5.8.2.2

above) present greater construction challenge and risk for an underpass. The ground is susceptible to settlement if loaded or if the groundwater is lowered, which in turn may impact on existing structures and services surrounding the site;

- **Construction impacts on utilities/infrastructure** – The bridge option was preferred under this criterion on the basis that an underpass would necessitate relocation of an existing stormwater pipe, local utilities, and a fibre cable not otherwise required by a bridge. The level of disruption for the rail corridor was also greater for an underpass (note this is also addressed below in construction disruption);
- **Construction disruption** – The bridge option was preferred under this criterion given that the assumed construction methodology for a bridge would be limited to disruptions to local property access and road traffic, with relatively limited rail disruption. The underpass option was not preferred on the basis that the construction methodology was assumed to require either prolonged closure of the NIMT (exceeding the duration of a typical block-of-line), or temporary realignment of the NIMT which would result in greater land requirements (see above); and
- **Construction costs/risk** – The bridge option was preferred under this criterion on the basis that high groundwater table and deep soft peat ground conditions present significant construction challenge and risk for an underpass. An underpass would require cut-off walls along both sides of the excavation to prevent groundwater drawdown/ground settlement (see 5.8.2.2 above), and that the construction of these walls would result in significant rail disruption (see above). Moreover, the completed structure would be below the groundwater table and therefore buoyant, thus requiring anchoring in place. Finally, it is noted that DBE costing of the two options assessed was completed following the MCA process, and indicated that an underpass would be 2-3 times the cost of a bridge.

5.8.4 Preferred option

On the basis of the above assessment, the road-over-rail bridge option was identified as a clear preference for the Walters Road location.

The key constraints identified in the above assessment for the underpass option relating to ground conditions, construction complexity, lack of resilience, and urban design and safety concerns for the community would also apply to the Taka Street context. Accordingly, a potential underpass option was also not preferred for that location.

5.9 Design refinement

Following on from feedback received, further design refinement was undertaken which will be incorporated into the design for the NoR.

6 Final retesting of Walters Road physical form – June-September 2023

6.1 Context

The assessment documented from in Section 5 of this report informed the technically preferred options for the TLC identified in the DBC as of 30 May 2023 – both in terms of the number and location of grade-separated crossings of the NIMT for the future network; and the physical form of grade-separation. The optioneering process **to this point** is summarised in the figure below.

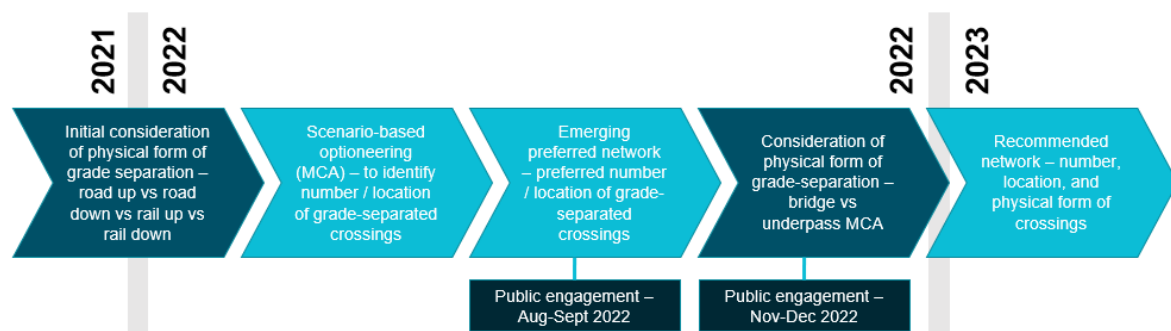


Figure 6-1 - TLC optioneering process to May 2023

A decision on endorsing the recommended DBC options was sought from the AT Board in May 2023. At this time, the Board approved the DBC recommendations as they related to four of the five project areas – Spartan Road, Manuia Road, Manuroa Road, and Taka Street. Immediately prior to the AT Board meeting, new design and technical information was received by AT regarding a potential alternative underpass design for the Walters Road crossing proposed by the Takanini Group (TG).⁴

Consequently, the Board's decision as it related to the Walters Road project area was deferred to enable further consideration of the merits of bridge and underpass options in this location, in addition to the optioneering already completed and documented at section **Error! Reference source not found.** The Board's instruction to further consider these matters was to allow time for the additional design and technical information provided by TG to be evaluated and considered by the Project Team together with TG experts, and to allow for further Local Board and community engagement on these matters.

The Project Team has therefore retested previous optioneering as it relates to the physical form of grade separation at Walters Road in response to these concerns, and in light of the new information received. To that end, this section of the report documents:

- New information received from TG (see section 6.2);
- The Project Team's consideration of the new information, in particular the implications of new information in the context of MCA assessment previously undertaken (see section 6.3);
- Retesting of the previous MCA assessment responding to the above considerations and recommendations (see section 6.4); and

⁴ A collective entity comprising Takanini Village Limited, Tonea Investments Limited, the Takanini Business Association, and associated local community groups.

- Further engagement undertaken following the May 2023 Board direction (see section 6.5).

6.2 New information received

New information received from TG experts comprised the following:

- Reports from Riley Consultants Limited dated 16 May 2023 outlining an alternative underpass design ('the first TG underpass') developed for the Walters Road location. The reports contain design drawings and commentary on comparative land requirements, costs, and constructability of the first TG underpass as compared with the bridge option preferred in the assessment by Te Tupu Ngātahi;
- Two reports by Coffey Geotechnics NZ Limited from 2011 and 2012 documenting ground investigations undertaken for the 30 Walters Road site; and
- One report provided by Richard Knott Limited dated 26 July 2023 comparing bridge and underpass options from an urban design and visual effects perspective.

The information contained in the above reports was discussed extensively in meetings between Te Tupu Ngātahi and TG experts.

6.3 Implications of new information for assessment

6.3.1 Alternative underpass designs

May 2023 – First TG Underpass

The first TG underpass option documented in the May 2023 Riley reports differed from the underpass concept assessed and not progressed earlier by Te Tupu Ngātahi (described and documented in section **Error! Reference source not found.** of this report). The key differences in design parameters between Te Tupu Ngātahi and the first TG underpass option are outlined in Table 6-1 below.

Table 6-1 - Differences in design parameters between Te Tupu Ngātahi and TG

Design Parameter	Te Tupu Ngātahi Underpass	First TG Underpass
Maximum underpass depth	7.5m	7.05m
Minimum vertical clearance	6m	5.05m
Minimum grade	0.5%	0%
Maximum grade	8%	8%
Minimum crest curve	K=8	K=5
Minimum sag curve	K=6	K=3
Four-tracking provided for?	Yes	No
Resultant longitudinal extent	315m	255m

Design Parameter	Te Tupu Ngātahi Underpass	First TG Underpass
Road cross-section width	18m	20.9m

TG experts considered that their underpass design would require less land than the underpass concept developed by Te Tupu Ngātahi and would be less costly and complex to construct than assumed by Te Tupu Ngātahi. On this basis, TG experts considered that the TG underpass should be considered as a viable option in the optioneering process undertaken by Te Tupu Ngātahi and that the preference for a bridge over an underpass identified in assessment to date should be revisited.

Te Tupu Ngātahi engineers analysed the TG underpass in detail and identified that the benefits claimed by the TG experts in terms of the compactness in its underpass design were a function of its shorter overall length. This length in turn is a function of the assumed vertical geometry – i.e. depth, vertical clearances, grades, and vertical curves. The analysis undertaken by Te Tupu Ngātahi found that the vertical geometry parameters assumed in the TG underpass were not compliant with relevant standards in AT's TDM. The noncompliant parameters are summarised in Table 6-2 below.

Table 6-2 - Vertical geometry parameters of the options compared with AT TDM standards

Design Parameter	AT TDM standard	Te Tupu Ngātahi Underpass	TG Underpass
Minimum vertical clearance	6m preferred	6m	5.05m
Minimum grade	0.5%	0.5%	0%
Maximum grade	8%	8%	8%
Minimum crest curve	K=6.8	K=8	K=5
Minimum sag curve	K=6	K=6	K=3

Table 6-2 demonstrates that the claimed greater compactness of the TG underpass design relies on noncompliance with design standards, which would require departures from AT TDM standards to approve. Te Tupu Ngātahi experts did not consider that seeking an NoR on the basis of a noncompliant concept design was appropriate at the current stage of design given that it would limit future design flexibility, and 'lock in' a design with inherent vertical geometry flaws and resultant safety and resilience risks. This view was tested with relevant AT subject matter experts, who agreed that it was appropriate to include risk allowances for design uncertainty at the designation stage. They further noted that lodging an NoR based on minimum or noncompliant dimensional design standards would be unacceptable to AT given the risk of the ultimate design failing to fit within the designation boundaries.

Conversely, adoption of compliant design parameters consistent with those used by Te Tupu Ngātahi would result in a near-identical project extent and land requirement (noting that the underpass concept developed by Te Tupu Ngātahi provides for some flexibility in design by slightly exceeding minimum standards for vertical curves as shown in Table 6-2).

Table 6-1 further identifies differences in provision for future rail widening between the two options. In short:

- The underpass option developed by Te Tupu Ngātahi explicitly provides for the four-tracking of the NIMT as an integral design consideration and project design requirement. The rail ‘bridge’ over the underpass trench was assumed at 28.8m in width to match the horizontal clearance required for four rail tracks, and vertical geometry provides for AT TDM-compliant vertical clearances beneath the rail formation; and
- Conversely, the TG underpass option does not explicitly provide a rail ‘bridge’ over the underpass trench with sufficient width for four rail tracks, but rather assumes that additional tracks could be retrofitted in future. Given the minimum vertical clearance identified in Table 6-1 and Table 6-2, retrofitted tracks would not achieve AT TDM-compliant vertical clearances below the rail, which would present a safety and network resilience risk.

For these reasons, the TG underpass as proposed in May 2023 was **not** considered a viable option. Accordingly, it has not been considered further in the optioneering process undertaken by Te Tupu Ngātahi.

September 2023 TG Underpass

Following extensive discussion regarding these vertical geometry concerns with Te Tupu Ngātahi experts, Riley Consultants provided a revised TG underpass design concept in September 2023. Table 6-3 shows that the revised TG underpass achieves compliance with the relevant AT TDM standards. This in turn results in an additional 30m of length as compared with the initial May 2023 TG underpass, in turn negating much of the claimed advantage of the earlier design in terms of land requirements and associated cost savings.

It is understood that the revised TG underpass also provides sufficient horizontal and vertical clearances to allow for four-tracking.

Table 6-3 - Vertical geometry parameters of revised TG underpass compared with earlier options and AT TDM standards

Design Parameter	AT TDM standard	Te Tupu Ngātahi Underpass	First TG Underpass	Revised TG underpass
Minimum vertical clearance	6m preferred	6m	5.05m	6m
Minimum grade	0.5%	0.5%	0%	0.5%
Maximum grade	8%	8%	8%	8%
Minimum crest curve	K=6.8	K=8	K=5	K=6.8
Minimum sag curve	K=6	K=6	K=3	K=6
Resultant longitudinal extent		315m	255m	285m

The remaining 30m difference between the lengths of the revised TG underpass and the underpass developed by Te Tupu Ngātahi are attributable to differences in assumed vertical curves. As noted above, the underpass design developed by Te Tupu Ngātahi slightly exceeds minimum standards for vertical curves to provide for an appropriate level of future detailed design flexibility, while the revised TG underpass simply adopts minimum standards. As noted above, AT SMEs did not favour lodging an NoR on the basis of minimum standards with no risk margin or allowances for design uncertainty.

Te Tupu Ngātahi experts consider that a near-identical length to the revised TG underpass would be achieved by adopting the same minimum standards, and that this would be possible in future within a

designation footprint informed by the more conservative vertical curves. In short, the options are considered near identical for all intents and purposes.

Accordingly, the revised TG underpass has **not** been considered further in the optioneering process undertaken by Te Tupu Ngātahi, as it is not materially different from an option that has already been assessed and not progressed in section **Error! Reference source not found.** above.

6.3.2 Geotechnical information

Review of Coffey report data

The two reports by Coffey Geotechnics New Zealand Limited (Coffey reports) provided by TG experts were reviewed by Te Tupu Ngātahi geotechnical engineers and hydrogeologists. This review concluded that the data contained in these reports enabled some refinement of the ground profile assumed in the bridge vs underpass MCA undertaken for the Walters Road grade-separation in September 2022, as documented in section **Error! Reference source not found.** of this report (which was derived from publicly available site investigation data). The changes in assumed ground profile are summarised in Table 6-4.

Table 6-4 - Changes in ground profile assumed as a result of the Coffey reports

MCA Ground Profile	Revised Ground Profile
0 – 2 m bgl: Fill	0 – 1.8 m bgl: topsoil and v stiff silt and clay
2 – 12 m bgl: Peat [Ardmore Member]	1.8 – 7.0: organic silt / clay with common rootlets and occasional woody fragments [Ardmore Member]
	7.0 – 8.5: soft to firm silt / clay [Holocene Alluvium]
	8.5 – 9.8: Organic clayey silt with common rootlets, “spongy” [Ardmore Member?]
	9.8 – 11.0: soft silty clay [Takaanini Formation]
12 – 18 m bgl: soft clay [Takaanini Formation]	11.0 – 25.3: very stiff silty clay [Takaanini Formation]
18 – 30 m bgl: stiff alluvium [Takaanini Formation]	14.0 – 15.0: <i>firm to stiff silt / clay</i>
	16.2 – 18.8 <i>loose silty sand</i>
	18.8 – 19.7: <i>firm amorphous peat</i>
	25.3 – EOH: medium dense silty sand [Takaanini Formation]
Unknown depth to top of Waitematā Group rock	
Groundwater level assumed at 2 m bgl	Groundwater level assumed at 1.5 m bgl

From a design perspective, the geotechnical and hydrogeology experts considered that this revised ground profile could enable some reduction in the sheet piling depth for underpass sections requiring less than 5m of excavation – the previously assumed 13m (as set out in section **Error! Reference source not found.**) can be reduced to 10m. This has been estimated by Te Tupu Ngātahi cost estimators to result in a \$610,000 cost saving, which is negligible in the context of the project cost estimate generally.

The change in assumed ground profile was not considered to justify any change to the assumed piling requirements for deeper secant piled wall sections at this stage of design (see below).

Implications of these changes for the MCA assessment are documented at section 6.4.

Validity of TG underpass piling assumptions

Both TG underpass concepts are understood to assume narrower and shallower piling to the underpass option developed by Te Tupu Ngātahi (see Table 6-5).

Table 6-5 - Piling assumptions adopted in Te Tupu Ngātahi and TG underpass concepts

Design Parameter	Te Tupu Ngātahi Underpass	TG Underpasses
Assumed pile depth	23m	15m
Assumed pile diameter	900mm	750mm

TG experts considered that less conservative piling assumptions were appropriate based on the ground conditions at a single Cone Penetration Test (CPT) location at 30 Walters Road near the NIMT documented in the Coffey reports. This CPT shows a reduced peat depth and layers of dense sand that are not present in the assumed ground profile adopted by Te Tupu Ngātahi. TG experts considered that this ground condition justified the less conservative piling assumptions, which in turn would result in significant cost savings as compared with the piling assumptions adopted by Te Tupu Ngātahi (addressed further under costs at section 6.3.3 below).

Te Tupu Ngātahi geotechnical and hydrogeology experts did not agree based on a single CPT location that it was appropriate to adopt narrower and shallower piling assumptions at this stage of design, and further noted that the required depth to achieve groundwater cutoff was the more relevant consideration in determining pile depth and sizing. On this basis, Te Tupu Ngātahi experts consider that its piling assumptions (as documented in section **Error! Reference source not found.** above) remain valid (with the exception of the adjustment to sheet piling depth at shallow excavation depths described above).

Additionally, Te Tupu Ngātahi cost estimators and constructability experts did not agree that adopting the less conservative piling assumptions relied on in the TG underpass design would result in the level of cost savings assumed by TG experts.

The implications of the new information provided by the Coffey Reports and subsequent discussions are that the piling assumptions underpinning the original MCA assessment undertaken by Te Tupu Ngātahi for Walters Road – particularly for the cost and natural hazards scoring – are still considered appropriate by Te Tupu Ngātahi experts. Accordingly, while acknowledging the minor shift in sheet piling requirements, no fundamental change in piling assumptions is assumed to be merited.

6.3.3 Cost Estimates

Cost estimates for the various TG underpass designs were provided in the Riley reports. Based on these estimates, TG experts considered that an underpass could be constructed at less cost than that estimated by Te Tupu Ngātahi; and therefore, that the difference in cost between a bridge and an underpass had been overstated by Te Tupu Ngātahi in its technical recommendations in May 2023.

While noting that different underpass options have been costed by the respective project teams, Te Tupu Ngātahi has considered the Riley costings and notes that there is a fundamental difference in cost estimation approach between the two sets of estimates. Te Tupu Ngātahi cost estimates followed Waka Kotahi Cost Estimate Manual SM014 (**SM014**), which is industry standard for business cases. This approach requires the use of industry cost databases by professional cost estimators to obtain rates

and apply them to material quantities derived from concept design. The manual also requires allowance for project development and pre-implementation costs, a range of additional physical works items including environmental compliance, and contingency. The Riley estimates by contrast use bespoke rates obtained from contractors applied to material quantities derived from the TG underpass designs; and exclude a number of the additional cost allowances required to be included under SM014.

Accordingly, Te Tupu Ngātahi experts consider that the two sets of cost estimates are not directly comparable, and that the TG costings are likely to materially underestimate the construction cost of an underpass. Irrespective of cost estimate methodology for an underpass, Te Tupu Ngātahi experts consider that the bridge option remains considerably less costly than an underpass. Given the above, Te Tupu Ngātahi experts consider the MCA assessment under the cost criterion remain valid. Accordingly, no fundamental change in overall costings is assumed to be merited.

6.3.4 Construction Disruption

The Riley reports include construction programmes for the TG underpass options and assume an overall construction duration of between 12-18 months for the underpass works. The high-level construction methodology which informed the MCA undertaken by Te Tupu Ngātahi estimates a duration of approximately 2.5 – 3 years for either a bridge or an underpass and includes wider network integration works beyond the bridge or underpass itself. The longer duration in the construction methodology proposed by Te Tupu Ngātahi reflects more conservative assumptions, but ultimately is not a significant differentiator between a bridge and an underpass.

However, Te Tupu Ngātahi and TG construction methodologies differ materially in their approach to managing NIMT rail closures to enable construction of an underpass. In short, the TG methodology assumes works within the rail corridor can be undertaken within a 14-day block-of-line period, while the assessment undertaken by Te Tupu Ngātahi assumes the need for either construction of a temporary rail diversion to reduce disruption or a need for further prolonged closure of the NIMT during construction. Te Tupu Ngātahi assessment favours temporary rail diversion following consultation with KiwiRail. The assumed need to provide for a temporary rail diversion informed the initial MCA assessment under the land requirement and construction disruption criteria in particular.

While consultation with KiwiRail has identified that there are a range of possible means of managing rail closures, the preferred methodology remains a temporary rail diversion. Moreover, KiwiRail noted that a 14-day block-of-line period was likely to be an unacceptable solution given the significance of the NIMT for freight. On this basis, Te Tupu Ngātahi experts remain of the view that the assumptions underpinning the MCA assessment under the land requirement and construction disruption are appropriate.

6.3.5 Urban Design and Visual Effects

The report provided by TG's urban design expert outlined a preference for an underpass over a bridge on the basis that an underpass would have a lesser visual effect, would maintain greater visual connectivity at ground level, and that CPTED and personal security concerns could be mitigated by the limitation of the enclosed extent of the underpass to 30-40m and design features including egress stairs.

Te Tupu Ngātahi urban design expert reviewed the above report and did not consider that it materially changed the earlier MCA urban design assessment. In particular, it remained Te Tupu Ngātahi urban designers' expert view that an underpass was not preferred due to CPTED and personal safety issues – a lack of surveillance, visibility, and outlook; susceptibility to vandalism and graffiti, and susceptibility

to noise and air quality effects. Moreover, it was noted that the 30-40m enclosed extent assumed in the TG underpass design would not provide for four-tracking of the NIMT, (as discussed at section 6.3.1 above), or adequate space for at-grade access lanes above the underpass (described in section **Error! Reference source not found.**). TG's assumptions regarding limitations of enclosed extent were therefore incorrect. Given that the underpass option developed by Te Tupu Ngātahi provides for both four-tracking of the NIMT and at-grade access lanes above the underpass, the enclosed extent is approximately twice the length of the TG underpass. This in turn has informed the urban design scoring, and the continued preference for a bridge by the Te Tupu Ngātahi urban design expert.

Te Tupu Ngātahi landscape and visual effects expert also re-examined earlier assessment of the merits of bridge and underpass options in light of the TG assessment, and the same general findings and conclusions were reached – that a bridge would have a greater visual effect than an underpass, that both options would introduce grade changes and result in a disconnect between the road and adjacent properties and would affect the outlook from adjacent properties and roads. Moreover, the reassessment emphasised that the effects of a bridge or underpass is anticipated in the context of an existing urban environment with two intersecting transport corridors (road and rail).

Implications of these matters for the MCA assessment are documented at section 6.4.

6.4 Retesting of previous MCA outputs

The MCA assessment of physical form options for grade-separation at Walters Road (documented in section **Error! Reference source not found.**) has been retested in light of the new information documented above and in discussion with TG experts. Given the scope of new information provided to Te Tupu Ngātahi, the retesting was limited to six MCA criteria – urban design, land requirement, landscape and visual effects, natural hazards, construction disruption, and construction risk. Remaining criteria scoring was not considered to be materially changed by the new information.

Table 6-6 - Retesting of Walters Road MCA assessment

Criteria	Previous MCA scores		Commentary
	Bridge	Underpass	
Urban design			As noted at 9.3.5, no fundamental changes to urban design rationale or assessment as a result of the TG assessment. No change in scores or commentary.
Land requirement			As noted at 9.3.1, Te Tupu Ngātahi experts do not agree with TG experts that an underpass can be made meaningfully more compact while remaining AT TDM-compliant. Accordingly, no change in scores. It is noted for completeness that while both options are scored the same on an 11-point scale, Te Tupu Ngātahi remains of the view that an underpass will require additional property associated with temporary rail diversion to enable construction, and to provide for offset between the underpass trench and remaining buildings to reduce risk of damage. Accordingly, a bridge will require less land than an underpass.
Landscape / visual			As noted at 9.3.5, the landscape and visual criterion was revisited in light of the TG assessment. This reassessment resulted in no change in scoring, noting that an underpass would have lower visual effects than a bridge; but that both options would represent grade changes, introduce a

Criteria	Previous MCA scores		Commentary
	Bridge	Underpass	
			disconnect between the road and adjacent properties, and affect the outlook of adjacent properties and roads.
Natural hazards			As noted at 9.3.2, the geotechnical data provided by TG experts enabled some refinement of the ground profile resulting in changes to sheet piling depth assumptions for excavations of less than 5m, but not for secant wall piling depth assumptions at greater than 5m. Other aspects of the previous assessment were considered to remain valid with the new geotechnical data – high groundwater table and large combined thickness of soft peat and alluvium present an elevated settlement risk profile for an underpass when compared with a bridge. Accordingly, no change in the preferred option or scoring differential between the two options.
Construction disruption			As noted at 9.3.4, no fundamental changes to Te Tupu Ngātahi assumptions regarding construction method as a result of the TG assessment, in particular the preference for a temporary rail diversion to manage rail disruption.
Construction cost / risk			As noted at 9.3.3, no fundamental changes to Te Tupu Ngātahi assumptions regarding the costs of the bridge and underpass options as a result of the TG assessment. Te Tupu Ngātahi still estimates that an underpass is still around twice the cost of a bridge, and as noted above there remains an elevated settlement risk profile for an underpass when compared with a bridge. Accordingly, no change in the preferred option or scoring differential between the two options.

6.5 Further engagement

Following the 30 May AT Board direction, Te Tupu Ngātahi undertook further engagement activities in parallel with the additional technical analysis documented above. The outcomes of this engagement were considered alongside the additional technical analysis in confirming a recommendation for the physical form of grade separation at Walters Road and are summarised below.

6.5.1 Public engagement – physical form assessment and visuals

In June 2023, Te Tupu Ngātahi undertook further public engagement. This included updated collateral on the Te Tupu Ngātahi website with further information on the alternatives assessment for bridge and underpass options, and several new visual simulations for three of the proposed crossing locations (see Figure 6-2). The intent was to communicate the reasoning for the earlier recommendation by Te Tupu Ngātahi of a bridge as the physical form of grade separation, and to give a better idea as to the scale and appearance of the recommended structures.

An additional public open day was held at the Takaanini Community Hub on 24 June 2023, which was attended by approximately 30-40 people including several elected members and potentially affected landowners. Key matters discussed with members of the community included the rationale for the scale of bridge structure shown in the visualisations, the effects of grade separation on access to the Takanini Town Centre development, and the extent to which ground conditions had been a determinative factor in identifying a preference for a bridge over an underpass. Some local residents also raised questions

regarding proposals at other TLC project areas, in particular the suitability of a pedestrian bridge at Manuroa Road. Te Tupu Ngātahi experts in attendance discussed these matters at length with community members.



Figure 6-2 - Visualisation of proposed Walters Road bridge presented in June 2023 engagement

6.5.2 Local Board engagement

Te Tupu Ngātahi representatives met with the Papakura Local Board on 9 August. The purpose of this meeting was to communicate the reasoning for the earlier recommendation of a bridge by Te Tupu Ngātahi as the physical form of grade separation, to present new visualisations to give a better idea as to the scale and appearance of the recommended structures, and to provide updates on the retesting process and new technical information provided by TG. AT representatives again met with the Papakura Local Board on 20 September to present the findings of a separately commissioned independent peer review of the technical analysis undertaken by Te Tupu Ngātahi.

It is understood that the Papakura Local Board has reserved its position in terms of identifying a clear preference for either a bridge or an underpass at Walters Road but has received and acknowledged the technical information presented in the meetings. Moving forward, the Local Board has noted an expectation of continued communication by AT, Te Tupu Ngātahi, and KiwiRail with the community regarding decision-making on the form of grade separation at Walters Road.

6.5.3 Manawhenua engagement

The Project Team maintained its monthly Hui with Manawhenua representatives through the mid-2023 engagement period. In the Hui held during this period, the Project Team sought to keep Manawhenua representatives up-to-date with the outcomes of the AT Board and ongoing discussion with TG, sought feedback on the visual simulations prior to public engagement, and generally sought further feedback on views regarding the form of grade-separation.

Manawhenua continue to have concerns with both options. For the bridge option, concerns were noted regarding the scale and visual impact of the proposed structure. For the underpass option, concerns

were consistently raised regarding flooding risk and associated safety and resilience issues, the underlying ground conditions, and the greater cost of an underpass relative to a bridge. Value-for-money and intergenerational equity were noted as concerns for both options also noting the relatively large costs associated with each. Overall, Manawhenua continued to express a preference for the bridge option in light of the above.

6.6 Conclusion

Following completion of the retesting and re-evaluation of the physical form of grade-separation, as well as the further engagement activities, it was confirmed that **a bridge remains the preferred physical form of grade separation at Walters Road**. The complete process documented above is summarised in Figure 6-3 below.

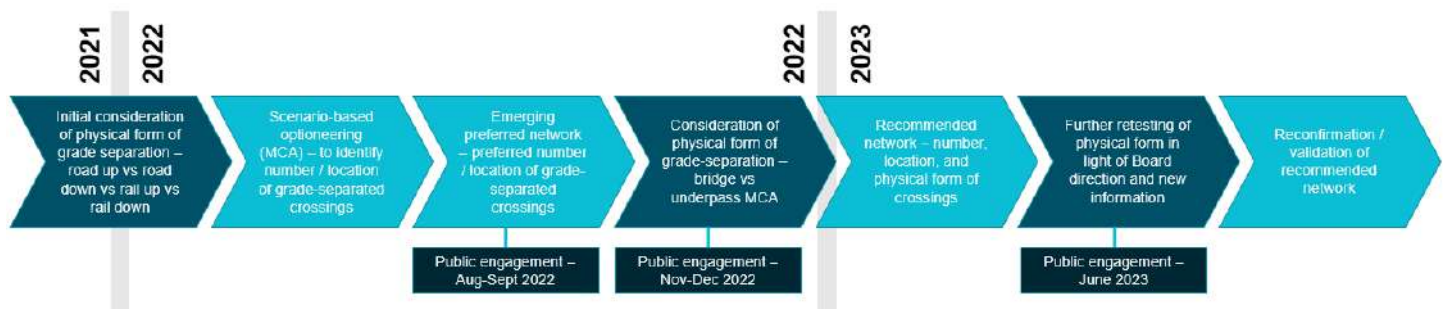


Figure 6-3 - Full TLC optioneering process including June-September 2023 retesting and further engagement

7 Preferred option

This section summarises the preferred option and discarded options.

7.1 Preferred option

The preferred option includes:

- **Spartan Road** – closure with active modes connection provided.
- **Manuia Road** – new east-west connection in the form of a bridge from Oakleigh Ave through to Great South Road.
- **Manuroa Road** – closure with active modes connection provided.
- **Taka Street** – grade separation of the existing level crossings in the form of a bridge.
- **Walters Road** - grade separation of the existing level crossings in the form of a bridge.

7.2 Discarded options

7.2.1 Part One assessment: Industrial Access

Table 7-1 shows the network options (scenarios) discarded as part of the initial Part One assessment which focussed on finding a connection for the Takaanini industrial area. Enclosed in red are the connections under consideration as part of the assessment.

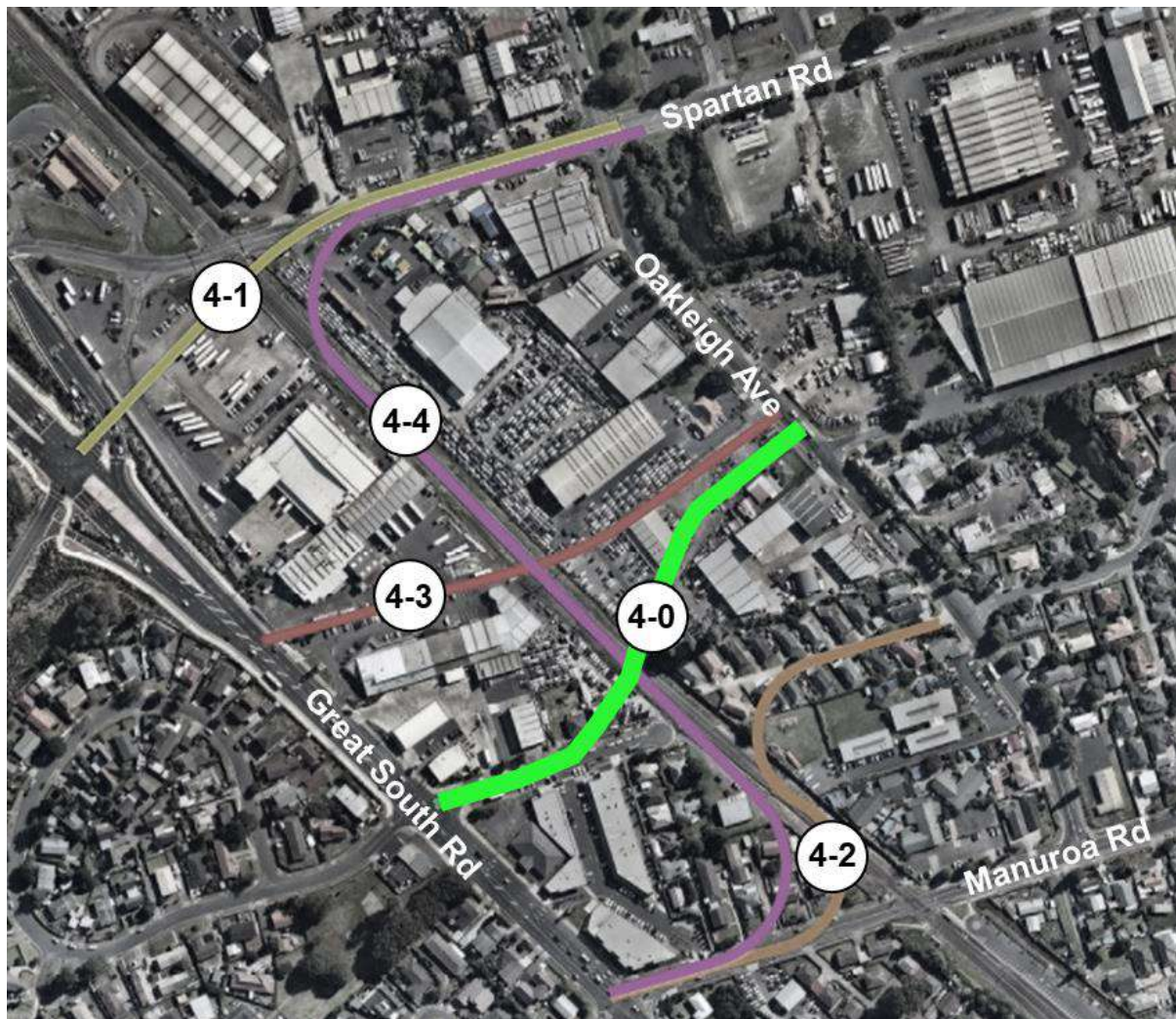
Table 7-1 : Discarded options in the initial Part One assessment

East-West Crossings	Scenarios		
	Scenario 1: IBC Recommended	Scenario 2: Spartan Road	Scenario 3: Manuroa Road
Alfriston Road (Existing)	Open	Open	Open
Rangi Road	Open	N/A	N/A
Spartan Road	Closed	Open	Closed
Manuroa Road	Closed	Closed	Open
Taka Street	Open	Open	Open
Walters Road	Open	Open	Open

The outcome of the assessment suggested alternatives should be explored given all three scenarios had issues that should be avoided where possible.

Figure 7-1 shows the alternative options explored with Option 4-0 being the preferred and all others are discarded.

Figure 7-1 : Part One assessment discarded options



7.2.2 Options between Taukari Road/ Beach Street and Waterview Road

Following on from the Part One assessment, a transport network review was undertaken and it was established that a connection is required between Taukari Road/ Beach Street and Waterview Road.

Figure 7-2 shows the options explored with Option 6, using the existing Walters Road alignment being the preferred and all other options are discarded.

Figure 7-2 : Discarded options between Taukari Road/Beach Street and Waterview Road



7.2.3 Part Two assessment: South of the industrial area

Table 7-2 shows the network options (scenarios) discarded as part of the Part Two assessment which focussed on finding a connection south of the Takaanini industrial area. Enclosed in red are the connections under consideration as part of the assessment.

Table 7-2 : Discarded options for Part Two assessment

East-West Crossings	Scenarios	
	Scenario 5: Manuroa Road Only	Scenario 6: Taka Street Only
Alfriston Road (Existing)	Open	Open
Rangi Road	N/A	N/A
Spartan Road	Closed	Closed
Manuia Road	Open	Open
Manuroa Road	Open	Closed
Taka Street	Closed	Open
Walters Road	Open	Open

7.3 Next steps

The next steps for the project following on from the approval of the DBC:

- Further engagement with affected landowners and update design if required.
- Lodgement of NoR for route protection of the preferred option.
- Implementation date is yet to be confirmed and will be determined by the Auckland Networkwide Level Crossings SSBC. The SSBC will also undertake a more detailed design which will inform a more detailed analysis of the properties impacted.

Appendix A – EAST Assessment

Date:	
Project name:	Takaanini Level Crossings DBC

Business case phase:	Single stage business case
Problem/opportunity s	The existing level crossings causes safety risks, limits rail capacity, reduces network resilience and access

Do minimum:	Do nothing - retain the level crossings
-------------	---

Investment objective:	Provide improvements at level crossings that contribute to a transport network that is free from deaths and serious injuries
Investment objective:	Support mode share by improving active mode facilities and rail capacity
Investment objective:	Support network resilience for Takaanini and improved reliability for the southern rail line
Investment objective:	Improve east-west connections to enable access to economic and social opportunities
Note: Please copy the row above to add an additional investment objective.	

Alternative or option details			Investment objective				Practical Feasibility						Climate change			Environmental and Social Responsibility				Summary of decision made		
Unique identifier	Name of alternative/option	Description of alternative/option	Provide improvements at level crossings that contribute to a transport network that is free from deaths and serious injuries	Support mode share by improving active mode facilities and rail capacity	Support network resilience for Takaanini and improved reliability for the southern rail line	Improve east-west connections to enable access to economic and social opportunities	Technical	Safety and Design	Consentability				Mitigation	Adaptation		Identify	Mitigation Can these be avoided, remedied or mitigated?	Fatal flaws		Summary of decision made	Progress or discontinue this alternative/option ?	
1	Rail trenching	Rail line is underground in a trench	4	4	4	4	5. Red (difficult/complex)	2.Amber/green	5. Red (difficult/complex)	5+ years	\$50+ million	Significant construction cost and complexity anticipated due to the peat soil condition in the area. Uncertainty around how this will interact with KiwiRail plans especially around 4-tracking	Reduce	Maybe	-	Groundwater, settlement risk, large construction disruption.	Yes	Groundwater treatment required. Construction methodology developed will need to minimise the disruption as much as possible	Yes	The option was not supported and discarded during the IBC given the risk and reward ratio was not worth pursuing further.	Not to progress based on the significant risk around construction and consenting and very limited benefits. Also noted that this option was not supported and discarded during the IBC.	Discontinue
2	Rail viaduct	Rail line on a viaduct leaving the road network at ground level	4	4	4	4	5. Red (difficult/complex)	2.Amber/green	5. Red (difficult/complex)	5+ years	\$50+ million	Similar to above.	Reduce	Maybe	-	Large construction disruption and landscape/ visual impact	Yes	With the NPS-UD and MDRS, the height of the bridge will no longer seem so significant in relation to its surroundings.Construction methodology developed will need to minimise the disruption as much as possible	Yes	Similar to above	Not to progress based on the significant risk around construction and consenting and very limited benefits. Option was also discarded during the IBC.	Discontinue
3	Road bridge	Road network is above the rail line on a bridge	4	4	4	4	4.Red/amber	2.Amber/green	4.Red/amber	0-2 years	\$50+ million	Significant construction cost and complexity is expected although less so compated to the other options	Reduce	Maybe	-	Landscape/visual impact on the surrounding residents	Yes	With the NPS-UD and MDRS, the height of the bridge will no longer seem so significant in relation to its surroundings.	No	No fatal flaws identified	Option to proceed as	Progress
4	Road underpass	Road network is underground below the rail	4	4	4	4	5. Red (difficult/complex)	2.Amber/green	5. Red (difficult/complex)	2-5 years	\$50+ million	Significant construction cost and complexity anticipated.	Reduce	Maybe	-	Groundwater, settlement risk, large construction disruption and also CPTED issues.	Yes	Groundwater treatment required, careful design to ensure safety for active modes i.e. passive surveillance . Construction methodology developed will need to minimise the disruption as much as possible	No	No fatal flaws identified	Although no fatal flaw was identified, the option was discontinued given the the anticipated cost and construction challenges are much greater than that of a road bridge for little to no additional benefits over a road bridge.	Discontinue

Takaanini Level Crossings Project Appendix E - Engagement summary

October 2023

Version 1.0

Document Status

Responsibility	Name
Author	██████████
Reviewer	██████████
Approver	████████████████████

Revision Status

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1 Executive Summary

1.1 Introduction

Te Tupu Ngātahi Supporting Growth is a collaboration between Auckland Transport and Waka Kotahi NZ Transport Agency. Te Tupu Ngātahi was formed to investigate, plan, and secure route protection for transport projects in the Auckland region to support the region's growth over the next 30 years. As part of this work, Te Tupu Ngātahi has planned to ensure enough land is set aside for a future transport network in South Auckland. A crucial part of this network is the Takaanini level crossings project, which propose to close two current level crossings, grade separate another two existing crossings and create one new grade separated crossing. This has been planned to make Takaanini safer, and to respond to growth in Takaanini, along the broader South Auckland network, and to support the capacity of the future rail network in Auckland.

Engagement with partners, stakeholders, potentially affected landowners, and the wider community is a fundamental part of the planning process. This report summarises the community and landowner engagement held in Takaanini between 12 August to 26 September 2022, and the second round between 5 November – 20 December 2022. Both consultation periods aimed to gather feedback on proposed closures or grade separation at five different locations, where road users currently must drive across at-grade train tracks.

1.2 What we heard

We heard from people that they support some locations of the project but were unsupportive towards others. Feedback indicated that there was support for the proposed Taka Street crossing. People felt as though there was sufficient land surrounding the crossing to construct a new bridge. Feedback was unsupportive of a proposed bridge at Walters Road, as the community felt it would severely impact properties in the area. Some feedback questioned why it was not an underpass, believing this was a better alternative for this crossing. The proposed closure of the Spartan Road and Manuroa Road level crossings was generally unsupported. Freight industry feedback was against the closure of routes for heavy vehicles, whereas community users did not want heavy vehicles diverted to Taka Street. They also raised design considerations for bridges and the heavy vehicles using those. We heard that people did not give support to the proposed Manuia Road bridge, as they felt it would create traffic congestion on Oakleigh Avenue, and that it is not a widely used arterial. People wanted to know what it would look like and what path it might follow.

1.3 Next steps

The feedback gathered has been analysed, and the community knowledge within it will contribute to the decision making around the project. We will share this feedback with the community by early 2023, in the form of a two-page summary. Landowner engagement will continue into 2023, where we will be able to outline to landowners any potential property impacts with greater certainty.

Lodgement of Notices of Requirement to support route protection of the preferred options is planned to occur in mid-2023.

2 Background

In 2016, a strategic transport network for the future growth areas of Auckland was identified as part of a Programme Business Case (PBC). Te Tupu Ngātahi investigated the parts of this network in Southern Auckland through an Indicative Business Case (IBC) in 2018, which included the Takaanini growth area. We heard from the community at the time that most supported new grade separated rail crossings and the closure of the remaining crossings. The IBC was endorsed by both Waka Kotahi and AT boards in 2019.

Due to this network containing over 16 transport projects, the decision was made to split these into different Detailed Business Cases (DBC)s for route protection. The level crossings DBC is one of two for Takaanini, with the Frequent Transit Network (FTN) DBC being prepared in parallel. The Takaanini DBC package follows on from outcomes identified at PBC and IBC stages. For the level crossings, this is confirming the need for the removal and/or replacement of the current level crossings in Takaanini.

In order to support the DBC and lodgement processes, engagement on the level crossings was held to gather feedback on the preferred locations for level crossing removal. The approach of Te Tupu Ngātahi for route protection is illustrated below in Figure .



Figure 2-1: Te Tupu Ngātahi Supporting Growth funnel diagram

This report summarises community and potentially affected landowner feedback received between 12 August 2022 to 26 September 2022, and 5 November 2022 to 20 December 2022. It focuses on the proposed road closures at Spartan Road and Manuroa Road, as well as the addition of three new grade-separated crossings at Manuia Road, Taka Street, and Walters Road.

2.1 Indicative Strategic Transport Network – Level Crossings

The Takaanini Level Crossings DBC is one of two in Takaanini, alongside the Takaanini Frequent Transit Network DBC. Both are part of the wider 'Strategic South' transport network. The level crossings project is anticipated to be delivered in the next 10 to 20 years. There is currently no provision within local or central government funding this project, or the wider south network, to the next stage.

The level crossings removal project includes:

- **Spartan Road** – closure of the current railway level crossing, with a new walking and cycling bridge
- **Manuia Road** – a new rail crossing for motorists and active modes
- **Manuroa Road** – closure of the current railway level crossing, with a new walking and cycling bridge
- **Taka Street** – closure of the current railway level crossing, replacing it with a fully separated crossing for motorists and active modes
- **Walters Road** – closure of the current railway level crossing, replacing it with a fully separated crossing for motorists and active modes.

A map of the project is shown in Figure .

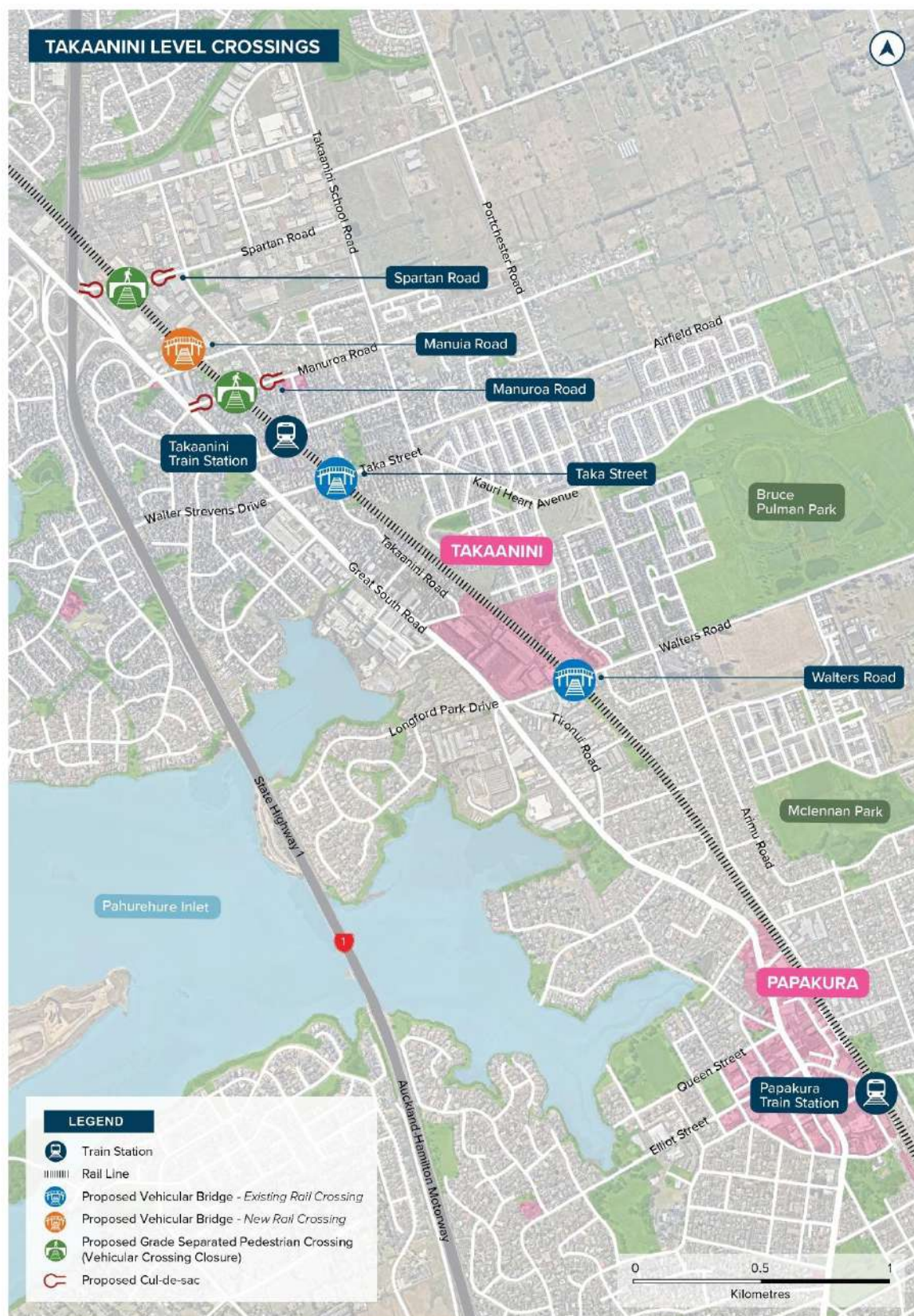


Figure 2-2: Map of the Takaanini level crossings project

3 Engagement Activity and Feedback

3.1 Engagement activity

We engaged with partners, elected members, potentially affected landowners and other key stakeholders. Table 1 summarises our engagement methods and the groups we engaged with.

Table 1: Engagement activity by stakeholder group

Who we engaged	How we engaged
Partners	• Southern manawhenua table – ongoing twice monthly hui with manawhenua and the project team • Auckland Council Partnership Forum – twice monthly meetings to update Council on Te Tupu Ngātahi projects (including the level crossings project) • Update to Kiwirail – two online meetings held with Kiwirail as project partners to update them on the project. These were held on 18 July and 22 July. KiwiRail was also invited to provide comments on the Revision A design during August and September.
Elected Members	• Papakura Local Board presentation – updates on the level crossings project held on 15 June 2022, and post-election in November 2022 • Written updates to Franklin and Manurewa Local Boards – project updates sent in December 2022 • Dr Anae Neru Leavasa MP for Takanini and Councillors Dalton and Newmann – a meeting to provide a project overview and invite to the Business breakfast • Briefing pack – informative brief on the project that contained the community flyer (see Appendix 1), the landowner letter with the project map, and a memo to Papakura Local Board. This was distributed to Mayor Phil Goff, the Auckland Council Planning Committee, Papakura Local Board, ward councillors, and offices of local MPs.
Local stakeholders	• Information packs – we sent information via email and dropped flyers to local stakeholders to inform them of the project; this was sent to local schools, the Takanini Business Association, and early childhood centres • Meetings – we held meetings with the Papakura Commercial Projects Group, and Wallace Construction to discuss the project • Presentation – we presented to the Auckland Transport Regional Freight Group on 3 October • Business breakfast sessions – working with the Takanini Business Association, we held breakfast presentations to local business owners on 27 November and 12 December 2022.
Potentially affected landowners	• Letters – 380 letters sent out in August 2022 to potentially affected landowners encouraging them to have their say • Landowner meetings – 1:1 meetings, either online for face to face were offered to potentially affected landowners to provide them with a further opportunity to discuss the project with members of the project team.

Who we engaged	How we engaged
Community	• Advertising – we distributed an interactive poster (see Appendix 2) and newspaper advertorial (see Appendix 3), as well as information and links posted on Papakura Local Board's social media channels • Video – a visual of the project created for use on the Te Tupu Ngātahi YouTube page, as well as the project's interactive online engagement platform • The Hive - an online engagement platform open to the public to give their feedback • Community open days – we held community open days on 5 November (Takaanini Community Hub) and 8 November (Bruce Pulman Park), to give people the chance to come and speak with the project team and learn more about the project.

3.1.1 Manawhenua engagement summary

We engaged closely with manawhenua on the level crossings project prior to and during wider community engagement. Collaborating with manawhenua as project partners, we actively sought feedback and their involvement during the DBC process.

Te Tupu Ngātahi held southern hui with manawhenua representatives, occurring twice a month from November 2021. The purpose of these hui was to collaborate with manawhenua on option development and assessment processes, update manawhenua on progress on the level crossings project as part of the DBC phase, present technical information, and findings from investigations to involve manawhenua as partners. The following captures the feedback manawhenua gave in these hui from February to September 2022; however, some hui are not included due to no pieces of feedback emerging from them.

At the hui held on 3 February 2022, Te Tupu Ngātahi introduced the Takaanini level crossings project to kaitiaki and kaimahi from Ngāti Tamaoho, Ngāti Whanaunga, Te Ākitai Waiohua, Ngāti Te Ata Waiohua, and Ngāti Maru. We heard from representatives at this hui that the level crossings area has a history of poor safety, and a reputation for serious injury and death.

Subsequent hui saw different manawhenua representatives give their feedback on considerations for the project team. Feedback was based around the environment, ecology, and the surrounding landscape in Takaanini. We heard in the 22 February 2022 hui attended by Te Ākitai Waiohua, Ngāti Tamaoho, and Ngāti Whanaunga that manawhenua were concerned with stormwater diversion and treatment. Additionally, we heard that wetlands in the project area are significant to manawhenua; as is the Papakura Stream. This was emphasised again in the 3 March 2022 hui, attended by the same representatives at the last hui, in addition to Ngāti Paoa Trust Board.

Manawhenua raised with the project team that they viewed it as important to explore their rationale towards decisions, especially where they value matters including wellbeing, ecology, heritage and the like. Kōrero on this occurred during the 26 April 2022 hui, attended by Te Ākitai Waiohua, Ngāti Tamaoho, Ngai Tai Ki Tāmaki, Ngāti Tamaterā, and Ngāti Whanaunga.

The hui held on 5 May 2022 was attended by Ngāti Maru, Ngāti Tamaoho, Ngāti Whanaunga, Te Ākitai Waiohua, and Ngāti Tamaterā. It was raised during this hui that manawhenua had issues with peat in

the area due to cultural aspects that need to be adhered to, in respect to tikānga around food gathering. Manawhenua also noted visual amenity was a key concern in their position towards the potential level crossings. In addition, manawhenua did not want adverse impacts across communities. There was kōrero about some representative's familiarity with the area and their concerns towards diverting heavy traffic with the closures of Spartan Road and Manuroa Road. The project team began to present options to manawhenua from May 2022. In the 2 June 2022 hui, we heard that manawhenua did not like any of the options presented to them, but they acknowledged that these will provide the community with transport choice. This hui was attended by Ngāti Maru, Ngāti Tamaoho, Ngāti Whanaunga, Te Ākitati Waiohū, Ngāti Tamaterā, and Ngāti Te Ata Waiohū.

Manawhenua raised concerns with the Manuia Road concepts presented in the 21 June 2022 hui, due to the proposed impacts on property, people, businesses, and the environment. In the 7 July 2022 hui, manawhenua representatives noted the social and visual impacts of the options, juxtaposed with their recognition of the importance and need for grade separated crossings.

We heard from manawhenua representatives in the 23 August 2022 hui around the importance of broad outreach and engagement to ensure greater reach across the community. It was recommended engagement design take a segmented approach, and harness community outreach available in schools, community venues, and churches in the Takaanini area. The project team was able to present 3D concept designs of the potential bridges during the 1 September 2022 hui. Manawhenua representatives in attendance noted the visual and psychological impacts of these structures, and the potential barriers to movement they could be to some people.

Manawhenua in attendance at the October 25 2022 hui acknowledged that the four current level crossings (Spartan Road, Manuroa Road, Taka Street, and Walters Road) are dangerous and it has now reached a point where something must be done. Kōrero also took place around how to best capture and understand Tāmaki Makaurau iwi values, narrative, and hertiage in design conditions, against an urban design framework that is a western construct. Feedback was given that the design response from iwi condones Papatūānuku is not impacted any further than she has been.

The challenge to the urban design approach was acknowledged as helpful by the project team in the November 3 2022 hui. Manawhenua representatives in attendance discussed with the project team the values incorporated into the design conditions of the project – Rangatiratanga, Wairuatanga, Kaitiakitanga, Manaakitanga, Kotahitanga, and Mātauranga.

Manawhenua representatives at the 1 December 2022 hui were presented with artistic interpretations of the proposed Walters Road bridge, as well as an impression of an underpass. One representative suggested that future interpretations could use other angles, to give residents and corridor users context. Feedback was also given by representatives to update the impressions to accurately show pedestrian's height, and to diversify the pedestrians shown.

The project team engaged closely with manawhenua during the DBC process, and has carefully considered and integrated their issues, concerns, and considerations into their decisions. Te Tupu Ngātahi will continue to engage with manawhenua as project partners as the Takaanini Level Crossings project progresses.

3.1.2 Key stakeholder interactions

We spoke to a number of key stakeholders during and around the engagement period. Table 2 summarises the feedback we received. Formal submissions (where received) are noted.

Table 2: Key stakeholder interactions

Who we engaged	Feedback
Papakura Local Board	The Papakura Local Board gave their support for the proposed changes in the level crossings project. Their written feedback requested works be sequenced to minimise the impact on the wider road network. The sequence they advised is Manuia Road, Taka Street, Walters Road, followed by the closures at Spartan and Manuroa Road. Their feedback noted congestion in the morning and early afternoon between Manurewa and Papakura. It also requested others undertake assessments into transport management and audit fencing and barriers, to ensure safety around the crossings. The Local Board requested that extensive information campaigns in multiple languages take place, to engage the community about track safety and the risks of crossing at a rail line.
Hynds Pipe Systems	Hynds Pipe Systems ('Hynds') submitted written feedback during the initial consultation period, on behalf of their Takaanini branch at 28 Spartan Road. Their feedback voiced Hynds' concerns towards the proposed closures of the Spartan Road and Manuroa Road level crossings. Whilst supportive of transport choices, Hynds want there to be suitable alternatives should the project commence. Hynds are against the proposed new crossing at Manuia Road on the basis that the surrounding area would not support the kind of traffic using it. Hynds are concerned that if the Manuia Road crossing is not constructed, there would be a poor outcome for the community in terms of freight traffic using this crossing and creating congestion. The submission highlights this possible outcome as inconsistent with all four strategic priorities of the Government Policy Statement on Land Transport 2021/22.
Ia Ara Aotearoa Transporting New Zealand	This submission was made after consultation with Ia Ara Aotearoa Transporting New Zealand (Transporting NZ) members and associates based in Takaanini. The submission states that Transporting NZ do not support the closure of the Spartan Road and Manuroa Road closures. They also do not support traffic using Taka Street as an alternative to these closures, and they want to see grade separated crossings at both Spartan and Manuroa Roads. They state that the proposals are inconsistent with the Government Policy Statement on Land Transport 2021/22 strategic priorities. The result of this will impact freight and commercial vehicle movements, disrupting business and productivity. The submission was supportive of active modes but believe the closure of key crossings is unnecessary to provide for these connections.
NZ Heavy Haulage Association	This was feedback placed online, via our survey on our interactive online engagement platform. In this feedback, the NZ Heavy Haulage Association ('Heavy Haulage') wanted to bring to the project team's awareness that Manuroa Road is a key route for over-height and overweight loads to Auckland. They are opposed to the proposed Manuroa Road closure and believe it has been invested in as a long-established over-height route. Heavy Haulage supports the Taka Street grade separated crossing in principle, but comment on the need for design to accommodate for tall, wide, and/or heavy loads.
Tegel Foods	Tegel do not support the proposed closures at Spartan Road and Manuroa Road, with the vehicles being redirected to Taka Street. Their concerns were that redirected freight traffic would impact safety in residential and school streets,

Who we engaged	Feedback
	discourage other forms of transport, contribute to greenhouse gas emissions, and negatively impact connectivity for the Takaanini freight industry. Tegel reference their own business operations in the submission, and how the closures will impact these. The submission acknowledges the growth occurring in Takaanini, but states that it needs infrastructure improvements. It also acknowledges that a new crossing would need to replace the two closed crossings.
Kāinga Ora Homes and Communities	Kāinga Ora state that they do not support the closure of the Manuroa Road level crossing. Acknowledging that Kāinga Ora owns 36 properties in Takaanini, one third of these are within the Manuroa Road area. They are concerned that a pedestrian-only bridge will impact their customer's ability access eastern Takaanini, where education and shopping facilities are located. Kāinga Ora also question why Manuroa Road is to be closed, when it experiences the greatest volume of traffic.
Takaanini Business Association	We received a letter from [REDACTED] on behalf of the business association that expressed the association's concern with the project and its scope. The association would prefer to see future grade separation be part of a new master plan for Takaanini. They do not want to see grade separation 'isolated', instead wanting it considered as part of a wider transport network for the community. The letter requests that the proposals are suspended, reviewed, and replaced with a new scope of work within an updated master plan.

3.1.3 Community and landowner engagement summary

Between 12 August and 26 September 2022, and 5 November to 20 December, the community were invited to provide feedback. We primarily used our online engagement tool 'The Hive', featuring an online survey and an interactive map with the option to 'drop' a pin and add a comment. Our survey questions were:

- 1. What design features might we need to consider for the new walking and cycling bridges?**
- 2. Level crossings are being progressively removed throughout Tāmaki Makaurau, to improve safety and reduce delays. Is this a good safety initiative for Takaanini?**
- 3. Is there any other feedback you would like to share?**

We sent 380 letters to potentially affected landowners in early August 2022. These notified landowners that their property was in a study area and could potentially be affected by the level crossings project. The letters encouraged landowners to give their feedback online, and to contact us on our 0800 number with any questions.

We heard from freight industry members near the end of engagement that they felt they had not been notified properly. Ensuring they were given a chance to give their feedback, a presentation was made to the Auckland Transport Regional Freight Group on 3 October 2022.

Feedback was re-opened on 5 November to ensure the community had a chance to share their thoughts. This coincided with the first of two community open days. We also held two business breakfast presentations to local business owners.

3.2 Feedback

We gathered feedback from the wider community and from potentially affected landowners. There was a low level of feedback overall. This is a summary of this feedback and the key themes that we received.

3.2.1 Online engagement statistics

We received **70 pieces of feedback** via our online engagement platform. 26 (37%) came from survey responses, and 44 (63%) came from drops on the interactive project map. We also received 11 email submissions. Initially, we received 53 pieces during the August-September period, and further 17 more online pieces of feedback between November-December.

The project page received **2,278 visits** across the engagement period. **1,627** of these were unique visitors. Traffic on the page peaked on August 19, with nearly **350** visits in a single day. During the second round of consultation, traffic peak again on November 9 with **137** visits. This former was a clear peak across the duration of the engagement period. The project page also attracted 1,540 new visitors. Overall, most visitors came via social media, with 630 referred via social media posts.

A copy of the project flyer, as well as project area maps were uploaded to the project page. These were well received, with the Walters Road map receiving 211 'downloads' (views), Spartan Road receiving 193 downloads, and Manuia Road receiving 189 downloads.

3.2.2 Landowner feedback

We heard from 23 potentially affected landowners over both engagement periods. Potentially affected landowners that got in touch with us via email or through our 0800 number wanted to know how the closest level crossing removal to their property would impact them. Several comments and questions were made around land requirements, project timeframes until construction, and queries over what the grade separated crossings would look like. A small number of landowners gave anecdotal evidence of traffic congestion in the community due to the nearby motorway interchange, with some anxious that closure at two of the current railway crossings would make congestion worse. Some landowners conversely expressed support for the project and its contribution to safety improvements in Takaanini.

We held two face-to-face meetings with potentially affected landowners at the time of writing. A common concern was that there was not enough information. We took this feedback on board and held a second round of community engagement between November – December 2022. This saw two open days take place, as well as an extended timeframe for landowners to get in touch with the project team. Engagement with landowners will continue as the project progresses through the DBC phase, and into the NoR phase in 2023.

3.2.3 Overall feedback

We asked survey respondents what design features we need to consider for the new walking and cycling bridges. A range of responses were submitted for this question. A group of responses focused on the width of shared paths, wanting the project team to ensure these were wider than usual. Different reasoning was given across these answers, such as capacity, accessibility for disabled users, and to prevent vandalism. Other comments proposed an underground subway instead of bridges, wanted vehicle access ensured for each bridge, or wanted structures that improved visual amenity.

Respondents were also asked whether they thought the progressive removal of level crossings across Auckland was a good safety initiative. Sixty one percent of survey respondents thought that

removing level crossings is a good safety initiative for Takaanini, whereas 39% did not think level crossing removals are good safety initiative.

Level crossings are being progressively removed throughout Tāmaki Makaurau, to improve safety and reduce delays. Is this a good safety initiative for Takaanini?

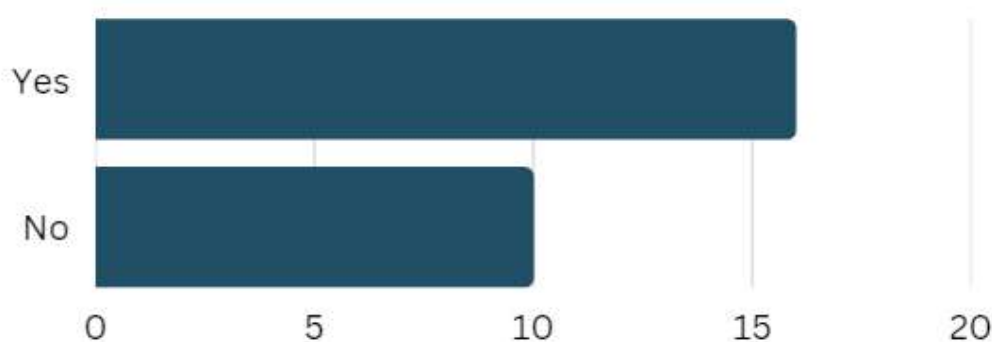


Figure 3-1: Support towards region-wide level crossing removals as a safety initiative

The project page also had an interactive ‘social’ map that allowed people to drop pins with comments at a location along the project footprint. The Takaanini level crossings social map received 44 pin drops from 31 contributors. There was also 104 ‘upvotes’ from people who agreed with other comments, yielding an average of 2.97 upvotes per contributor. Comments were spread out across the project area; Walters Road received 13 comments, Manuroa Road received 8, with Manuia Road receiving 6 pin drops



Figure 3-2: Hive social map with pin drops, by location

Key themes drawn from public feedback is summarised in Table 3 below, alongside our responses to the feedback we received.

Table 3: Summary of key themes and responses

Key theme	Comments	What we will do
Requests for more information	- People felt that the engagement collateral did not have enough information - Some pieces of feedback asked whether there were 3D models or concept designs we could show for the bridges. This was a common question across both rounds of consultation. - People also commonly asked where the bridges would start and stop, what height they would be, and what route they would follow.	- We presented more information about our options for each of the proposed level crossing removals at our community open days on 5 November and 8 November 2022 - We have engaged local businesses at a Business Breakfast on Thursday 27 October and Monday 12 December - We cannot provide more design detail at present. This is information that is developed during the detailed design phase of the project, which is at present 10-20 years away - We will continue to update potentially affected landowners, key stakeholders and the community as the project progresses.
Utilising underground space at Walters Road	- Pieces of feedback questioned why the option of an underpass at Walters Road was not the preferred option - Some people also stated they wanted to see the current rail tracks move underground or become a 'subway' style network.	We have investigated the option of an underpass at Walters Road. It is not our preferred option due to geotechnical issues with peat, in addition to cost. The area is also a floodplain, which would create high risk.
Potential closures of the Spartan Road and Manuroa Road level crossings	- We heard from industrial freight stakeholders that this is an important route for them and their ability to conduct business - People felt that closing Spartan Road would redirect heavy vehicle traffic into residential streets and create congestion - Some feedback did not think Oakleigh Avenue has the capacity to support increased traffic movements should both crossings potentially close - People also told us that the current Manuroa Road crossing is widely used by thousands of vehicles a day, and that closing it would not be a good outcome for the community.	- We have proposed to close both the Spartan Road and Manuroa Road crossing and provide an alternative crossing at Manuia Road. - We cannot grade separate at Spartan Road due to the proximity of the Takanini interchange. There is not enough space for a bridge at this location and constructing a bridge at Spartan Road would have significant impact on the built environment. The current crossing also has a poor safety record. - We have proposed to close Manuroa Road to ensure an even distribution of grade separated crossings with vehicle access. Keeping the ability to cross at Manuroa Road would mean the potential Manuia Road bridge would not have all of the possible benefits for users in the future.
Grade separation at Takaanini Train Station	A small number of the feedback placed requested that grade separation also be extended to the Takaanini Train Station. People feel the current level crossing to get to the platform is unsafe, and that increased train services will heighten the chance of an accident.	Grade separation of the level crossings at Takaanini Train Station is not within the scope of this project. We will pass on feedback around people's concerns with this crossing to Auckland Transport.
Active modes	Some pieces of feedback from the community doubted an uptake on active modes, based on anecdotal evidence that it is currently unsafe and that the	We are proposing to provide active modes facilities at all the proposed crossings in the project. This will provide the community with more transport choice, as

Key theme	Comments	What we will do
	- current community does not walk or cycle. - Other pieces of feedback voiced concern for the proposed road closures impacting people's ability to walk around the community. Some people felt this would disrupt their ease of walking to locations of interest. - A small number of mobility scooter users, trolley, pram users and the like were concerned that bridges would disrupt accessibility around the community.	- well as facilities that are safe and user friendly. - We will designate space that will allow for flexibility in design. This leaves enough room for design features that will provide accessibility to each of the proposed bridges, such as staircases, ramps, and lifts. We are giving flexibility in design so that these facilities can be determined during detailed design in 10 to 20 years' time. This will ensure these facilities serve the community that will be using the new bridges.
Amenities	- Concern was expressed across all feedback about the impact the potential grade separated crossings would have on the community - Feedback covered topics including visual amenity, land use, as well as noise and vibration during construction.	We have carried out technical investigations as part of the DBC process. These will help the project team understand these impacts in greater detail.
Approach to community engagement	- We heard from some people in the first round of consultation that the approach to engagement was not enough - Some people questioned why there was not a community open day during the August-September consultation period - We heard from concerned freight stakeholders that they were not informed or directly consulted on for the project during the first round of engagement	- Following the first round of consultation, we accepted this as an opportunity to improve our approach to engagement with the community - We held two community open day November 2022 to present more information to the community, and to give people an opportunity for face-to-face discussions with the project team - We also held a briefing session with AT's freight industry group in response to freight stakeholder concern that they felt unengaged - We will continue to engage with our partners, key stakeholders, potentially affected stakeholders, and the wider community.

3.3 Feedback by area

3.3.1 Spartan Road

Feedback towards the Spartan Road level crossing closure was unsupportive. Feedback and submissions highlighted that this crossing is important to local businesses and freight, serving as a key industrial route for many. A small number of people thought that this railway crossing closure would also make traffic flow worse in an already busy area of roading.

3.3.2 Manuia Road

Feedback for the new Manuia Road level crossing was unsupportive. People felt dubious of this new crossing improving traffic flow, especially with the closure of both Spartan and Manuroa Road crossings. Concern was expressed by landowners along Oakleigh Avenue towards land acquisition, and by community members who expressed that Oakleigh Avenue is used by traffic is a throughfare,

as well as for street parking. Capacity for this new bridge and Oakleigh Avenue to support heavy vehicle traffic was additionally questioned by several pieces of feedback.

3.3.3 Manuroa Road

People were unsupportive of the Manuroa Road crossing. Some pieces of feedback highlighted that the current railway crossing is widely used by the community and is an important point of access for park and ride users at Takaanini Station. Feedback did not agree with the replacement crossing being for active modes only and were concerned at the traffic congestion a permanent closure would bring. A small amount of feedback also discussed people's concerns for Oakleigh Ave and its capability to support more traffic.

3.3.4 Taka Street

Feedback was supportive of the Taka Street crossing in principle. Feedback focused on design opportunities by way of using minimal land, supporting heavy vehicle traffic, and upgrading current infrastructure such as overhead wires.

3.3.5 Walters Road

The Walters Road crossing was not supported by most pieces of feedback. People were concerned at the impact a new crossing would have on surrounding properties. Several pieces of feedback made on Walters Road advocated for an underpass as opposed to a bridge, with some wanting the tracks to go underground and become a subway.

3.4 Media coverage

Media coverage was closely monitored during the engagement period. Table 4 below summarises the media coverage of the project.

Table 4: Media coverage of the project

Media Outlet	Date	Title	Key Points
Greater Auckland	1/09/2022	<i>Southern Level Crossing Removal</i>	This article provided an overview of each of the project's level crossings that are proposed to close. It included some general comments on other level crossing removal projects announced or out for tender by Auckland Transport.

4 Next Steps

The feedback gathered during both of the formal consultation periods has been analysed. This will be used to better understand the issues and opportunities with the level crossings removal project. This will also contribute to decision making on the project.

We will continue to engage with landowners, the community, and key stakeholders beyond our consultation periods.

We will share feedback and our analysis with landowners and the community in early 2023. Further technical and specialist investigations will continue until late 2022. We will be in a position to outline

with affected landowners any property impacts from the project in early 2023. Lodgement of the Takaanini Level Crossings NoR to support route protection will occur in mid-2023.

The project is currently without funding for detailed design and construction, with construction not expected to begin for another 10 to 20 years, in line with Auckland Council land release.

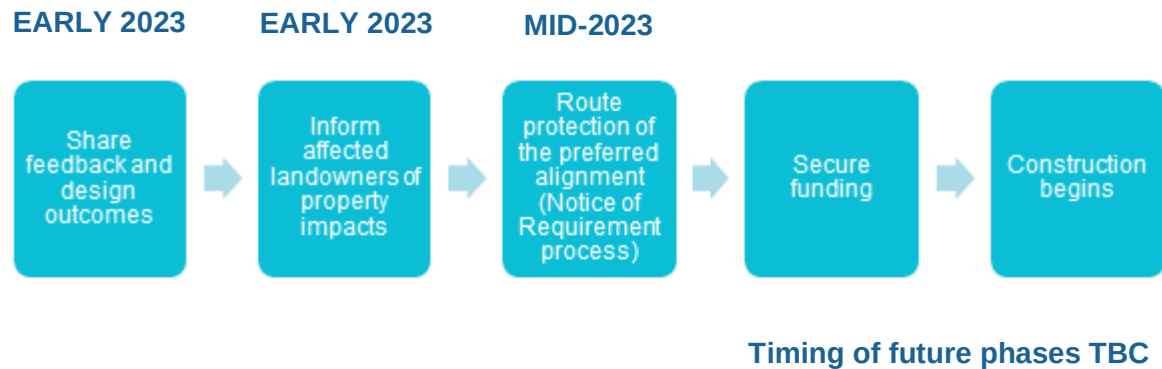


Figure 4-1: Indicative project timeline

Appendices

Appendix A

This flyer was distributed across the local community in early August. It aimed to socialise the project with the community and was timed to 'drop' in line with opening of the consultation period.



Changes to level crossings in Takaanini Growth story

August 2022

By 2050 the population of Tāmaki Makaurau is expected to grow by another one million people.

To connect future communities in growth areas like Takaanini, we are planning a long-term strategic transport network with well-designed transport connections that are safe, accessible and sustainable.

Level crossings in Takaanini – what might change in the future?

In the future there will be even more trains in Tāmaki Makaurau – that's awesome because it will make public transport even better! As well as improved train services, we're looking at changes to help reduce delays at level crossings in Takaanini meaning you won't have to wait so long to cross the railway tracks.

After 2030, we expect trains to pass level crossings on the Southern line every 2 - 3 minutes. More trains will mean a bigger delay at level crossings because safety barrier gates will be down more often and for longer. Some people take risks to avoid being delayed by safety barrier arms.

We want to reduce the number of level crossings in Takaanini. Removing level crossings will make it safer and faster for you to move around Takaanini because you won't need to stop for trains when safety barrier arms come down.

We are looking at options, like bridges, to get you safely across the railway tracks. These changes are still a number of years' away, but we are planning them now to make sure people can move around Takaanini more safely and efficiently.



Future urban zoned areas in South Auckland



Where are we thinking about changing level crossings in Takaanini?

Taka Street – We're suggesting closing the railway level crossing on Taka Street and replacing it with a fully separated crossing over the railway, like a bridge, for people walking, cycling and driving.

Walters Road – We're suggesting closing the railway level-crossing on Walters Road and replacing it with a fully separated crossing over the railway, like a bridge, for people walking, cycling and driving.

Spartan Road – We're suggesting completely closing the railway level crossing on Spartan Road and replacing it with a new walking and cycling bridge. While you won't be able to drive across the railway on Spartan Road anymore, we are proposing an alternative crossing for vehicles close by.

Manuroa Road – We're suggesting completely closing the railway level crossing on Manuroa Road and replacing it with a new walking and cycling bridge. While you won't be able to drive across the railway on Manuroa Road anymore, we are proposing an alternative crossing for vehicles close by.

Manuia Road – We're suggesting a brand-new railway crossing on Manuia Road. It would be a fully separated crossing, like a bridge, for people walking, cycling and driving.



Where can I get more information about future changes to level crossings in Takaanini?

There's lots more information about the work we're doing to plan for level crossing changes in Takaanini.



Check out <https://haveyoursay-supportinggrowth.nz/level-crossings-in-takaanini> for more information including a video and frequently asked questions.



You can talk with us on the phone 0800 GROW AKL (4769 255)



You can email us at info@supportinggrowth.nz

Appendix B

This poster was displayed at each of the level crossings involved in the project. It contained a QR code that took users to the project's online engagement platform when scanned.

TE TUPU NGĀTAHI
SUPPORTING GROWTH

Level crossings are changing.

Find out what we're proposing by scanning the QR code.

P 0800 4769 255 (GROW AKL)
E info@supportinggrowth.nz
W supportinggrowth.govt.nz

WAKA KOTAHI
MŌHIOHIO
AGENCY

AT

New Zealand Government

Appendix C

An advertorial was published in the Papakura Courier on 14 September.



TE TUPU NGĀTAHI
SUPPORTING GROWTH

PLANNING AUCKLAND'S TRANSPORT FUTURE TOGETHER




Been delayed at a railway level crossing in Takaanini lately? You'll want to read this

In less than 10 years, trains are expected to go past level crossings in Takaanini every two to three minutes. This means safety barrier arms could be down more often than not in the morning peak, and would create significant delays for anyone trying to cross the railway tracks.

Te Tupu Ngātahi Supporting Growth (a collaboration between Auckland Transport and Waka Kotahi NZ Transport Agency), is investigating changes at level crossings in Takaanini. The changes are needed to reduce delays and to support and improve the wider transport network.

The plan is to remove existing vehicle level crossings in Takaanini. This will make it easier and more efficient to move around Takaanini because people won't need to stop for trains when safety barrier arms are down. Removing level crossings will also reduce weaknesses in the rail system because there will be a lower risk of faults and incidents.



TAKAANINI LEVEL CROSSINGS

Map showing proposed changes to level crossings in Takaanini. The map includes the Takaanini Train Station and various roads. The proposed changes are:

- Spartan Road** - We're suggesting completely closing the railway level crossing on Spartan Road and replacing it with a new walking and cycling bridge. While you won't be able to drive across the railway on Spartan Road anymore, we are proposing an alternative crossing for vehicles close by.
- Manuia Road** - We're suggesting a brand-new railway crossing at Manuia Road. It would be a fully separated crossing, like a bridge, for people walking, cycling and driving.
- Manuroa Road** - We're suggesting completely closing the railway level crossing on Manuroa Road and replacing it with a new walking and cycling bridge. While you won't be able to drive across the railway on Manuroa Road anymore, we are proposing an alternative crossing for vehicles close by.
- Taka Street** - We're suggesting closing the railway level crossing on Taka Street and replacing it with a fully separated crossing over the railway, like a bridge, for people walking, cycling and driving.
- Walters Road** - We're suggesting closing the level-crossing at Walters Road and replacing it with a fully separated crossing over the railway, like a bridge, for people walking, cycling and driving.

Gary Holmes, Manager of the Takaanini Business Association, says he looks forward to the day that he won't be stuck at a railway crossing waiting for trains to go by.

"They're looking at better options, like bridges, to get people safely across the railway tracks," says Mr Holmes. "The proposal is for some existing level crossings to be replaced with bridges for pedestrians and cyclists, and others to be replaced with bridges for use by everyone. There's even a brand-new crossing location proposed."

"Ultimately, this work will reduce delays, and that's great for Takaanini."

We're currently investigating the following:

- Spartan Road** - We're suggesting completely closing the railway level crossing on Spartan Road and replacing it with a new walking and cycling bridge. While you won't be able to drive across the railway on Spartan Road anymore, we are proposing an alternative crossing for vehicles close by.
- Manuia Road** - We're suggesting a brand-new railway crossing at Manuia Road. It would be a fully separated crossing, like a bridge, for people walking, cycling and driving.
- Manuroa Road** - We're suggesting completely closing the railway level crossing on Manuroa Road and replacing it with a new walking and cycling bridge. While you won't be able to drive across the railway on Manuroa Road anymore, we are proposing an alternative crossing for vehicles close by.
- Taka Street** - We're suggesting closing the railway level crossing on Taka Street and replacing it with a fully separated crossing over the railway, like a bridge, for people walking, cycling and driving.
- Walters Road** - We're suggesting closing the level-crossing at Walters Road and replacing it with a fully separated crossing over the railway, like a bridge, for people walking, cycling and driving.

To provide feedback or find out more information on these projects please check out our information online or call or email the project team.



haveyoursay-supportinggrowth.nz

Ph 0800 Grow Akl (088 4769 255)

Email info@supportinggrowth.nz

While the timeframe for construction is not yet confirmed, it is hoped that construction work will start within the next 10 years,¹ although this is subject to further planning and funding.

Takaanini Level Crossings

Appendix F – Urban Design Evaluation

October 2023

Version 1.0

Document Status

Responsibility	Name
Author	
Reviewer	
Approver	

Revision Status

Version	Date	Reason for Issue
0.1	06/10/2022	Draft for internal review
0.2	04/11/2022	Draft for Auckland Transport and Waka Kotahi SME review
0.3	01/01/2023	Issue for IQA review
1.0	31/10/2023	Final

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1 Introduction

This urban design evaluation has been prepared for the Takaanini Level Crossings Detailed Business Case (DBC) based on the guidance and principles established in the programme wide document - Te Tupu Ngātahi Design Framework (Design Framework).

The Design Framework takes a systems-based approach as the basis on which urban areas are organised and understood and pulls these apart as a series of layers; environment, social, built form, movement and land use, with cultural and sustainability values underpinning and spanning across these. In this way transport networks are not seen in isolation rather in terms of how they can contribute to the urban system as a whole.

The Design Framework provides measurable guidance for outcomes-based decisions throughout each phase of the programme delivery including:

- Option development
- Option evaluation
- Detailed business case preparation, and
- The corridor protection and consenting process.

There are 20 design principles that have been established within these layers to provide high level guidance on the attributes of responsive, resilient, sustainable and high-quality urban environments. Each preferred option has been evaluated against these 20 programme wide design principles based on the current design detail (Rev A). The record notes where an option is supportive of each of the design principles. Where the option was assessed as being neutral or as an opportunity for development, this has been elaborated on as urban design recommendations that should be considered and developed in future design stages.

The intention of this evaluation is to provide a high level urban design overview that considers the following:

- Spartan Road – road closure and grade separated active modes crossing
- Manuia Road – new grade separated bridge
- Manuroa Road – road closure and grade separated active modes crossing
- Taka Street – grade separated bridge on existing level crossing
- Walters Road – grade separated bridge on existing level crossing

The urban design commentary will also identify design opportunities and refinements that should be considered at subsequent stages of the design and help to form the basis of future urban design specific consent conditions.

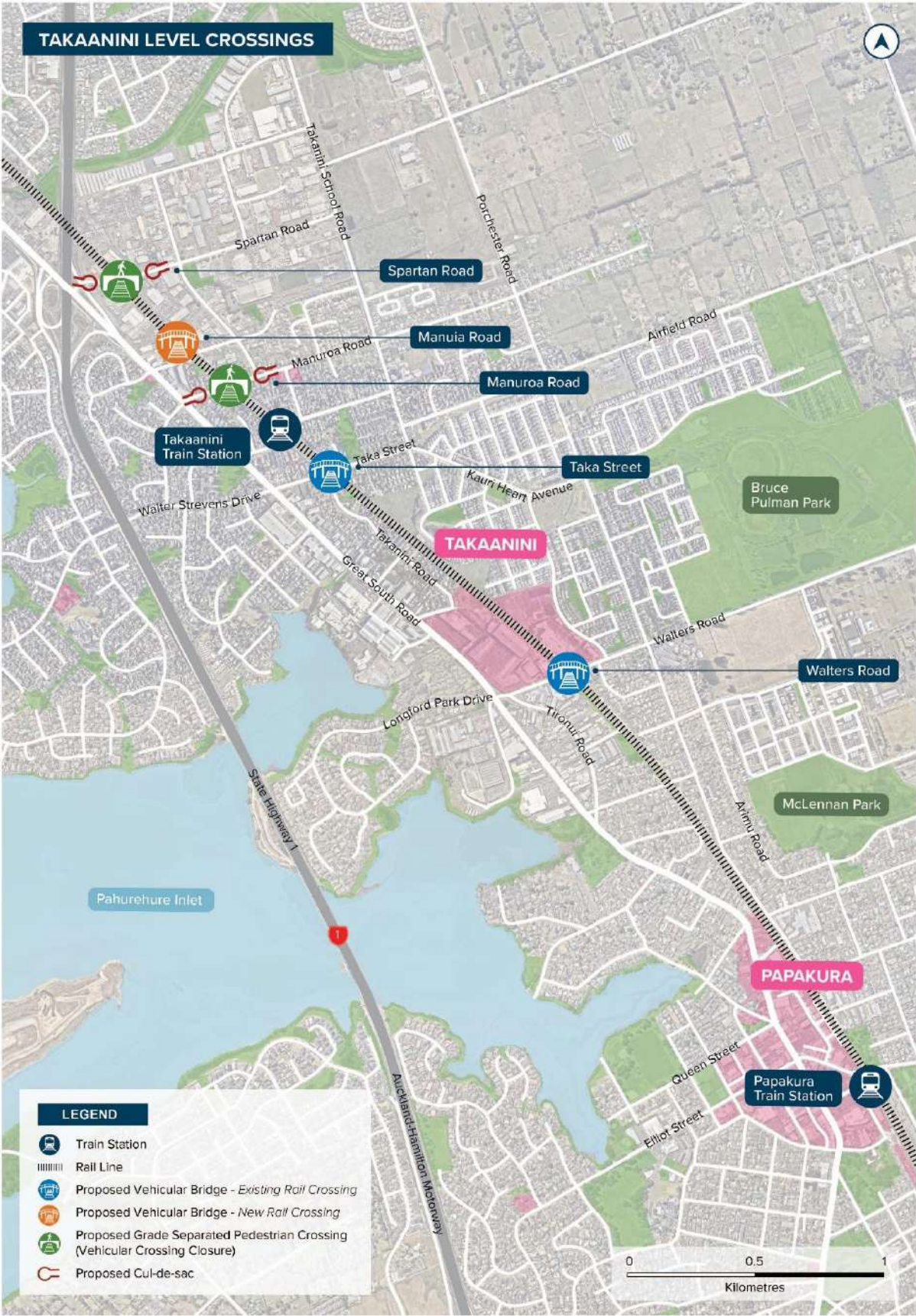


Figure 1 – Scope of projects

2 Spartan Road Preferred Option

		Supports	Neutral	Opportunity for Development	Not relevant
System layers	Design Principles				
Environment	1.1 Support and enhance ecological corridors and biodiversity				●
	1.2 Support water conservation and enhance water quality in a watershed		●		
	1.3 Minimise land disturbance, conserve resources and materials	●			
	1.4 Adapt to a changing climate and respond to the microclimatic factors of each area		●		
Social	2.1 Identity and place			●	
	2.2 Respect culturally significant sites and landscapes				●
	2.3 Adaptive corridors	●			
	2.4 Social cohesion	●			
	2.5 Safe corridors	●			
Built form	3.1 Align corridors with density				●
	3.2 Corridor scaled to the surrounding context and urban structure		●		
	3.3 Facilitate an appropriate interface between place and movement		●		
Movement	4.1 Connect nodes	●			
	4.2 Connect modes	●			
	4.3 Support access to employment and industry	●			
	4.4 Prioritise active modes and public transport	●			
	4.5 Support inter-regional connections and strategic infrastructure				●
	4.6 Support legible corridor function	●			
Landuse	5.1 Public transport directed and integrated into centres				●
	5.2 Strategic corridors as urban edges				●

Figure 2 – Spartan Road Urban Design Evaluation

The proposed grade separated active modes crossing at Spartan Road is supportive of the following Design Framework principles:

Environment

- Minimise land disturbance, conserve resources and materials

Social

- Adaptive corridors
- Social cohesion
- Safe corridors

Movement

- Connect nodes
- Connect modes
- Support access to employment and industry
- Prioritise active modes and public transport
- Support legible corridor function

The proposed grade separated active modes crossing at Spartan Road is generally supportive of the Design Framework principles. Those principles that scored neutral in their support include:

- **Support water conservation and enhance water quality in a watershed –**
Potential to provide an integrated water quality treatment system at a future stage. Currently there is flexibility within the design designation to accommodate land area for this.
- **Adapt to a changing climate and respond to the microclimatic factors of each area –**
Potential to provide amenity planting and water sensitive design elements to demonstrate consideration of urban heat island effects in this future urbanized area.
- **Crossing scaled to the surrounding context and urban structure –**
Further consideration and refinement of the spatial scale of the active modes crossing, including access stairs/ramps/elevators is needed. This is to ensure that it provides an appropriate response to the surrounding industrial area.
- **Facilitate an appropriate interface between place and movement –**
Further consideration and refinement of the active modes crossing configuration, including access stairs/ramps/elevators is needed. This is to ensure that it provides an appropriate interface and efficient connectivity into the surrounding industrial area, particularly where accessways border or overlook property boundaries.

The following principle was identified as an opportunity for development to the crossing:

- **Identity and place –**

The future design response needs to consider opportunities to incorporate underlying identity drivers of the surrounding context. This includes:

- Cultural values and narrative expressions in partnership with mana whenua. These should be considered in the arrangement of the bridge and accessway including retaining, abutments, or configurations.

The following principles were identified as not relevant to the crossing:

- Support and enhance ecological corridors and biodiversity
- Respect culturally significant sites and landscapes
- Align corridors with density
- Support inter-regional connections and strategic infrastructure
- Public transport directed and integrated into centres
- Strategic corridors as urban edges

3 Manuia Road Preferred Option

		Supports	Neutral	Opportunity for Development	Not relevant
System layers	Design Principles				
Environment	1.1 Support and enhance ecological corridors and biodiversity				●
	1.2 Support water conservation and enhance water quality in a watershed		●		
	1.3 Minimise land disturbance, conserve resources and materials		●		
	1.4 Adapt to a changing climate and respond to the microclimatic factors of each area		●		
Social	2.1 Identity and place			●	
	2.2 Respect culturally significant sites and landscapes				●
	2.3 Adaptive corridors	●			
	2.4 Social cohesion	●			
	2.5 Safe corridors			●	
Built form	3.1 Align corridors with density	●			
	3.2 Corridor scaled to the surrounding context and urban structure		●		
	3.3 Facilitate an appropriate interface between place and movement		●		
Movement	4.1 Connect nodes	●			
	4.2 Connect modes	●			
	4.3 Support access to employment and industry	●			
	4.4 Prioritise active modes and public transport	●			
	4.5 Support inter-regional connections and strategic infrastructure				●
	4.6 Support legible corridor function	●			
Landuse	5.1 Public transport directed and integrated into centres				●
	5.2 Strategic corridors as urban edges	●			

Figure 3 – Manuia Road Urban Design Evaluation

The proposed bridge crossing at Manuia Road is supportive of the following Design Framework principles:

Social

- Adaptive corridors
- Social cohesion

Built form

- Align corridors with density

Movement

- Connect nodes
- Connect modes
- Support access to employment and industry
- Prioritise active modes and public transport
- Support legible corridor function

Landuse

- Strategic corridors as urban edges

The proposed bridge crossing at Manuia Road is generally supportive of the Design Framework principles. Those principles that scored neutral in their support include:

- **Support water conservation and enhance water quality in a watershed –**
Potential to provide an integrated water quality treatment system in future stages. Currently there is flexibility within the design designation to accommodate land area for this. This should be considered in conjunction with and alongside a landscaping strategy to reduce hard engineering solutions.
- **Minimise land disturbance, conserve resources and materials –**
Further design detail on the extent of earthworks and retaining structures is required to address their impact and mitigate adverse effects. Consideration of a retained solution alongside the bridge instead of embankments that maximises the potential of built form outcomes on aggregated land should be explored.
- **Adapt to a changing climate and respond to the microclimatic factors of each area –**
Provide further details and definition at future design stages of the proposed amenity planting and water sensitive design elements to demonstrate consideration of urban heat island effects in this future urbanized area.
- **Crossing scaled to the surrounding context and urban structure –**
The crossing provides an appropriate response to the potential needs of the adjacent precinct functions, by providing connectivity to the industrial employment lands to the north. However, further consideration and refinement of the spatial scale and configuration of the bridge crossing in relation to adjacent land use is required. This includes consideration of high density residential zoning under the policy guidance of the NPS-UD. Considerations to be addressed could include, overshadowing, building offsets and residual space function.

- **Facilitate an appropriate interface between place and movement –**

An urban integration strategy should be developed in future stages to address interface issues with bridging structures, retaining walls and ramp connections particularly to the residential area to the south. This will provide for active edge permeability, maximise built form outcomes, and ensure local access and connectivity can be achieved.

Consideration should also be given to fine grain pedestrian access around the intersections at Great South Road and Oakleigh Avenue.

The following principles were identified as opportunity for development to the crossing:

- **Identity and place –**

The future design response needs to consider opportunities to incorporate underlying identity drivers of the surrounding context. This includes:

- Cultural values and narrative expressions in partnership with mana whenua, these should be considered in the arrangement of the bridge and accessway including retaining, abutments, or configurations.
- Addressing the existing and future amenity values of the surrounding area.

- **Safe corridors –**

Further definition and resolution of the spatial arrangement, residential street address and unresolved residual land around the accessway is needed. Considerations to be addressed could include residual space function, public private interface with existing residential and the potential to support high density residential redevelopment under the NPS-UD.

The following principles were identified as not relevant to the crossing:

- Support and enhance ecological corridors and biodiversity
- Respect culturally significant sites and landscapes
- Support inter-regional connections and strategic infrastructure
- Public transport directed and integrated into centres

4 Manuroa Road Preferred Option

		Supports	Neutral	Opportunity for Development	Not relevant
System layers	Design Principles				
Environment	1.1 Support and enhance ecological corridors and biodiversity				●
	1.2 Support water conservation and enhance water quality in a watershed		●		
	1.3 Minimise land disturbance, conserve resources and materials	●			
	1.4 Adapt to a changing climate and respond to the microclimatic factors of each area		●		
Social	2.1 Identity and place			●	
	2.2 Respect culturally significant sites and landscapes				●
	2.3 Adaptive corridors	●			
	2.4 Social cohesion	●			
	2.5 Safe corridors	●			
Built form	3.1 Align corridors with density	●			
	3.2 Corridor scaled to the surrounding context and urban structure		●		
	3.3 Facilitate an appropriate interface between place and movement		●		
Movement	4.1 Connect nodes	●			
	4.2 Connect modes	●			
	4.3 Support access to employment and industry				●
	4.4 Prioritise active modes and public transport	●			
	4.5 Support inter-regional connections and strategic infrastructure				●
	4.6 Support legible corridor function	●			
Landuse	5.1 Public transport directed and integrated into centres				●
	5.2 Strategic corridors as urban edges				●

Figure 4 – Manuroa Road Urban Design Evaluation

The proposed grade separated active modes crossing at Manuroa Road is supportive of the following Design Framework principles:

Environment

- Minimise land disturbance, conserve resources and materials

Social

- Adaptive corridors
- Social cohesion
- Safe corridors

Built form

- Align corridors with density

Movement

- Connect nodes
- Connect modes
- Prioritise active modes and public transport
- Support legible corridor function

The proposed grade separated active modes crossing at Manuroa Road is generally supportive of the Design Framework principles. Those principles that scored neutral in their support include:

- **Support water conservation and enhance water quality in a watershed –**
Potential to provide an integrated water quality treatment system at a future stage. Currently there is flexibility within the design designation to accommodate land area for this.
- **Adapt to a changing climate and respond to the microclimatic factors of each area –**
Potential to provide amenity planting and water sensitive design elements to demonstrate consideration of urban heat island effects in this future urbanized area.
- **Crossing scaled to the surrounding context and urban structure –**
Further consideration and refinement of the spatial scale of the active modes crossing including access stairs/ramps/elevators is needed. This is to ensure that it provides an appropriate response to the surrounding residential area and in particular to the future high density residential proposed under the NPS-UD.
- **Facilitate an appropriate interface between place and movement –**
Further consideration and refinement of the active modes crossing configuration, including access stairs/ramps/elevators is needed. This is to ensure that it provides an appropriate interface and efficient connectivity into the surrounding residential area, particularly where accessways border or overlook property boundaries. Connectivity to the Takaanini Train Station should also be considered.

The following principles were identified as opportunity for development to the crossing:

- **Identity and place –**

The future design response needs to consider opportunities to incorporate underlying identity drivers of the surrounding context. This includes:

- Cultural values and narrative expressions in partnership with mana whenua, these should be considered in the arrangement of the bridge and accessway including retaining, abutments, and configurations.
- Addressing the existing and future amenity values of the surrounding area, particularly in relationship to the Takaanini Train Station.

The following principles were identified as not relevant to the crossing:

- Support and enhance ecological corridors and biodiversity
- Respect culturally significant sites and landscapes
- Support access to employment and industry
- Support inter-regional connections and strategic infrastructure
- Public transport directed and integrated into centres
- Strategic corridors as urban edges

5 Taka Street Preferred Option

		Supports	Neutral	Opportunity for Development	Not relevant
System layers	Design Principles				
Environment	1.1 Support and enhance ecological corridors and biodiversity				●
	1.2 Support water conservation and enhance water quality in a watershed		●		
	1.3 Minimise land disturbance, conserve resources and materials		●		
	1.4 Adapt to a changing climate and respond to the microclimatic factors of each area		●		
Social	2.1 Identity and place			●	
	2.2 Respect culturally significant sites and landscapes				●
	2.3 Adaptive corridors	●			
	2.4 Social cohesion	●			
	2.5 Safe corridors			●	
Built form	3.1 Align corridors with density	●			
	3.2 Corridor scaled to the surrounding context and urban structure			●	
	3.3 Facilitate an appropriate interface between place and movement			●	
Movement	4.1 Connect nodes	●			
	4.2 Connect modes	●			
	4.3 Support access to employment and industry	●			
	4.4 Prioritise active modes and public transport	●			
	4.5 Support inter-regional connections and strategic infrastructure				●
	4.6 Support legible corridor function	●			
Landuse	5.1 Public transport directed and integrated into centres				●
	5.2 Strategic corridors as urban edges				●

Figure 5 – Taka Street Urban Design Evaluation

The proposed bridge crossing at Taka Street is supportive of the following Design Framework principles:

Social

- Adaptive corridors
- Social cohesion

Built form

- Align corridors with density

Movement

- Connect nodes
- Connect modes
- Support access to employment and industry
- Prioritise active modes and public transport
- Support legible corridor function

The proposed bridge crossing at Taka Street is generally supportive of the Design Framework principles. Those principles that scored neutral in their support include:

- **Support water conservation and enhance water quality in a watershed –**
Potential to provide an integrated water quality treatment system at a future stage. Currently there is flexibility within the design designation to accommodate land area for this.
- **Minimise land disturbance, conserve resources and materials –**
Further design detail on the extent of earthworks and retaining structures required to address their impact and mitigate adverse effects.
- **Adapt to a changing climate and respond to the microclimatic factors of each area –**
Provide further details and definition at future design stages of the proposed amenity planting and water sensitive design elements. This is to demonstrate consideration of urban heat island effects in this future urbanized area.

The following principles were identified as opportunity for development to the crossing:

- **Identity and place –**
The future design response needs to consider opportunities to incorporate underlying identity drivers of the surrounding context. This includes:
 - Cultural values and narrative expressions in partnership with mana whenua, these should be considered in the arrangement of the bridge and accessway including retaining, abutments, or configurations.
 - Addressing the existing and future amenity values of the surrounding area, including Takaanini Train Station and Takaanini Reserve.

- **Safe corridors –**

Residual parcels of land adjacent to the rail line and under the bridge could lead to potential CPTED and functionality issues. Further clarification and refinement of the spatial arrangement is needed in future design stages in order to provide legible and safe active modes connections between Taka Street and Takaanini Train Station.

- **Crossing scaled to the surrounding context and urban structure –**

The scale of the proposed bridge poses challenges to the existing context, including single level housing, a carehome and small neighbourhood park. The spatial scale and relationship to the surrounding context requires further definition and resolution. This includes consideration of how the area could develop in the future with high density residential under the NPS-UD.

Considerations to be addressed could include, overshadowing, building offsets and residual space function.

- **Facilitate an appropriate interface between place and movement –**

The functionality and legibility of the accessways and residual space under the bridge is unresolved. Wayfinding is potentially compromised for pedestrians which could lead to public private interface issues. Facilitating a clear active modes connection between Taka Street and the Takaanini Train Station is important within this context.

An urban integration strategy should be developed in future stages to address interface issues with bridging structures, retaining walls and accessways. This will provide for active edge permeability, maximise built form outcomes, and ensure local access and connectivity can be achieved.

The following principles were identified as not relevant to the crossing:

- Support and enhance ecological corridors and biodiversity
- Respect culturally significant sites and landscapes
- Support inter-regional connections and strategic infrastructure
- Public transport directed and integrated into centres
- Strategic corridors as urban edges

6 Walters Road Preferred Option

		Supports	Neutral	Opportunity for Development	Not relevant
System layers	Design Principles				
Environment	1.1 Support and enhance ecological corridors and biodiversity				●
	1.2 Support water conservation and enhance water quality in a watershed		●		
	1.3 Minimise land disturbance, conserve resources and materials		●		
	1.4 Adapt to a changing climate and respond to the microclimatic factors of each area		●		
Social	2.1 Identity and place			●	
	2.2 Respect culturally significant sites and landscapes				●
	2.3 Adaptive corridors	●			
	2.4 Social cohesion	●			
	2.5 Safe corridors		●		
Built form	3.1 Align corridors with density	●			
	3.2 Corridor scaled to the surrounding context and urban structure			●	
	3.3 Facilitate an appropriate interface between place and movement			●	
Movement	4.1 Connect nodes	●			
	4.2 Connect modes	●			
	4.3 Support access to employment and industry	●			
	4.4 Prioritise active modes and public transport	●			
	4.5 Support inter-regional connections and strategic infrastructure				●
	4.6 Support legible corridor function	●			
Landuse	5.1 Public transport directed and integrated into centres				●
	5.2 Strategic corridors as urban edges				●

Figure 6 – Walters Road Urban Design Evaluation

The proposed bridge crossing at Walters Road is supportive of the following Design Framework principles:

Social

- Adaptive corridors
- Social cohesion

Built form

- Align corridors with density

Movement

- Connect nodes
- Connect modes
- Support access to employment and industry
- Prioritise active modes and public transport
- Support legible corridor function

The proposed bridge crossing at Walters Road is generally supportive of the Design Framework principles. Those principles that scored neutral in their support include:

- **Support water conservation and enhance water quality in a watershed –**
Potential to provide an integrated water quality treatment system at a future stage. Currently there is flexibility within the design designation to accommodate land area for this. In this location there is potential to consider integration with the water retention area adjacent to Arion Road intersection.
- **Minimise land disturbance, conserve resources and materials –**
Further design detail on the extent of earthworks and retaining structures is required to address their impact and mitigate adverse effects.
- **Adapt to a changing climate and respond to the microclimatic factors of each area –**
Provide further details and definition at future design stages of the proposed amenity planting and water sensitive design elements. This is to demonstrate consideration of urban heat island effects in this future urbanized area.
- **Safe corridors –**
Residual parcels of land adjacent to the rail line and under the bridge could lead to potential CPTED and functionality issues. Further clarification and refinement of the spatial arrangement is needed for how this is addressed in future design stages.

The following principles were identified as opportunity for development to the crossing:

- **Identity and place –**
The future design response needs to consider opportunities to incorporate underlying identity drivers of the surrounding context. This includes:

- Cultural values and narrative expressions in partnership with mana whenua, these should be considered in the arrangement of the bridge and accessway including retaining, abutments, or configurations.
- Addressing the urban space qualities of the Takaanini local centre and future amenity values of the surrounding area.
- **Crossing scaled to the surrounding context and urban structure –**
The scale of the proposed bridge poses challenges to the existing context, including low level housing and the Takaanini local centre. The spatial scale and relationship to the surrounding built form requires further definition and resolution. Considerations to be addressed could include, overshadowing, building offsets and residual space function.
- **Facilitate an appropriate interface between place and movement –**
The functionality and legibility of the accessways and surrounding residual land is unresolved. An urban integration strategy should be developed in future stages to address interface issues with bridging structures, retaining walls and accessways. This will provide for active edge permeability, maximise built form outcomes, and ensure local access and connectivity can be achieved. The commercial area to the south east of the crossing is important in this context. Consideration should also be given to fine grain pedestrian access and prioritisation at intersections as a significant active modes link between the Great South Road and Porchester Road FTN's.

The following principles were identified as not relevant to the crossing:

- Support and enhance ecological corridors and biodiversity
- Respect culturally significant sites and landscapes
- Support inter-regional connections and strategic infrastructure
- Public transport directed and integrated into centres
- Strategic corridors as urban edges

Takaanini Level Crossings Appendix G – Transport Outcomes Report

October 2023

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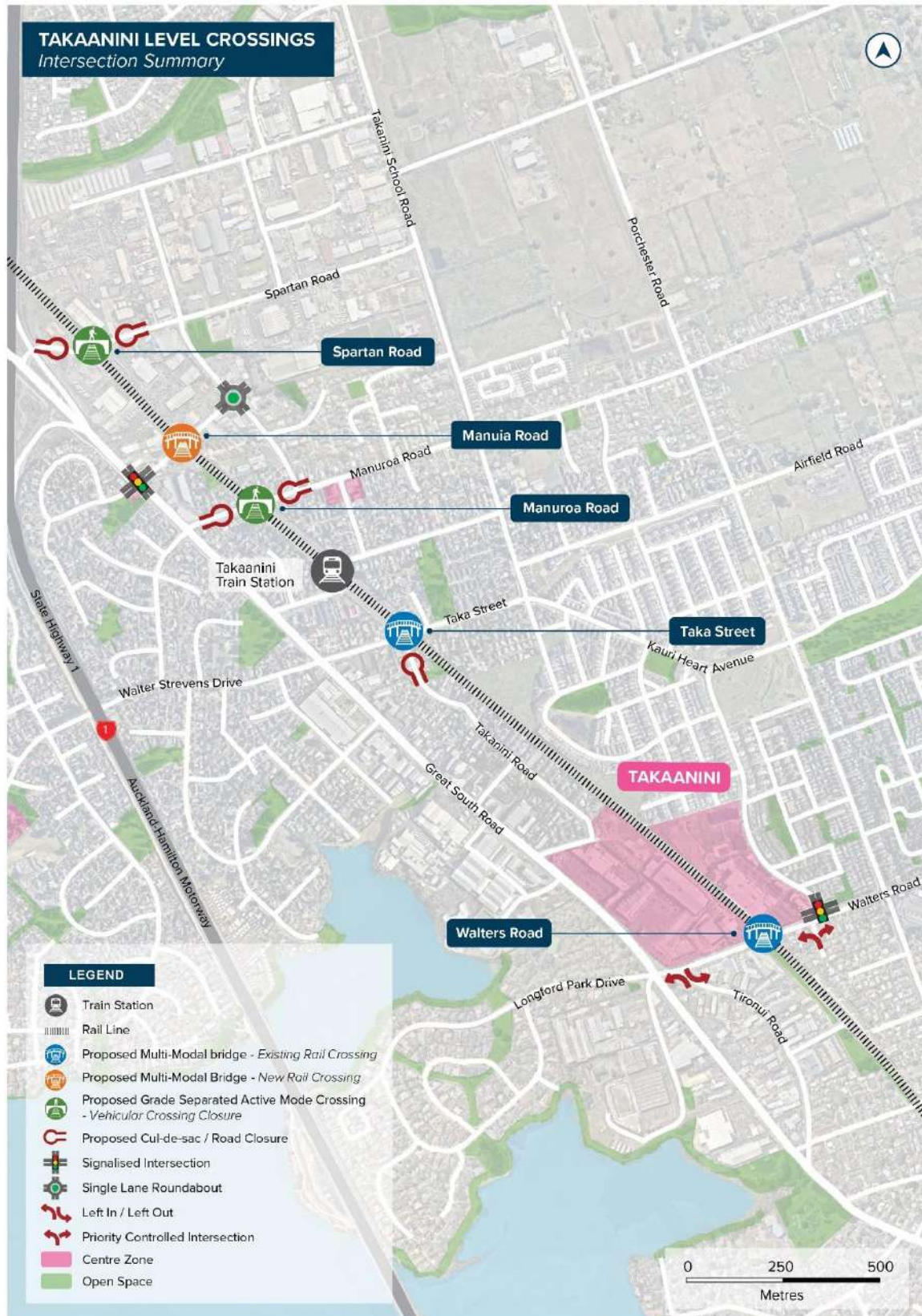
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Acronyms

Acronym/Term	Description
ADT	Average Daily Traffic (number of vehicles per day)
ALT	Alliance Leadership Team
AMP	Alliance Management Plan
AMT	Alliance Management Team
AT	Auckland Transport
AUP	Auckland Unitary Plan
DBC	Detailed Business Case
Do-min	Do-Minimum Option
FUZ	Future Urban Zone
FULSS	Future Urban Land Supply Strategy
GIS	Geographic Information System
IBC	South Indicative Business Case
KPI	Key Performance Indicator
LOS	Level of Service
MCA	Multi-Criteria Assessment
MSM	Macro Strategic Model
NIMT	North Island Main Trunk
NOP	Non-Owner Participant (AECOM, Beca, Bell Gully, Buddle Findlay)
OP	Owner Participant
PAA	Programme Alliance Agreement
PAB	Programme Alliance Board
PCG	Project Control Group
PMO	Programme Management Office
PT	Public Transport
QoS 1	Quality of Service 1
RAMC	Regional Active Mode Corridor
RT	Rapid Transit

Acronym/Term	Description
RTC	Rapid Transit Corridor
RTN	Rapid Transit Network
SATURN	Meso-simulation modelling software package used for transport assessment – Simulation and Assignment of Traffic to Urban Road Network
Te Tupu Ngātahi	Supporting Growth Alliance
Waka Kotahi	Waka Kotahi New Zealand Transport Agency

1 Introduction

1.1 Purpose and scope of the report

This Transport Outcomes report has been prepared by Te Tupu Ngātahi for the Takaanini Level Crossings Detailed Business Case (Takaanini Level Crossings DBC). Te Tupu Ngātahi (the Supporting Growth Alliance) is a collaboration between Waka Kotahi NZ Transport Agency (Waka Kotahi) and Auckland Transport (AT) to carry out the planning phase of the Te Tupu Ngātahi Programme (the Programme) (formerly known as the Transport for Future Urban Growth (TFUG) Programme).

This Transport Outcomes report:

- Details the transport outcomes including Key Performance Indicators (KPIs) of the recommended network for Takaanini Level Crossings.
- Provides an overview of the key transport assessments undertaken to support the optioneering process for the Takaanini Level Crossings recommended network including:
 - Corridor Form and Function assessments, and
 - Intersection Form and Function assessments.

As identified, the focus of this report is the transportation outcomes of the recommended network for Takaanini Level Crossings only, with a more detailed description of the option development and assessment process provided within Appendix C - Options Assessment Report.

A separate DBC under the Takaanini DBC Package is the South Frequent Transit Network (FTN) DBC, which is being undertaken in parallel and focused on developing the strategic FTN routes between Drury and Manukau.

1.2 Report Structure

The report has been split into several sections, covering the following:

Section 2 provides some wider strategic context for this project.

Section 3 summarises the recommended network for the Takaanini Level Crossings corridors.

Section 4 summarises the investment objectives identified for the Takaanini Level Crossings corridors and the associated Key Performance Indicators (KPIs) set for each of these objectives. These KPIs subsequently measure how well the recommended network performs against the investment objectives.

Section 5 summarises the transport assessment undertaken to reach the recommended network.

There are several appendices to this report that provide further detail, specifically:

- Appendix 1: Form and Function Takaanini Level Crossings Corridors
- Appendix 2: Intersection Methodology and Performance Summary
- Appendix 3: KPI Development and Methodology
- Appendix 4: Modelling Specifications

2 Strategic Context and Baseline Scenarios

Passenger rail is planned to provide the core rapid transit functionality for southern Auckland to drive significant mode shift away from reliance on passenger cars. Various existing and planned projects are progressing the expansion of the southern rail line capacity and attractiveness, including:

- Higher train frequencies enabled by the CRL project
- Additional rail capacity at key locations such as Wiri
- Electrification of the passenger rail services to Pukekohe
- New rail stations in Drury and Paerata
- Inter-regional passenger rail service to Hamilton
- Station upgrade works
- Additional track capacity (4-track) planned from Pukekohe to Wiri (longer-term)

Collectively, these upgrades are estimated to result in a significant mode shift to public transport, to address both existing needs and accommodate the high growth planned in both southern Auckland and northern Waikato regions. Figure 2- indicates the significant uplift in travel (of over 450% in the region of the level crossings) by public transport predicted with the rail upgrades in place, the majority of which would be carried by the rail system.

This Level Crossings project therefore sits within this wider mode-shift strategy, as an important part of enabling increased rail capacity in the future.

Given this strategic context, various different 'baseline' scenarios were assessed when considering the proposed Project investment:

- **Scenario 1:** This scenario assumes that the train frequency and track capacity upgrades proceed (as separate projects), with consequential impact in Takaanini from the progressively worsening delays and safety risks at the level crossings
- **Scenario 2:** This scenario assumes that the train frequency and track capacity upgrades proceed (as separate projects), however the consequential impact in Takaanini from the progressively worsening delays and safety risks at the level crossings is considered so significant that the level crossings are closed ahead of level crossing replacements being implemented
- **Scenario 3:** The train frequency and track capacity upgrades to the rail system are constrained due to the impact at the level crossings in Takaanini.

Under baseline scenarios 1 and 2, the Project would primarily result in improving east-west connectivity within and to Takaanini. Under baseline scenario 3, the Project would improve east-west connectivity in Takaanini, but also enable higher rail service, with wider network mode shift benefits.

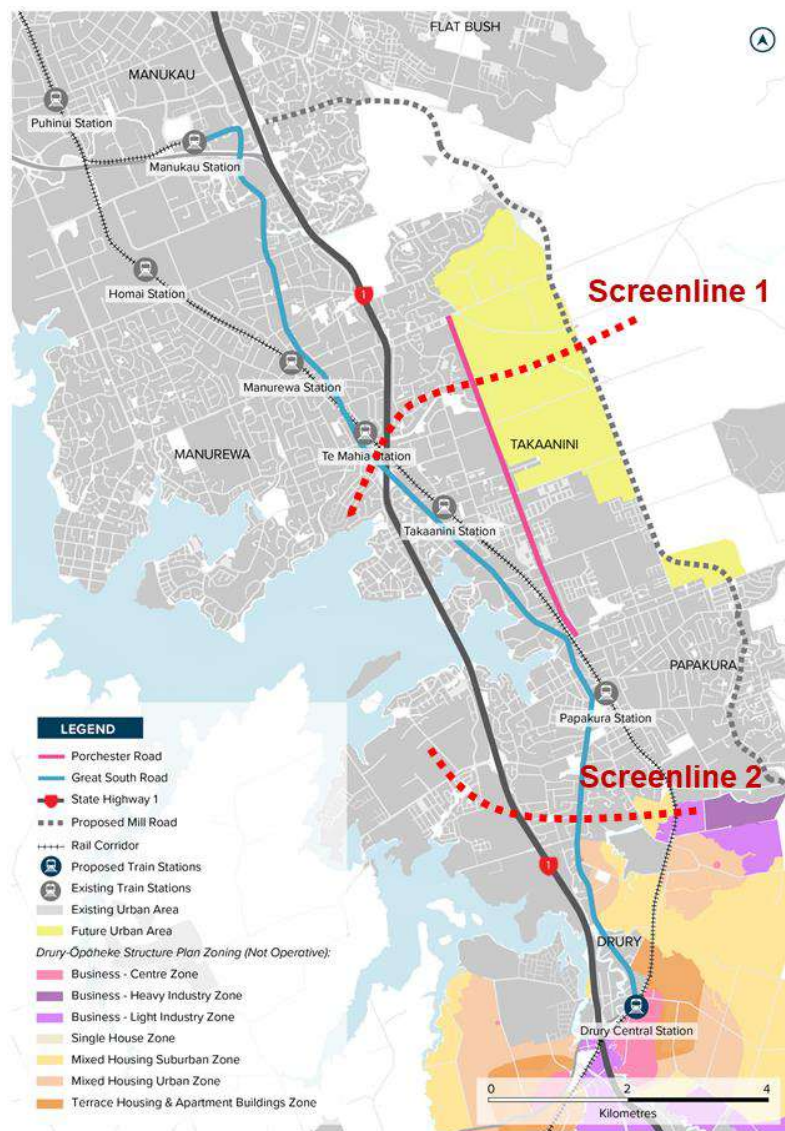
Although Scenario 3 is considered a valid possibility, this assessment report has focussed on comparison of the Project against scenarios 1 and 2. This permits the Project to be considered as a stand-alone business case, whereas an issue with Scenario 3 is that rail must be prioritised over road crossings by virtue of the Railway Act and hence would include costs and benefits for transport elements beyond the scope of this investment (such as increased rail frequency/capacity).

Therefore, while this Project has been considered primarily as a Takaanini accessibility Project, it arguably also contributes to the wider sub-regional PT strategy in southern Auckland. Additionally, while this Project is treated independently of the FTN project (which is the subject of a separate Business Case), the Baseline scenarios used here have all assumed the two FTN corridors are

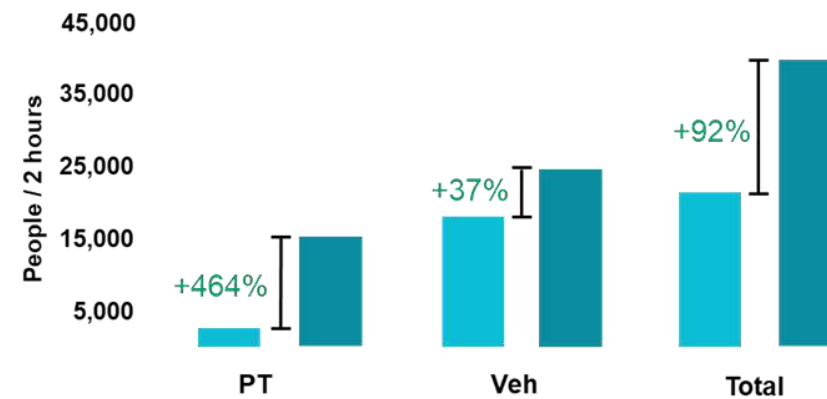
implemented. This is to ensure the crossing Project is developed in an integrated approach with the FTN corridors.

For the purposes of reporting, scenario 1 and scenario 2 will be referred to as 'Do Nothing' and 'Do Minimum Closure' respectively, through this report.

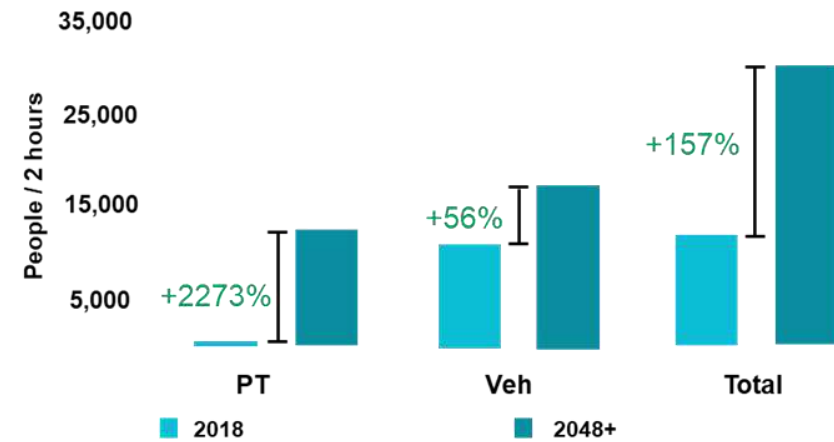
Figure 2-1: South growth context - people movement



Screenline 1 People Movement (NBD AM)



Screenline 2 People Movement (NBD AM)



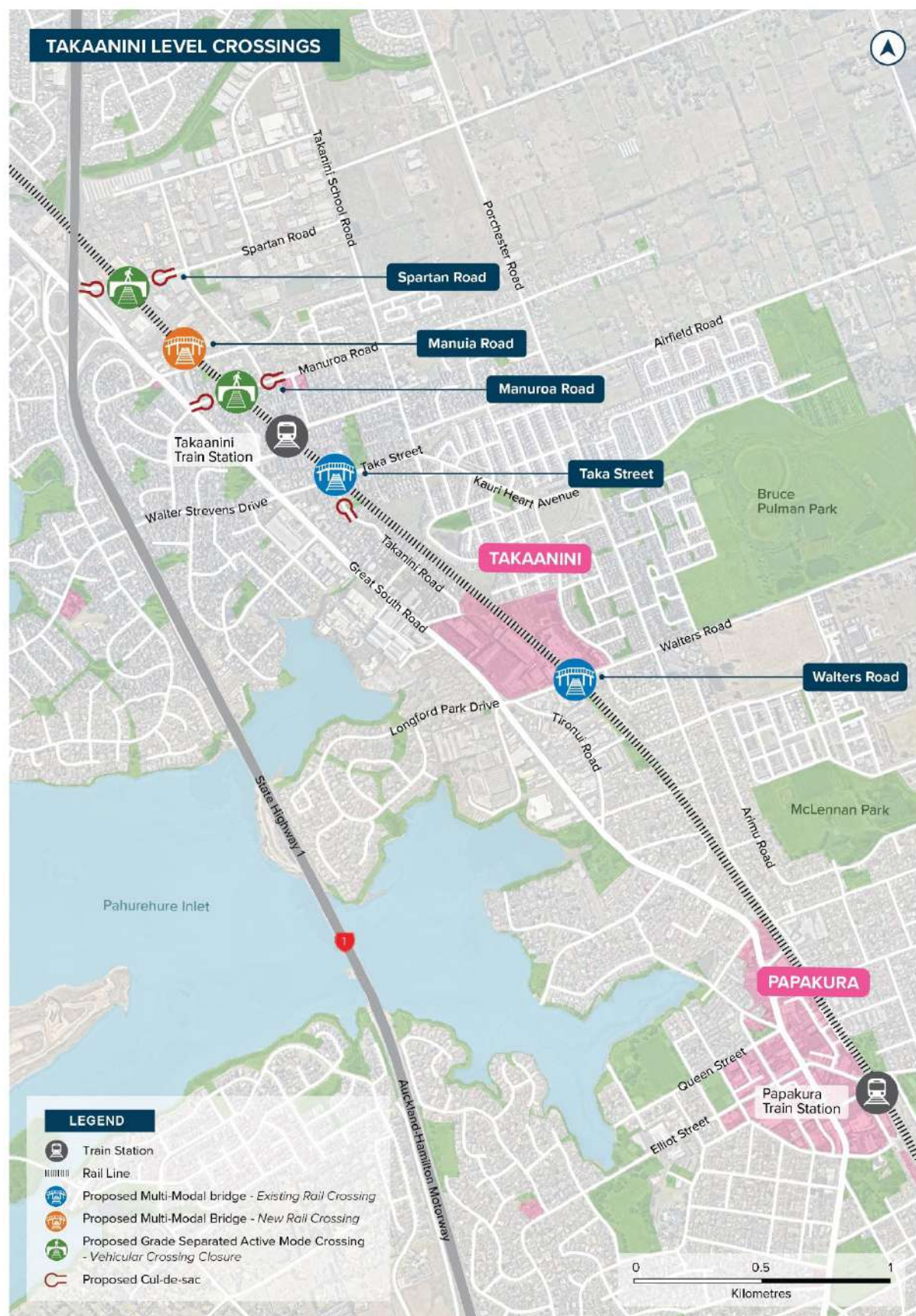
3 Recommended network

The following section outlines the recommended option for the Takaanini Level Crossings DBC. The recommended network for the Takaanini Level Crossings DBC consists of the removal and/or replacement of existing level crossings. Further detail on the specific features of these interventions are provided in the following section.

Overall, it is considered that the Takaanini Level Crossings recommended network provides a safe, reliable transport system that supports growth, offers sustainable travel choice and access to employment and social amenities.

Figure 3- shows the overall Takaanini Level Crossing emerging recommended network. The figure shows which level crossings will be closed or replaced with grade-separated bridges for all modes or active mode bridges. The figure also shows where new connections are proposed.

Figure 3-1: Recommended Takaanini Level Crossings Option



The Takaanini Level Crossings recommended network is summarised below:

- The project is no longer recommending a new grade-separated crossing/viaduct at **Rangi Road**, as initially recommended in the IBC.
- A new grade-separated bridge connection is proposed between **Manuia Road** and Oakleigh Avenue/ Hitchcock Road. The connection will provide direct access to the Takaanini industrial area.
- Existing level crossings at **Spartan Road** and **Manuroa Road** will be fully closed to vehicular traffic but will be replaced by grade-separated active mode bridges.
- Existing level crossings at **Taka Street** and **Walters Road** will also be closed but will be replaced by grade-separated bridges which will accommodate all modes.
- Separated walking and cycling facilities will be provided in the bridge footprint at the location where a grade-separated crossing is recommended i.e., Manuia Road, Taka Street and Walters Road.

Table 3-1 summarises the recommended option, indicating where closure or access is occurring at each level crossing in relation to active modes and vehicular traffic, separately. The table also summarises the network role of each level crossing connection in the future.

Table 3-1: Takaanini east-west crossing connection network summary

East west crossing	Vehicular traffic (open/ closed)	Active modes (open/ closed)	Role in the network
Alfriston Road	Open (existing bridge)	Open	FTN route
Spartan Road	Closed	Open	Active mode connection
Manuia Road	Open	Open	Multimodal E-W connection to industrial area
Manuroa Road	Closed	Open	Active mode connection
Taka Street	Open	Open	Multimodal E-W connection
Walters Road	Open	Open	Multimodal E-W connection

Open – New or existing crossing or bridge

Closed – Existing level crossing removed and existing corridor to be a cul-de-sac

The key east-west corridors that are recommended in the Takaanini network are as follows:

- **Spartan Road** – A key walking and cycling connection providing access between Great South Road and the Takaanini industrial area. This active mode facility will provide connectivity to the Southern Path which is part of the regional cycle network. A Spartan Road active mode connection will reduce severance caused by closing the level crossing and the constraints due to the Papakura Stream to the north. It is expected that walking and cycling demand will increase on Spartan Road, contingent on the development of the industrial zone surrounding Spartan Road. This walking and cycling connection will provide access to employment in the future, given the expected increase in jobs in the Takaanini industrial area.

- **Manuia Road** – A two lane multi-modal secondary arterial connection with dedicated walking and cycling facilities. Manuia Road will connect Great South Road to the Takaanini industrial area and will be a key freight connection, enabling access to employment.
- **Manuroa Road** - A key walking and cycling connection providing access between Great South Road and key destination on the eastern side of the rail line such as Takaanini School, Takaanini Train Station and the neighbourhood centre. Manuroa Road will increase active mode permeability across the southern rail line in the Takaanini network.
- **Taka Street** - A two lane multi-modal secondary arterial connection with dedicated walking and cycling facilities. Taka Street has a wider strategic function of connecting with Airfield Road to provide an east-west connection through to Clevedon. Taka Street also provides connectivity to the Conifer Grove residential catchment on the western side of SH1.
- **Walters Road** - A two lane multi-modal secondary arterial connection with dedicated walking and cycling facilities. This connection will provide access to adjacent retail and nearby recreational activities. Walters Road has a wider function of providing an east-west link between Great South Road and the N-S Mill Road strategic arterial.

4 Investment Objectives and KPIs for the Takaanini Level Crossings Recommended Option

The following section provides a breakdown of the performance of the Takaanini Level Crossings recommended option against the Investment Objectives and subsequent KPIs.

The KPI measures compare the 'Do Nothing' and 'Do Minimum Closure' transport networks (baseline scenario 1 and 2 referenced in Section 2), against the proposed Te Tupu Ngātahi projects in the recommended South DBC network, using a full build-out 2048+ scenario.

The 2048+ land use scenario was agreed with Auckland Council to be the most appropriate scenario for route protection purposes. This is not a specified date but reflects the full build-out (post 2048) of the currently planned development, which then informs the long-term infrastructure needs.

The proposed South DBC projects and improvements have been identified in order to support growth in the South and unlock the future land use. These South DBC projects are shown in Table 4-1, with the present Takaanini Level Crossings DBC highlighted in bold.

Table 4-1: Te Tupu Ngātahi DBC Packages in the South

DBC Package	DBC	Projects / Elements
Takaanini DBC Package	Level Crossings DBC assessed for removal and/or replacement (this DBC)	• Spartan Road • Manuia Road • Manuroa Road • Taka Street • Walters Road
	South Frequent Transit Network (FTN) (being prepared in parallel with this DBC)	• Great South Road FTN between Drury Central Station and Manukau Station • Takaanini FTN between Drury West Station and Manukau Station • Popes Road and Croskery Road urbanisation
Rail DBC Package	Rail DBC	• New Drury West Station • New Drury Central Station • New Paerata Station • Additional rail capacity (four tracks between Wiri and Pukekohe)
South Strategic DBC Package	Mill Road and Drury DBC	• Mill Road Corridor upgrades • Upgrades in Drury
	Pukekohe DBC	• Alternative route to SH22 between SH1 and Pukekohe • New arterial connections to the proposed Pukekohe
Drury Local	Drury Local Arterials DBC	• New Drury arterial network

In addition to these projects, there are several key strategic projects that integrate with this network including:

- The City Rail Link (CRL) project currently being delivered by City Rail Link Ltd and anticipated to go live in December 2024,
- The four-tracking of the rail corridor between Wiri and Pukekohe which is expected to be implemented post 2032.
- Electrification of the passenger rail services to Pukekohe
- Station upgrade works as part of the Takaanini Station Masterplan and Auckland RTN Station study

It is the combination of these projects and the proposed Te Tupu Ngātahi projects that will enable the key transport and land use integration outcomes for the South community.

The inclusion of the key interdependent strategic projects in the baseline scenario networks (Do Nothing and Do Minimum Closure) is to account for the fact that those projects are being developed outside of the present DBC, so are not included as part of the Takaanini Level Crossings improvements.

It is noted that by incorporating these projects into the baseline scenarios, this will result in significant strategic transport improvements for the people living and working in the South in the future. In particular, it is expected that both the implementation of CRL and four-tracking will enable a large proportion of people in Takaanini and the wider South area to utilise trains for their trip purposes.

The result of these assumptions is that growth in PT users between the baseline scenario models and the recommended network model does not appear as significant as would otherwise be expected. The strategic network outcomes, including higher PT patronage are already present in the baseline scenario models, with the remaining changes in the Takaanini Level Crossings DBC recommended option reflecting supporting infrastructure to maximise the system-wide outcomes. The recommended network will enable better connections between and through the residential and industrial areas in Takaanini, enabling improved and safer travel choices to access the strategic projects assumed in the baseline scenario networks.

The key difference in the strategic network between the baseline scenarios and Takaanini Level Crossings recommended network is the replacement of grade-separated all-mode bridges at the closures of the existing level crossings; at Taka Street and Walters Road and the addition of a grade-separated all mode bridge at Manuia Road. Another key difference is the walking and cycling bridge replacements proposed at the Spartan Road and Manuroa Road level crossing closures.

4.1 Overall Takaanini Level Crossings Outcomes

As detailed above, the Takaanini Level Crossings recommended option has been developed within the context of a wider network, Table 4-2 reports on the overall outcomes of the entire system. The reported measures are based on the complete network, with the complete buildout- of projected growth in the South.

Table 4-2: Takaanini Level Crossings Outcomes

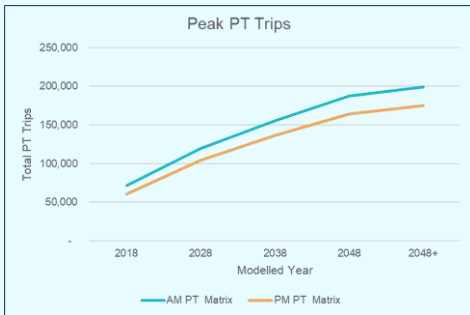
Key Performance Indicator	Measure	Outcome	Commentary
Investment Objective 1: Safety (Provide improvements at level crossings that contribute to a transport network that is free from deaths and serious injuries)			
DSIs (deaths and serious injuries)	Number of level crossing related incidents	4 DSIs/year are estimated to be saved in 2048+. From 2012 to 2020 there were 15 recorded crashes related to level crossings¹: • 2 at Spartan Road • 7 at Manuroa Road • 3 at Taka Street • 3 at Walters Road These crashes involved collisions with barrier arms, trains, or vehicles waiting for barrier clearance. With the forecasted growth in the area the number of crashes is expected to be exacerbated. Aside from the recorded crashes, the CAS (Crash Analysis System) does not consider barrier incidents that would result in near misses and safety risks. The number of faults/ incidents are reported under Investment Objective 3 – Resilience. Recommended network saves an estimated 120 DSIs over 40 years compared to the Do Minimum Closure scenario (based on a crash rate analysis). Recommended network saves an estimated 36 DSIs over 40 years compared to the Do Nothing scenario (based on a crash rate analysis).	Crashes at high-risk areas like level crossings are typically statistically rare and random, however have severe consequences. As such, historic recorded crash numbers at specific locations are not always a reliable indicator of the risk, and therefore the future likelihood of crashes. The risk at the crossings is expected to increase in the future due to the combination of increased frequent barrier closures, higher crossing movements and more delays (leading to increased frustration and risk-taking behaviour). The risk and consequences can effectively be removed by grade-separating the crossings. Additional to the crossing risk, improved east-west connectivity in the wider network reduces VKT, resulting in reduced crash risk exposure and DSI reduction across the wider network.

¹ Data extracted from Waka Kotahi Crash Analysis System (CAS) database

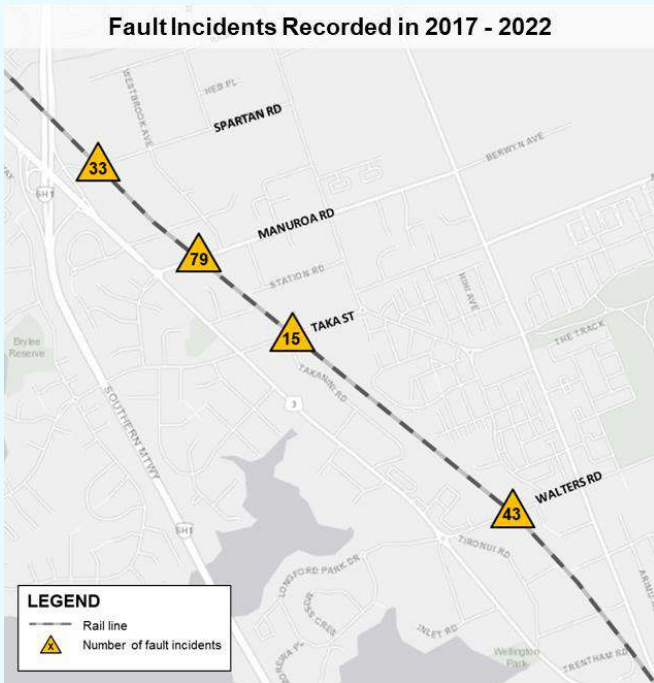
Key Performance Indicator	Measure	Outcome	Commentary
		Recommended network saves an estimated 94 DSIs over 40 years compared to the Staged Do Minimum scenario (based on a crash rate analysis).	
Investment Objective 2: Travel Choice (Support mode share by improving active mode facilities and rail capacity)			
Effectiveness of the Transport Corridor	People throughput of pedestrians and cyclists	There is a daily throughput of 1,800 pedestrian trips and 650 cyclist trips across the five east-west connections in the recommended network. Those trips would be significantly constrained if the crossings were fully closed, to the point that the longer diversion routes could fully suppress such typically short active mode travel. If the level crossing remained operational, users would experience delay, unreliability and safety risks. As well as reduce the safety and accessibility for such modes, this is expected to reduce daily throughput to some 1,700 pedestrian trips and 550 cyclist trips across the five east-west connections in the Do Nothing.	There is an increase of 100 daily pedestrian trips and 100 daily cyclist trips across the five east-west connections in the recommended network compared to the Do Nothing scenario. There would also be significant improvement in safety and accessibility for all active mode trips crossing the rail corridor.
Emissions	CO ₂ emissions – tonnes of CO ₂ equivalents emitted	Recommended network reduces 305,900 tonnes of CO₂ over 40 years compared to the Do Minimum Closure scenario. Recommended network reduces 65,500 tonnes of CO₂ over 40 years compared to the Do Nothing scenario. Recommended network reduces 182,800 tonnes of CO₂ over 40 years compared to the Staged Do Minimum scenario.	There is a 7,090 tonnes yearly reduction in CO₂ emissions in 2048+ (from the Do Minimum Closures scenario). These reductions are due to the reduced VKT (and congestion) enabled by the improved east-west connectivity in Takaanini. There is a 2,134 tonnes yearly reduction in CO₂ emissions in 2048+ (from the Do Nothing scenario).

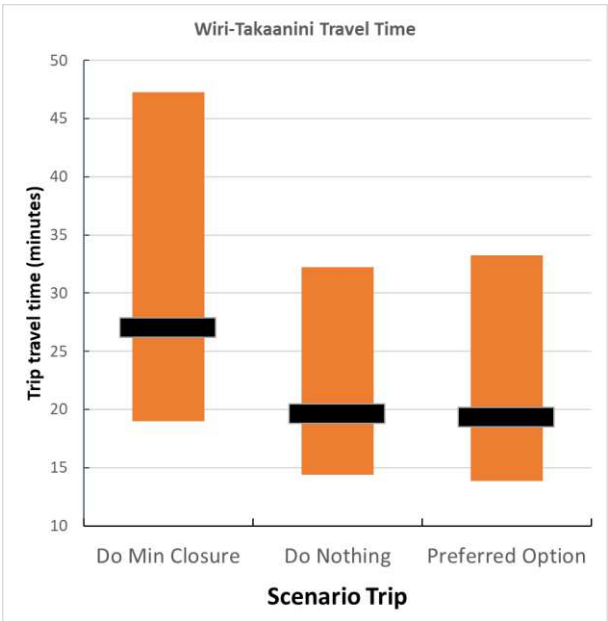
Key Performance Indicator	Measure	Outcome	Commentary
Vehicle Kilometres Travelled (VKT)	Reduction in vehicle kilometres travelled in the network	The average car user in NZ travels approximately 28 vehicle kilometres daily². Recommended network reduces 134,900 vehicle kilometres travelled daily compared to the Do Minimum Closure scenario. Recommended network reduces 44,313,400 vehicle kilometres travelled annually compared to the Do Minimum Closure scenario. Recommended network reduces 49,300 vehicle kilometres travelled daily compared to the Do Nothing scenario. Recommended network reduces 16,188,500 vehicle kilometres travelled annually compared to the Do Nothing scenario.	This VKT reduction is due to the improved east-west connectivity provided in Takaanini, for traffic that would otherwise be diverted to longer routes
Mode Share	Mode shift from single occupancy private vehicles	23% to 27% of Takaanini local (shorter) trips in the recommended network are active mode trips (3,200 trips in peak period). 36% to 40% of trips originating in Takaanini, travelling north of Manurewa are PT trips (1,900 trips in peak period). The overall PT trips in the network increase across the years as shown in the graph and table below. This is due to planned projects progressing the expansion of the southern rail line capacity and attractiveness i.e. CRL, four-tracking. The level crossings project enables the expansion of rail line capacity from 2-track to 4-track in the future. Expansion of rail	It should be noted that the 4-tracking and CRL plan are both in the recommended network and the baseline scenarios (Do nothing and Do Minimum Closure). Hence, mode shift benefits are expected to be low when measured against the baseline scenarios as these scenarios assume rail upgrades can proceed without constraint. In this context the improved bus connectivity enabled by the Project is offset by the improved car accessibility from the crossings. Overall, the PT trips in the South increase year on year, showing that passenger rail is planned to provide core rapid transit functionality in southern Auckland. The Level Crossings project allows people to access the station facilities, safely and further

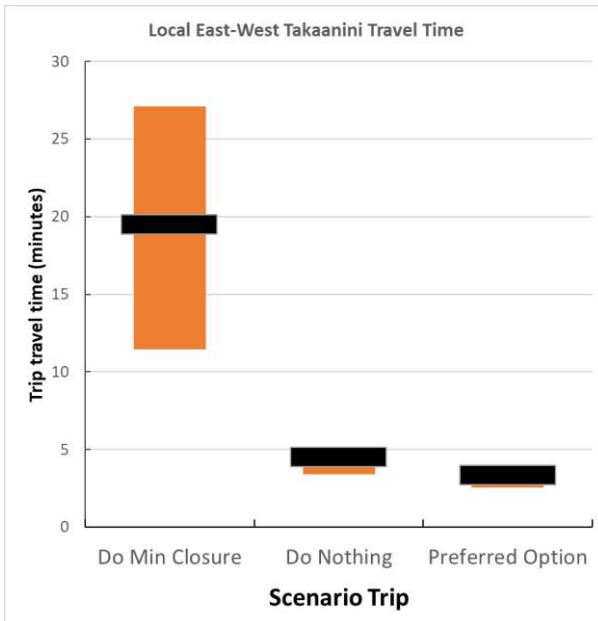
² Based on 2020 VKT per capita from the Ministry of Transport, assuming 329 operational days in a year (<https://www.transport.govt.nz/statistics-and-insights/road-transport/sheet/vehicle-kms-travelled-vkt>).

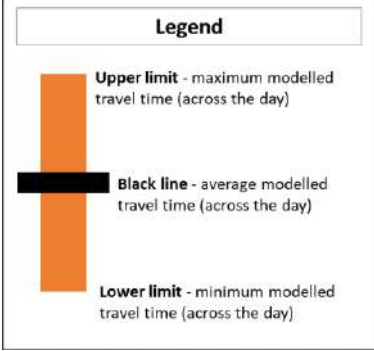
Key Performance Indicator	Measure	Outcome	Commentary																									
		capacity results in an uplift of 2,900 PT patronage in 2048+ (AM peak). Peak PT Trips <table><tr><th colspan="5">% growth in PT trips from 2018</th></tr><tr><th>Peak</th><th>2028</th><th>2038</th><th>2048</th><th>2048+</th></tr><tr><td>AM</td><td>67%</td><td>116%</td><td>161%</td><td>177%</td></tr><tr><td>IP</td><td>84%</td><td>146%</td><td>200%</td><td>222%</td></tr><tr><td>PM</td><td>72%</td><td>124%</td><td>169%</td><td>188%</td></tr></table>	% growth in PT trips from 2018					Peak	2028	2038	2048	2048+	AM	67%	116%	161%	177%	IP	84%	146%	200%	222%	PM	72%	124%	169%	188%	supports investment in CRL and rail upgrade projects. Overall, this project sits within the wider mode-shift strategy for the South.
% growth in PT trips from 2018																												
Peak	2028	2038	2048	2048+																								
AM	67%	116%	161%	177%																								
IP	84%	146%	200%	222%																								
PM	72%	124%	169%	188%																								
Investment Objective 3: Resilience (Support network resilience for Takaanini and improved reliability for the southern rail line)																												
Reduction of vulnerability in the system	Number of faults/ incidents	From 2017 to 2022, there were 170 recorded fault incidents at the level crossings³: 33 at Spartan Road 79 at Manuroa Road 15 at Taka Street 43 at Walters Road	The closure and replacement of the level crossings will reduce the number of incidents and lost productivity. This reduces risk of interruption to rail services and therefore impact on the wider transport system																									

³ Data provided by Kiwi Rail on 6th July 2022

Key Performance Indicator	Measure	Outcome	Commentary
		These include broken barrier arms, failed lights and warning bells not working. Hardware faults such as gates malfunctioning, or barrier arms being hit can lead to incidents causing unexpected delays and cancelled train services. The disbenefit per major incident that would cause rail network disruption is \$0.93 million and \$0.42 million for 2048+ and 2028, respectively. 	
Travel Time	Travel time variability	The travel time is measured for all vehicles travelling between the Wiri employment area and the Takaanini industrial area. The travel time varies less in the recommended network compared to	Network transport models typically predict average travel times, making it difficult to predict changes in travel time reliability. Rather than changes in reliability of a repeated trip (at a fixed

Key Performance Indicator	Measure	Outcome	Commentary
		the Do Minimum Closure scenario. Travel time spread across the day (comparing three modelled peaks and both directions of travel) is 19 minutes in the Recommended Option, while the travel time spread in the Do Minimum Closure scenario is 28 minutes. Travel time spread across the day for the Do Nothing scenario is 18 minutes.  The travel time for local east-west Takaanini trips across the rail line was also measured. The travel time varies significantly less in the recommended network compared to the Do Minimum Closure scenario. Travel time spread across the day (comparing the three modelled peaks and both directions of travel) is less than a minute in the Recommended Option, while the travel	time/direction), this measure considers the consistency between the model predictions by time period and direction. The models indicate that the spread between the slowest and fastest average journey between the Wiri employment area and the Takaanini industrial area (across the day) reduces from 28 minutes to 19 minutes. Similarly, the models indicate that the spread of travel times for local east-west Takaanini trips across the rail line reduces from 16 minutes to less than one minute. This results in improved consistency of travel time for those crossing this rail corridor.

Key Performance Indicator	Measure	Outcome	Commentary
		time spread is approximately 2 minutes for the Do Nothing scenario and 16 minutes for the Do Minimum Closure scenario.  Local East-West Takaanini Travel Time Trip travel time (minutes) Do Min Closure Do Nothing Preferred Option Scenario Trip	

Key Performance Indicator	Measure	Outcome	Commentary
			
Investment Objective 4: Access (Improve east-west connections to enable access to economic and social opportunities)			
Job Access	Proportion of employment accessible within 15, 30, and 45 minutes accessible by public transport	In the recommended network, 30,700 jobs can be accessible within 15 mins by PT. In the recommended network, 106,100 jobs can be accessible within 30 mins by PT. In the recommended network, 336,400 jobs can be accessible within 45 mins by PT.	Improved east-west connectivity in Takaanini enables access to jobs. In the Do Nothing scenario, there would be excessive delays resulting in traffic routing to parts of the FTN route. This impacts bus service reliability and the portion of jobs accessible by PT.
Job Access	Proportion of employment accessible within 15, 30, and 45 minutes accessible by active modes	In the recommended network, 3,300 and 11,000 additional jobs can be accessible within 15 mins of Takaanini East and Takaanini West, respectively by active modes. In the recommended network, 10,000 and 14,100 additional jobs can be accessible within 30 mins of Takaanini East and Takaanini West, respectively by active modes.	The proportion of employment accessible by active modes increases in each of the time intervals assessed. Within 15 mins the proportion of employment accessible increases by 7%-48%, in 30 mins there is a 13%-19% increase and in 45 mins there is a 2%-11% increase. There is increased access to jobs for the Takaanini West area since there is improved access to the Takaanini industrial area.

Key Performance Indicator	Measure	Outcome	Commentary
	(walking and cycling)	In the recommended network, 4,000 and 14,700 additional jobs can be accessible within 45 mins of Takaanini East and Takaanini West, respectively by active modes.	
Job Access	Proportion of employment accessible within 15, 30, and 45 minutes accessible by car	In the recommended network, 88,600 jobs can be accessible within 15 mins by car. In the recommended network, 253,800 jobs can be accessible within 30 mins by car In the recommended network, 420,800 jobs can be accessible within 45 mins by car.	Improved east-west connectivity in Takaanini enables access to jobs. In the Do Nothing scenario, there would be excessive delays resulting in an increase in travel time and trip time variability. This impacts the portion of employment accessible.

5 Transport Analysis

The transport analysis sets out the transport network planning undertaken to determine the recommended corridors and intersections.

5.1 Land Use Scenarios

This summary provides an overview of the land use scenarios and assumptions used to assess the transport network.

5.1.1 Land Use Assumptions

Land use data was the main input used to inform the expected growth in transport demand, which then informed the network planning. For network planning purposes, a 2048+ (full build-out of planned development) land use scenario was used to develop the recommended network, which reflects the needs for long-term transport infrastructure.

5.1.1.1 Land Use Inputs & Scenarios

The development of the land use scenarios includes inputs from future land use plans, forecasts, and policies, which includes:

- Future Urban Land Supply Strategy
- Unitary Plan Zoning
- Precinct Plans

A summary of planned growth and timing for each growth area in the South is set out below.

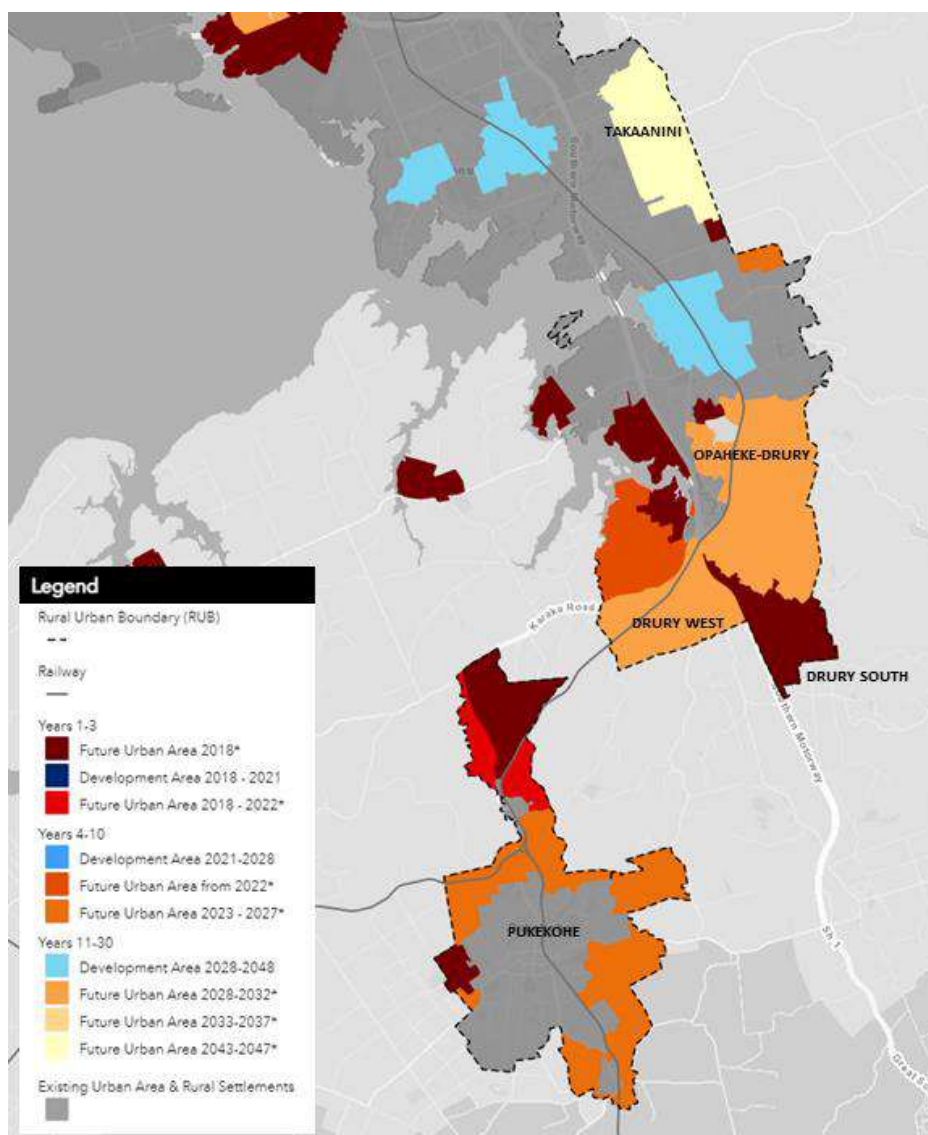
Table 5-1: Summary of South Planned Growth and Timing

Area	Growth Summary	Proposed Timing ⁴ – Development Ready (Large Future Urban Areas)
Drury South	365 hectares (including business) 1,000 dwellings	2012 – 2017
Drury West (Stage 1)	Approx. 390 hectares 4,200 dwellings	2018 – 2022
Cosgrave Rd, Takaanini	Approx. 60 hectares 500 dwellings 1 local centre	2023 – 2027
Pukekohe	Approx. 1100 hectares 7,200 dwellings	2023 – 2027

⁴ Based on Auckland Council Future Urban Land Supply Strategy

Area	Growth Summary	Proposed Timing ⁴ – Development Ready (Large Future Urban Areas)
Opaheke Drury	7,900 dwellings 1 town and 2 local centres	2028 – 2032
Drury West (Stage 2)	Approx. 550 hectares 5,650 dwellings 1 town and 2 local centres	2028 – 2032
Takaanini	Approx. 590 hectares 4,500 dwellings	2043 – 2047

Figure 5-1: South Area Planned Growth Map



5.1.2 Land Use Sensitivity Tests

5.1.2.1 Future Development Strategy (FDS): NPS-UD and MDRS

Policy direction has changed since the IBC and now consists of documents such as the Emissions Reduction Plan, Arataki, Waka Kotahi Sustainability Action Plan and Te Taruke a Tawhiri: Auckland's Climate Plan. The policy context includes drivers such as reallocating road space and providing for reliable rapid and frequent transit services.

The timing of growth within the South is based on the FULSS which remains the current forecast for land release in the Auckland Region. Within the greater Auckland area, growth is staged across 30+ years, with Takaanini staged to be development ready in the second half of decade three (2043 - 2047). The FULSS has identified this area as having 'significant flooding and geotech constraints' and signals the need to identify comprehensive solutions to these geotechnical and stormwater issues before development can commence. These technical investigations may alter the projected yields or timing of growth rather than whether the area will be "developed as planned" especially given its long-term horizon.

Based on the emerging objectives identified in Future Development Strategy (FDS), the project team considers there is a possibility that Auckland Council may down size (or delay) the Takaanini FUZ area given the constraints. The FDS consists of two policies: National Policy Statement-Urban Development (NPS-UD) and Medium Density Residential Strategy (MDRS). MDRS enables development of at-least six-storey high residential buildings which are within an 800m walkable catchment of an RTN stop/station and 800m from the edge of large metropolitan centre zones such as Papakura and Manukau. The MDRS refers to three dwellings permitted at any residential site resulting in terrace housing apartment building (THAB).

Auckland Council is currently considering how the NPS-UD and the MDRS will impact the timing of growth in existing urban and future urban areas in Auckland. These policies feed into the Intensification Planning Instrument (IPI) Proposed Plan Change 78 which is currently underway.

Te Tupu Ngātahi is liaising with Auckland Council and the Auckland Forecasting Centre to understand if new growth forecasts will be released. Te Tupu Ngātahi will continue to assume current land use yields, forecasts and FULSS timing, however, will assess the implications of this land use uncertainty and undertake sensitivity tests where required. Although the future urban zone growth areas have an influence on this Project, it significantly addresses accessibility for existing areas, and as such the outcomes are considered less sensitive to growth estimates than other greenfield growth areas.

5.1.2.2 Impact of FUZ changes on recommended network

As the level crossings are situated in the existing live zoned area, it is expected that downsizing or delaying of the Takaanini FUZ will not have a significant impact on the decisions made around the level crossings. Table 5-2 shows the proportion of FUZ-related traffic (traffic to or from the Takaanini FUZ) using each east-west link. Only 3% to 8% of the FUZ-related traffic use the proposed grade-separated bridges (Manuia Road, Taka Street and Walters Road). The majority of the trips to or from the Takaanini FUZ are using Stratford Road, further north to access SH1.

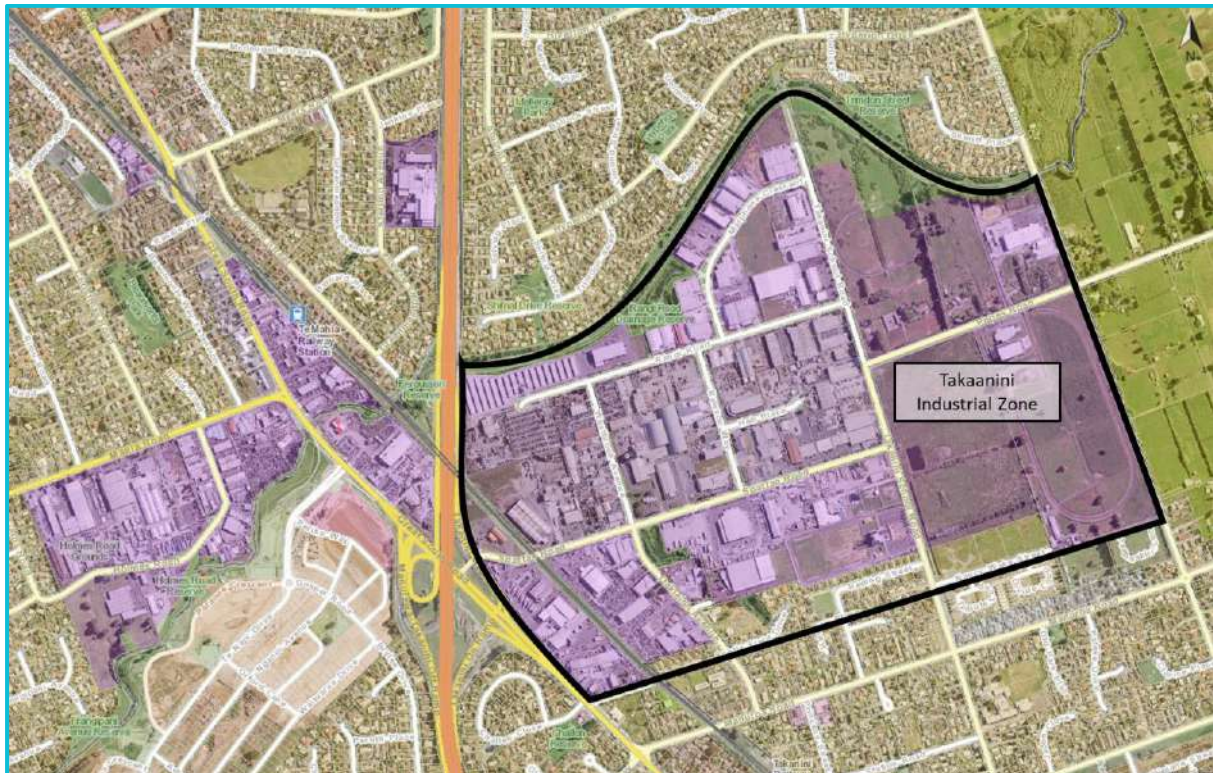
Table 5-2: Percentage of FUZ-related traffic using each east-west connection

FUZ-related traffic % on east-west corridor			
East-west corridor	ADT (Veh)	Light Vehicles	Heavy vehicles
Stratford Road	18%	17%	23%
Alfriston Road	7%	7%	6%
Manuia Road	8%	8%	8%
Taka Street	3%	3%	1%
Walters Road	3%	3%	1%

5.1.2.3 Forecasted growth in the Takaanini industrial area

Currently, the area adjacent to the SH1, Takaanini state highway interchange and the NIMT is zoned as light and heavy industrial as indicated in Figure 5-2. There is slow uptake in development of the eastern section of the industrial area. This land use and number of jobs have been discussed with Auckland Council, Waka Kotahi and Auckland Transport. Auckland Council wishes to maintain the industrial land use, AT acknowledges the slow land use uptake and this has been reflected in the modelling.

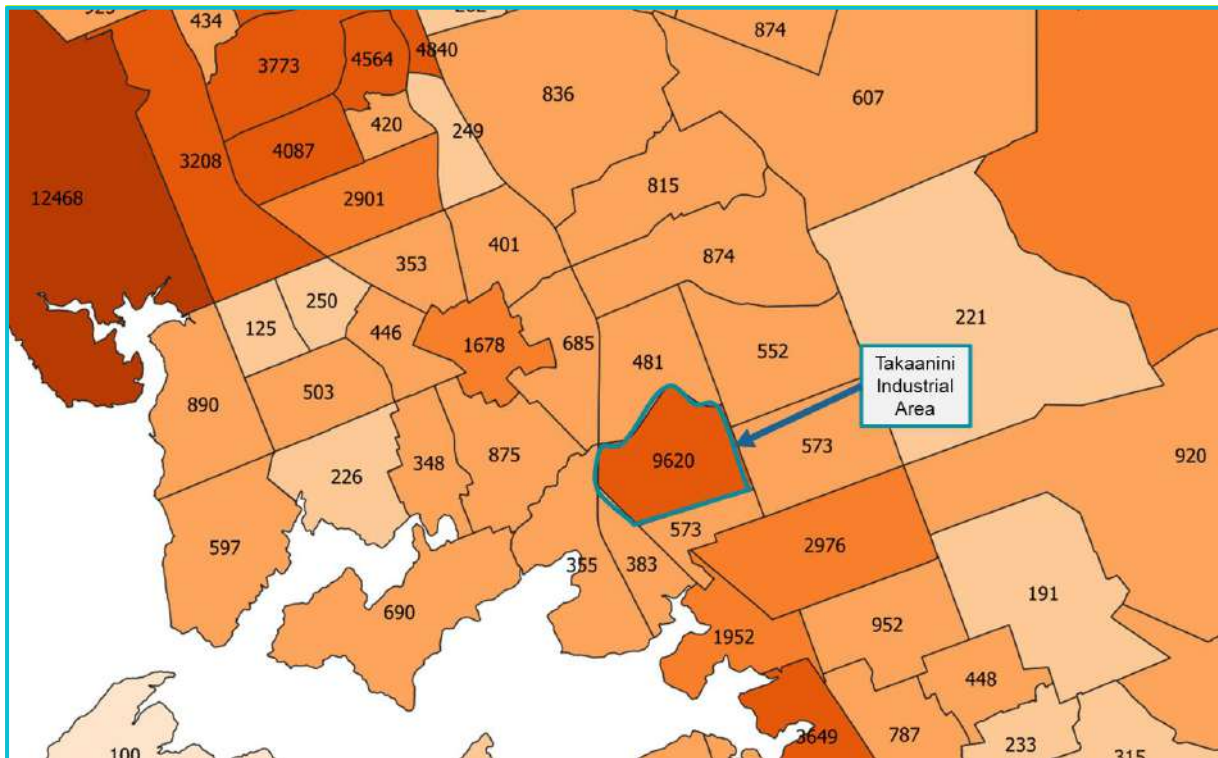
Figure 5-2: Takaanini Industrial Area (AUP:OiP)



The land use forecasts shows this area as having 1,665 jobs in 2018 (scenario i11.6 land use forecast). The i11.6 land use forecasts predict there will be 9,620 jobs in this industrial zone in 2048+.

This predicted employment density is high compared to other established employment areas such as Wiri and Manukau employment zones.

Figure 5-3: Number of jobs in 2048+ (i11v6 land use forecast)



The high level of predicted jobs directly affects the forecasted amount of traffic generated by this employment zone. Unusually high yield numbers should not be used as the basis for understanding the scale of transport infrastructure needed to support growth. The 9,620 jobs predicted in the Takaanini industrial area in 2048+ results in 63,900 vehicles per day being generated from this employment zone, with approximately 46% of this traffic being heavy vehicles. An accurate representation of forecasted employment growth is to be considered to make informed decisions around the optimal level of east-west connections in the future network. Hence, sensitivity testing of the 2048+ forecasted number of jobs in the Takaanini industrial area was undertaken to assess the scale of impact on the surrounding transport network.

Two scenarios of employment growth in the industrial zones were tested.

- 'Aspirational' scenario: 75% of 2048+ forecasted employment growth
- 'Likely' scenario: 50% of 2048+ forecasted growth

Table 5-3 shows the general and heavy vehicle traffic demand generated from the Takaanini industrial zone in each of the three scenarios. Sensitivity testing was undertaken to understand the risk profile and potential overestimation.

Table 5-3: Takaanini industrial demand sensitivity test – i11.6 land use forecasts

	50% forecasted daily industrial daily demand (likely)	75% forecasted industrial daily demand (aspirational)	100% forecasted industrial daily demand (unlikely)
2048+ number of jobs in industrial zone	4,800	7,200	9,600
Traffic generated by Takaanini industrial zone	32,200	48,300	64,500
Heavy vehicle traffic being generated from industrial zone	14,800 (46%)	22,200 (46%)	29,700 (46%)

Typically, around 30-50 employees per hectare (gross area) is considered plausible for light industrial zones. The revised AFC models suggests 7,400 employees in 54 ha, which amounts to a density of 137 jobs per hectare. This is considered unlikely in a light industrial zone in this particular location. The Takaanini industrial area is measured out to be 71 hectares (excluding the community facility). At 50 jobs per hectare this would give approximately 3,500 employees. Having more commercial activities will possibly increase this number, however, the 9,600 number is still considered very high.

Following this assessment, it was considered that the predicted 9,620 jobs in 2048+ is not to be applied for modelling purposes and the ‘aspirational’ employment growth scenario was to be progressed as it provided a balance in the risk profile.

‘Aspirational’ scenario (75% Takaanini industrial employment build-out) to be adopted and traffic flows scaled accordingly.

5.1.3 Assessment Years

The development of land use scenarios includes different analytical years to inform staging, economic assessments, and the development of the recommended network. The different assessment years and their intended use are summarised below in Table 5-4.

Table 5-4: Summary of Land Use Assessment Years

Assessment Year	Network Planning and Staging	Economic Assessments	Recommended Footprint
2018*	✓		
2028, 2038 & 2048 (interim years)	✓✓✓	✓✓✓	✓
2048+ (full build-out)	✓✓✓	✓✓✓	✓✓✓

relative significance low (✓), relative significance high (✓✓✓) and base year reference ()*

The I-11 land use forecast series was agreed by Waka Kotahi, AT, and Auckland Council as the most appropriate land use scenarios to use. This also includes the interpretation of the Future Urban Land Supply Strategy (FULSS). The inputs include Stats NZ medium growth population forecasts and detailed demographic trends, via 64 person categories, 6 employment types and 3 educational role categories.

Based on the I-11 land use forecast series, the Auckland Forecasting Centre (AFC⁵) created each forecast scenario used by Te Tupu Ngātahi for the interim and full build-out scenarios.

AFC created the forecasts for the South IBC and Takaanini Level Crossings DBC. These include the 2046+ (used in the IBC) and 2048+ (used in the DBC) datasets that include the full build-out in growth areas.

5.2 Transport Network Analysis

The following section describes the transport analysis undertaken to reach the recommended option for the Takaanini Level Crossings DBC. This includes the network, corridor and intersection assessments undertaken, including:

- Auckland Transports' Roads and Streets Framework (RASf)
- The Corridor Form Assessment Framework (CFAF)
- Cross-Section Design
- Intersection Form and Function
- Intersection Design

5.2.1 Transport Modelling

Throughout the transport network analysis process, a range of different transport modelling tools have been used to undertake quantitative assessments of the transport system. These then inform decisions about planning transport network, corridors, and intersections.

The modelling methodology undertaken for the Takaanini Level Crossings DBC options follow a typical hierarchical modelling structure and utilises a range of models as detailed below.

Strategic Multi-Modal Model

- MSM is a regional multimodal model for Auckland, which translated land use (such as population and employment) to travel patterns (which creates estimates of car, truck, and public transport movements) at a strategic and regionwide level.

SATURN Model

- The SATURN model is a mesoscopic traffic model, which loads the forecasted vehicle trip patterns from MSM onto the road network to investigate the traffic effects at a more detailed level.

Active Modes Model

- The AFC Strategic Active Modes Model (SAMM) provides strategic-level estimates of walking and cycling demands.

⁵ Auckland Forecasting Centre is a collaboration between Auckland Council, Auckland Transport, and the NZ Transport Agency.

- Te Tupu Ngātahi active modes station access model, this tool is only used to provide estimates of walking and cycling to major stations.

Intersection Modelling

- SIDRA modelling has been undertaken to assess the operational performance of key intersections along the project corridors. The demand was informed by the SATURN models.

Appendix 4 provides more model specifications and details for each respective model package used.

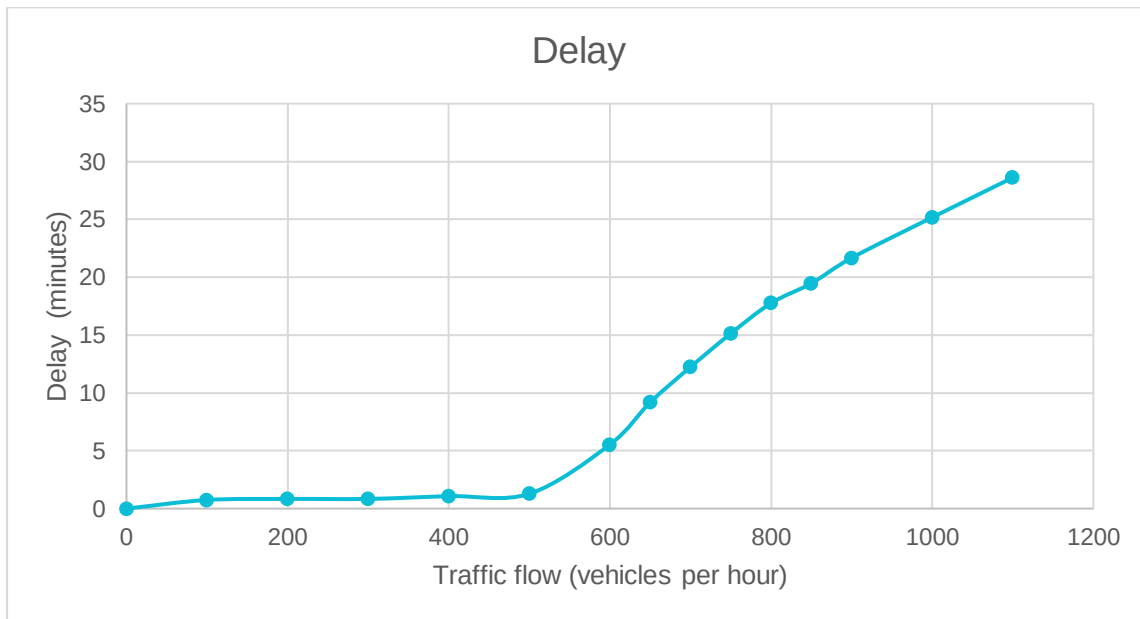
Bottleneck Model

A simple bottleneck model was employed to investigate the impact of retaining the level crossings in Takaanini under the expected higher barrier closures and high traffic flows on the crossings. This looked at the impact of adding additional train services that are proposed to support the growth in the south. This model estimates queues at the crossings under various traffic flow scenarios and different barrier closure scenarios. This tool considers traffic arrivals and barrier operation in small time segments, so that estimates of queues and delays from the barrier closures can be estimated more precisely than is possible in average-hour models such as SATURN. As well as estimating queues and delays at the barriers directly, the bottleneck models were used to identify the link capacity and delay functions to be used in the SATURN models to estimate traffic levels using the crossings.

The CRL rail plan (provided by AT), indicated 24 trains per peak hour were operating on the southern rail line, between Puhinui and Pukekohe, in 2031. A range of barrier downtime of 1.5 and 1.6 minutes were assumed for each time a train passes in the network. This indicates that the barrier at the Takaanini level crossings, may be down for 61% to 64% of the peak hour.

The bottleneck outputs were then used as an input in the local Saturn models to give a more detailed understanding of the delay expected due to barrier closure time in the future.

The duration and length of queueing estimated from the bottleneck models was tested under a range of traffic flows, as indicated in Figure 5-4. For example, this suggests that flows of 600 vehicles per hour could generate delays of 5 minutes in the peak period. The high frequency of closures from the high train frequencies would make the connections highly unreliable, unsafe and unattractive.

Figure 5-4: Delay caused by barrier downtime in the future network

5.2.1.1 Design philosophy

It is important to note that the transport modelling is used to inform, rather than as a pure basis for, decisions on the design and planning of the transport network, corridors, and intersections. While the Project improves local connectivity in the network, the purpose is not to be able to accommodate all traffic demand in the network as to avoid a 'predict and provide' approach. Given that the Project is developed in an integrated approach with the FTN corridors, such as Great South Road, the priority is to provide for PT along these routes.

5.2.1.2 Impacts on strategic network

The level crossings project improves local access for Takaanini and increases local access between the area and the strategic network (SH1). SATURN modelling in the AM peak shows that this increased accessibility could impact other movements on SH1 if not managed. The model predicts traffic from the Takaanini east area wanting to access the on ramps at Takaanini with the Project in place. If not managed (via the ramp signals), this increased on-ramp demand could worsen merge disruptions and increase delays to through traffic on SH1 during congested peak periods (such as northbound in the morning peak). The models showed that without ramp signal control, this could increase delays in the northbound direction on SH1. These increased demands for the Takaanini on-ramp would be somewhat off-set by reduced on-ramp demand at adjacent ramps such as Hill Road. However, the network impact of the change is hard to predict with certainty. For this reason it is recommended that the traffic accessing SH1 onramp at the Takaanini Interchange will need to be managed appropriately via measures such as ramp signalling. This will help alleviate traffic pressure on the strategic network in the morning peak period. It is expected that such on-ramp management will continue as normal operation of SH1, however, the need to expect and accommodate the ramp flow changes would need to be proactively considered at the time of implementation.

It should be noted that the change in ramp flows can also be beneficial to the operation of SH1. In the evening peak SH1 is expected to remain congested southbound, with the Project changing the selection of on and off-ramps. For example, the models indicated a reduction in on-ramp flow on the

Takanini southbound on-ramp, which reduced merge disruption and mainline delays for southbound traffic on SH1.

5.2.2 Roads and Streets Framework (RASf)

The development of the corridor design has included the use of AT's Road and Streets Framework (RASf), which qualitatively assesses the typology (movement and place value) and modal priority.

The intent of that framework is to classify the expected movement and place functions from a consistent regional context and identify the likely priority applied to each mode.

Each corridor within the Takaanini Level Crossings DBC was assessed based on the following:

- **Place function** – for existing and long term 2048+
- **Movement function** – for existing and long term 2048+
- **Modal priority** – that reflect a 2048+ environment

The framework itself does not directly dictate a specific corridor design but provides context and guidance regarding the intended function of the corridor. This in turn will be used to inform future development and operation of the corridor. A 'mandate' for each road corridor has been developed by Te Tupu Ngātahi and approved by the RASf Steering Group, comprising senior officers from AT and Auckland Council.

RASf mandates were completed for corridors that fall under the jurisdiction of AT.

5.2.3 Corridor Form Assessment Framework (CFAF)

The Corridor Form Assessment Framework (CFAF) has been designed by Te Tupu Ngātahi to provide a consistent methodology to define the desired corridor form and function requirements and ensure all modes are considered. The CFAF assessments were completed for all multi-modal corridors, including Manuia Road, Taka Street and Walters Road. The active mode bridges, Spartan Road and Manuroa Road, were also assessed.

Following the multi-disciplinary optioneering process of determining which east-west connections were to remain open, the CFAF was applied to all five level crossing connections. Hence, the RASf and the principles for modal space allocation were used in the development of cross sections for these corridors.

The CFAF output recommends traffic capacity, bus priority measures, walking and cycling facilities and other corridor elements which influence the corridor footprint. All modes are considered in the development of the cross-section, however facilities for all modes may not necessarily be provided. The resulting cross-section forms the basis for route protection for the corridor.

The form and function of a corridor is determined using a combination of 'place' and 'movement' significance on the individual setting:

- **Place factors** consider the existing land use, future land use plans and trip generators present in the catchment area. It also includes an assessment of the future density of residential, industrial, or mixed land use and local/regional trip attraction areas e.g., metro stations, schools, hospitals.
- **Movement factors** consider the hierarchy of the corridor in the regional road network (PT network, strategic freight network), modal priorities for the corridor and existing and future traffic volumes to determine the future typology and recommendations for a corridor function. Movement is

considered at both local and network levels to ensure that duplication of facilities is avoided, and the corridors have targeted modal functions.

Table 5-5 provides a summary of the inputs and outputs of the CFAF tool used during the assessment.

Table 5-5: Inputs and Outputs of the CFAF Tool

Inputs	Modelling Inputs Required?	Parameters	Outputs	Impact on Modelling
Place and Corridor Function	No	Qualitative assessment based on the Roads and Streets Framework (RASf)	Determines the purpose of the route and feeds into wider modal priority assessment	N/A
Public Transport	No	AT Remix file ⁶	Public transport priority	No
Walking and Cycling	No	Te Tupu Ngātahi primary and secondary walking and cycling network used, based on urban design framework	Helps with geometric design, determining suitable paths and which sides to include the facility	Chosen facility type for different corridors coded into SAMM
General Traffic	Yes	ADT volumes used, extracted from SATURN.	If PT priority needed, helps determine whether corridor is route protected for 2 or 4 lanes	Number of lanes included in MSM, used for SATURN outputs
Freight	Yes	User class 3 (heavy vehicles) divided by total of all user classes (all vehicles) to determine the percentage of freight. Data extracted from SATURN.	Informs role within wider freight network and whether specific freight measures are needed along corridor	Yes
Speed Environment	No	Assumption based on RASf and future land use. Parameters for high and low speed	High level assessment concludes a low speed of 50km/h or 60km/h or a high speed of 80km/h. These are the base	Speed along each network included in MSM, used for SATURN outputs

⁶ Te Tupu Ngātahi Remix File refers to the Auckland Transport vision of the 2048+ bus network. Data and routes are subject to change.

Inputs	Modelling Inputs Required?	Parameters	Outputs	Impact on Modelling
		based on the IBC design philosophy.	assumptions for the speed, subject to vary through the DBC Optioneering process.	

5.2.4 RASF and CFAF Summary

The following table provides a summary of the RASF mandates and CFAF results for the Takaanini Level Crossings corridors. The future typology (movement and place value) and future modal priority for each corridor is summarised below, along with the proposed future cross-section from the CFAF process. A fuller description of the CFAF summary can be found in Appendix 1.

Table 5-6: RASF and CFAF Mandates Summary – Takaanini Level Crossings (multi-modal connections)

Manuia Road (GSR – Oakleigh Avenue)	Future Modal Priority	CFAF Cross-Section														
Future Typology: P2/M2																
Place Assessment: The supporting rationale is that the future land use around Takaanini Station is likely to have higher density development (at least 6 storeys) and the industrial area growth will attract activity from across a subregion or neighbouring local board area.	<table><caption>Future Modal Priority Data</caption><thead><tr><th>Mode</th><th>Priority Level</th></tr></thead><tbody><tr><td>Pedestrian</td><td>High</td></tr><tr><td>Bicycle</td><td>High</td></tr><tr><td>Bus</td><td>Low</td></tr><tr><td>Truck</td><td>High</td></tr><tr><td>Car</td><td>Medium</td></tr><tr><td>Scooter</td><td>Medium</td></tr></tbody></table>	Mode	Priority Level	Pedestrian	High	Bicycle	High	Bus	Low	Truck	High	Car	Medium	Scooter	Medium	TWO LANE ARTERIAL - 24M
Mode	Priority Level															
Pedestrian	High															
Bicycle	High															
Bus	Low															
Truck	High															
Car	Medium															
Scooter	Medium															
Movement Assessment: The rationale for the M3 assessment is that both the new industrial connection and its proximity to the Takaanini Interchange will likely have high strategic significance with higher volume of users and is a key connection across Auckland linking between subregions, key centres, and other parts of New Zealand.																

Table 5-7: RASF and CFAF Mandates Summary – Takaanini Level Crossings (multi-modal connections)

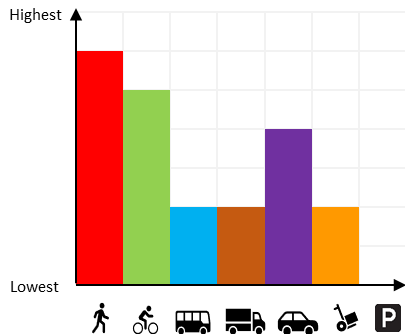
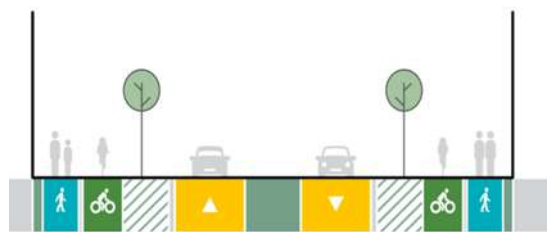
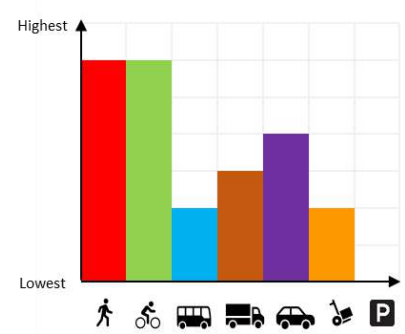
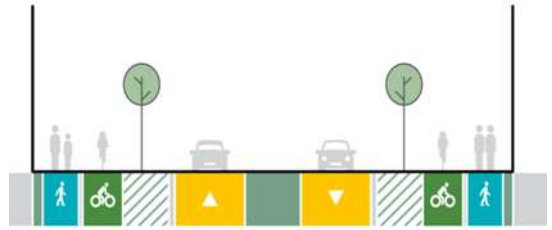
Taka Street (GSR – Kauri Heart Avenue)	Future Modal Priority	CFAF Cross-Section
Future Typology: P2/M2 Place Assessment: The supporting rationale is that the future land use around Takaanini Station is likely to have higher density development (at least 6 storeys) and may attract activity from across a subregion or neighbouring local board area. Movement Assessment: The rationale for the M2 assessment is that the corridor is likely to see an increase in the number of cyclists and pedestrians accessing the Takaanini Train Station. The industrial zone in the proximity of GSR and Taka Street will also increase traffic volumes.		
Walters Road (GSR – Porchester Road)	Future Modal Priority	CFAF Cross-Section
Future Typology: P2/M2 Place Assessment: The supporting rationale is that the presence of the local centre and the town centre in the area will attract activity across a subregion or neighbouring local board area. Movement Assessment: The rationale for the M2 assessment is that the new Walters Road bridge will support a range of modes: walking, cycling, private vehicles (note: no PT proposed along this section of Walters Road). It is also a key east-west connection with a medium strategic significance.		

Table 5-8: RASF and CFAF Mandates Summary – Takaanini Level Crossings (active mode connections)

Spartan Road	Future Modal Priority	CFAF Cross-Section
Future Typology: P1/M1 Place Assessment: The supporting rationale is that the surrounding industrial area is expected to develop and intensify, providing for more jobs in the future. Movement Assessment: The rationale for the M1 assessment is that the corridor is likely to see an increase in the number of cyclists and pedestrians accessing the Takaanini Train Station. The industrial zone in the proximity of GSR and Taka Street will also increase traffic volumes.		
Manuroa Road	Future Modal Priority	CFAF Cross-Section
Future Typology: P2/M1 Place Assessment: The supporting rationale is that the future land use around Takaanini Station is likely to have higher density development (at least 6 storeys) and may attract activity from across a subregion or neighbouring local board area. Movement Assessment: The rationale for the M1 assessment is that the corridor will see a significant decrease in general traffic and freight due to the closure of the level crossing and Manuroa Rd becoming a cul-de-sac. The corridor is likely to see an increase in the amount of cyclists and pedestrians accessing the Takaanini Train Station and the Town Centre Zone further along Manuroa Road due to the proposed active modes bridge. It is		

Spartan Road	Future Modal Priority	CFAF Cross-Section
expected that this connection will tie in with future plans for the Takaanini train station and enabling increased RTN access.		

5.2.5 Intersection Form and Function

A process was undertaken to identify likely future intersection form and function for the emerging Recommended Options. The purpose of this process was to identify the indicative intersection controls and subsequent footprint implications. It is noted that the final decision of the form and control of the intersections could be modified when further land use certainties are known at time of implementation.

For the purposes of the intersection assessment the following factors were considered:

- Safety
- Transport network function (movement) and land use function (place)
- Form and Level of Service (LOS) / Quality of service required for different modes
- Land use integration
- Site specific constraints
- Design constraints
- Roundabout vs signals guidance
- Network staging and route protecting
- Future land use assumptions
- Future transport network assumptions

For each intersection control chosen, design features were also considered to ensure that the intersection meets the needs of different users safely and effectively and responds to the site-specific factors. The guidance adopts a 'Safe System' approach and recommends roundabouts as the first choice for at-grade intersections due to the safety benefits for vehicular traffic resulting from slowing down through traffic and reducing the number of conflict points. However, where roundabouts are not considered appropriate for example due to engineering constraints, bus priority implications or land use implications, signalised intersections were then considered.

Currently, there are five intersections within the extents of the Takaanini Level Crossings corridors. The intersection assessments have been consolidated to consider the key intersections – specifically Arterial to Arterial or Arterial to Collector roads. Intersections with a local road are generally priority-controlled intersections and are assumed to remain priority-controlled in the future. Based on this assessment, three intersections are recommended as either a roundabout or signals.

SIDRA modelling was undertaken to assess the impacts of the intersection form on the wider network. It should be noted that in some cases modelling constraints resulted in limited turning volumes. In these cases, high level assumptions on likely turning movements were utilised.

Figure 5-5 indicates the location and forms of the intersections analysed and proposed for modification. Table 5-9 provides a summary of the existing and recommended intersection forms. Appendix 2 offers a summary of the proposed intersection forms and the associated modelling results for 2048+ for the relevant intersections that have been tested.

Figure 5-5: Takaanini Level Crossings indicative intersection forms

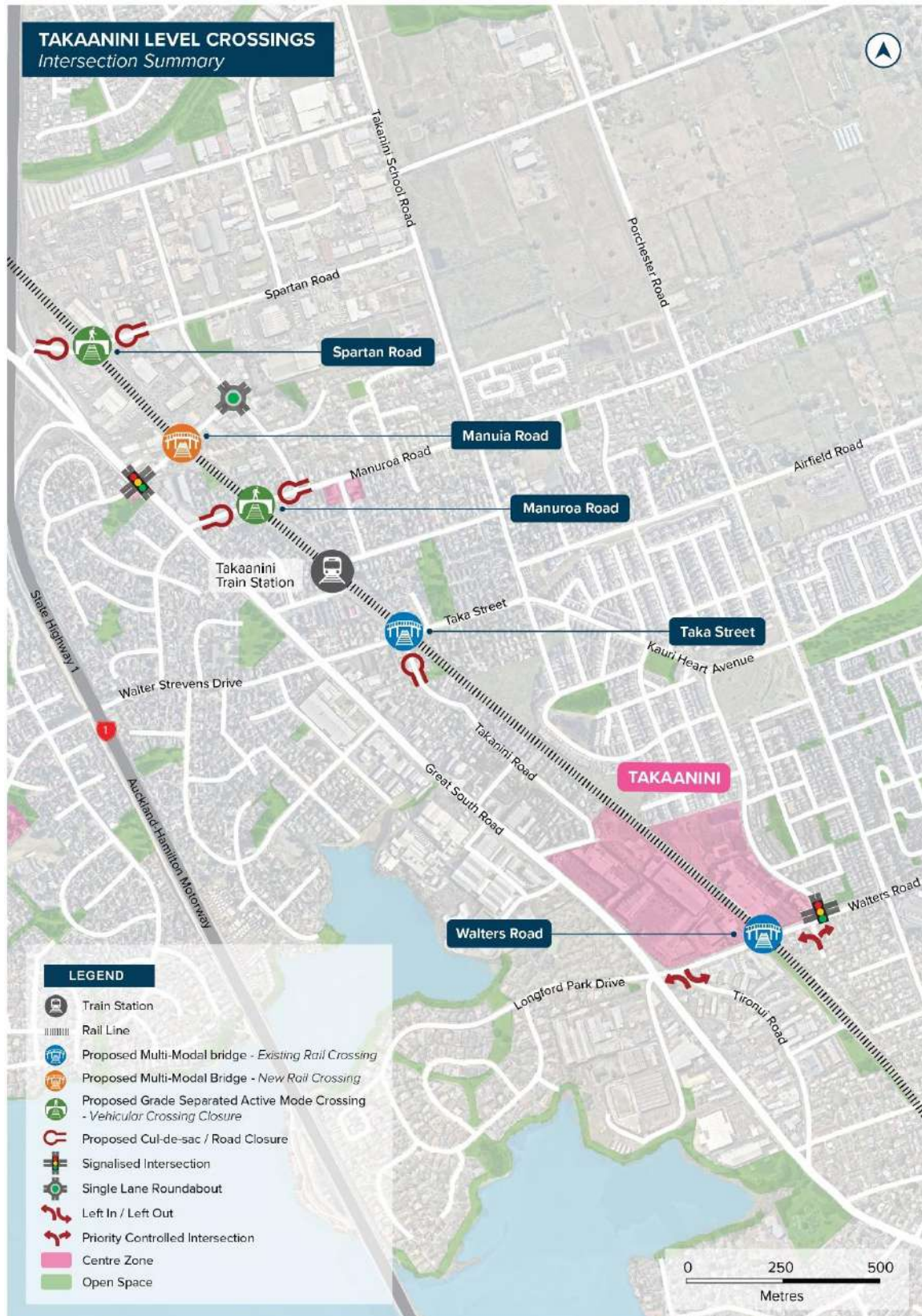
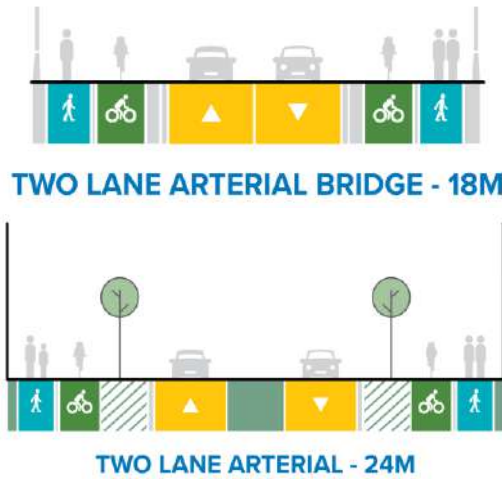
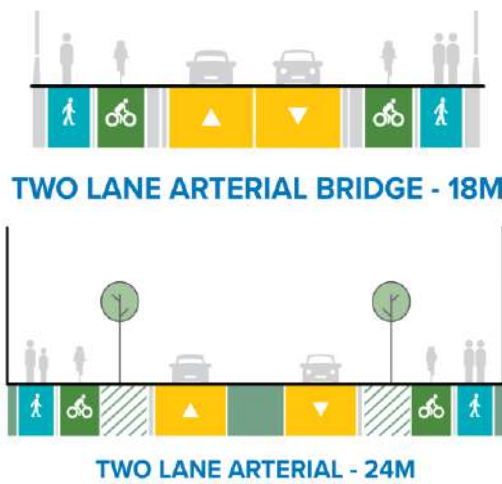


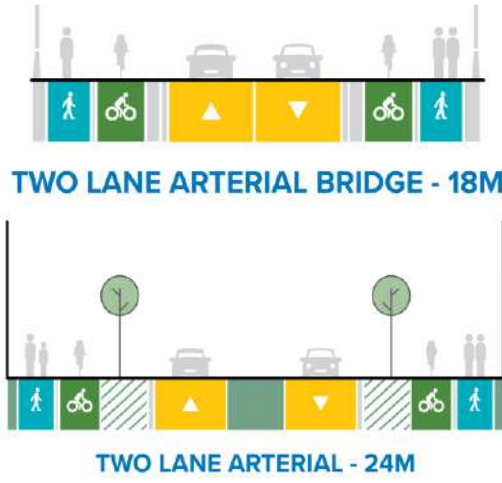
Table 5-9: Intersection summary

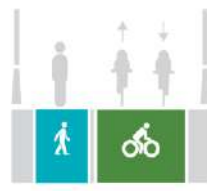
Intersection	Existing intersection form	Recommended intersection form
Great South Road/ Manuia Road	Priority Controlled	Signals
Manuia Road/ Oakleigh Avenue	N/A	Roundabout
Walters Road/ Arion Road	Signals	Signals
Walters Road/ Tironui Road	Priority Controlled	Left in/ left out
Walters Road/ Braeburn Place	Priority Controlled	Priority Controlled

Appendix 1: Form and Function Takaanini Level Crossings Corridors

Form & Function for Takaanini Level Crossings Corridors

Manuia Road	CFAF Summary
 TWO LANE ARTERIAL BRIDGE - 18M TWO LANE ARTERIAL - 24M	Purpose of Corridor: Currently a local road (Future Connect) and east-west freight connection across southern rail line and to/from Takaanini industrial area. An important strategic connection for resilience and improved walking and cycling connections.
	General Vehicle Volume: ADT 23,600 in 2048+
	Priority Vehicle: 0 buses per hour under indicative 2048 AT bus network
	Freight: Not an existing OW/OD route but expected to be a key freight route. Recommended that this corridor be considered by AT as part of freight network.
	Vehicle Lanes Total (Priority Lanes / PT Priority at Intersections): 2 (None/None)
	Active Modes: Separated cycle lanes and footpaths on both sides of the corridor
	Speed Environment: 50km/h
	Parking and Access: Limited access; no parking
Taka Street	CFAF Summary
 TWO LANE ARTERIAL BRIDGE - 18M TWO LANE ARTERIAL - 24M	Purpose of Corridor: Currently a secondary arterial (Future Connect) and east-west connection across southern rail line. An important strategic connection for resilience. Taka Street will be a key walking and cycling route and will provide access to/from Takaanini train station.
	General Vehicle Volume: ADT 16,900 in 2048+
	Priority Vehicle: 0 buses per hour under indicative 2048 AT bus network.
	Freight: Not an existing OW/OD route. Not considered to have a key strategic freight role.
	Vehicle Lanes Total (Priority Lanes / PT Priority at Intersections): 2 (None/None)
	Active Modes: Key walking and cycling connection to station: Separated cycle lanes and footpaths on both sides of the corridor.
	Speed Environment: 50km/h

Manuia Road	CFAF Summary
	Parking and Access: Limited access; no parking
Walters Road	CFAF Summary
 TWO LANE ARTERIAL BRIDGE - 18M TWO LANE ARTERIAL - 24M	Purpose of Corridor: Important strategic connection for resilience and improved walking and cycling connections. Considered the replacement for the future closure of Tironui Station Road pedestrian level crossing. Key east-west connection as the adjacent east-west connections are not in close proximity.
	General Vehicle Volume: ADT 12,600 in 2048+
	Priority Vehicle: 0 buses per hour under indicative 2048 AT bus network. PT priority lanes at GSR intersection.
	Freight: Not an existing OW/OD route. Not considered to have a key strategic freight role.
	Vehicle Lanes Total (Priority Lanes / PT Priority at Intersections): 2 (None/None)
	Active Modes: Separated cycle lanes and footpaths on both sides of the corridor
	Speed Environment: 50km/h
	Parking and Access: Limited access; no parking

Spartan Road	CFAF Summary
 ACTIVE MODE BRIDGE - 4.6M	Purpose of Corridor: Key walking and cycling connection providing access between Great South Road and the Takaanini industrial area. This active mode facility will provide connectivity to the Southern Path which is part of the regional cycle network. A Spartan Road active mode connection will reduce severance caused by the Papakura Stream to the north. This walking and cycling connection will provide access to employment in the future, given the expected increase in jobs in the Takaanini industrial area.
	General Vehicle Volume: N/A. East-west access over the rail line will be closed to vehicular traffic.
	Priority Vehicle: N/A. East-west access over the rail line will be closed to PT.

Spartan Road	CFAF Summary
	Freight: N/A. East-west access over the rail line will be closed to freight.
	Active Modes: Separated cycle lanes and footpaths on both sides of the corridor
	Speed Environment: 30km/h – there is an opportunity to reduce speeds on either side of the rail line as the corridor will form as local roads on either side.
	Parking and Access: Limited access, local parking as a result of the cul-de-sac.
Manuroa Road	CFAF Summary
 ACTIVE MODE BRIDGE - 4.6M	Purpose of Corridor: Key walking and cycling connection providing access between Great South Road and key destination on the eastern side of the rail line such as Takaanini School, Takaanini Train Station and the neighbourhood centre. Manuroa Road will increase active mode permeability across the southern rail line in the Takaanini network.
	General Vehicle Volume: N/A. East-west access over the rail line will be closed to vehicular traffic.
	Freight: N/A. East-west access over the rail line will be closed to freight.
	Vehicle Lanes Total (Priority Lanes / PT Priority at Intersections): 2 (None/None)
	Active Modes: Separated cycle lanes and footpaths on both sides of the corridor
	Speed Environment: 30km/h – there is an opportunity to reduce speeds on either side of the rail line as the corridor will form as local roads on either side.
	Parking and Access: Limited access, local parking as a result of the cul-de-sac.

Appendix 2: Intersection Methodology and Performance Summary

Intersection Proforma Guidelines

Table A2.1: Suitability of types of traffic control to different road types based on operational and Safe Systems objectives⁷

Corridor type	Arterial (80kph)	Arterial (50kph)	Collector	Local
Roundabouts				
Arterial (80kph)	L	L	M	U
Arterial (50kph)	L	L	L	U
Collector	M	L	L	M
Local	U	U	M	M
Signalised				
Arterial (80kph)	M	M	M	U
Arterial (50kph)	M	M	M	U
Collector	M	M	U	U
Local	U	U	U	U
Stop signs or give way signs				
Arterial (80kph)	U	U	M*	L*
Arterial (50kph)	U	U	M	L
Collector	M*	M	L	L
Local	L*	L	L	L

Legend:

L = Likely to be an appropriate treatment

M = May be an appropriate treatment

U = Unlikely to be an appropriate treatment

Inside bold area = intersections considered in Te Tupu Ngātahi network

*Likely to be controlled right turns

The below table is designed as a “quick reference” guide and should not be treated as definitive. For example, any proposed signalised intersection in a rural area will be labelled as “unlikely” to be an appropriate type of treatment. This does not automatically preclude it as a possible treatment since most issues can be “engineered out”, albeit at a cost.

⁷ Source: Adapted from WA, Roundabout and Traffic Signals: Guidelines for the Selection of Intersection Control, 2015

Table A2.2: Site specific factors and form of control choice⁸

Site specific factors	Roundabouts	Signals
Physical Controls		
Number of intersection legs	M – Up to maximum of 6	M – Up to maximum 4
Number of through/ circulating lanes if roundabout (use SIDRA to determine number of lanes needed to achieve desired LOS. Does 1 lane work?)	L – 1 M – 2 U – 3 – subject to design	L – Up to 3 (if was roundabout)
Space available (work with designer to determine suitability using SIDRA layout and standard intersection design)	M/U – subject to design (may be difficult in existing urban areas)	M – subject to design
Site topography (work with designer to determine suitability using SIDRA layout and standard intersection design)	M/U – subject to design (may be difficult in hilly terrains)	M – subject to design
Access to adjacent properties	M – subject to design (can assist with allowing u-turns)	M – subject to design
Road Environment		
Land Use: - Rural area - Urban – Low density - Urban – Med/ High density	L L L	U (M – if 3-leg) M L
Gateway area (e.g. rural/ urban transition, approach to town centre, amenity features)	L	M
High speed approaching traffic	L - with design features to control approach speed	U (M – if 3-leg, may consider with 80 km/h speed limit & warning signs /flashing lights & other design features)

Road Users	Roundabouts	Signals
Pedestrian needs: - Vulnerable users - High pedestrian flows	M – single lane and raised pedestrian crossing facility (may need pedestrian signals for vulnerable users) U – multi-lane unless grade separated or signalised pedestrian crossing (*see	M – single lane L – multi-lane

⁸ Source: Adapted from WA, Roundabout and Traffic Signals: Guidelines for the Selection of Intersection Control, 2015

Road Users	Roundabouts	Signals
	below for criteria to determine if either option appropriate)	
People on bikes - Vulnerable users - On primary/ secondary cycle network - Recreational route – either high use or designated	L – single lane with low speed design & off-road raised crossing option U – multi-lane unless grade-separated* or signalised cyclist crossing** *Consider grade-separation active modes where: - Higher speed environment - Rural/ semi-rural area - High movement function & low place function - High ped movements & significant land use e.g. train station - Topography & space available is suitable **AT considers that signalised ped/cyclist crossings are more desirable and only consider grade-separation by exception	M – single lane as long as cyclist protection provided L – multi-lane as long as cyclist protection provided
Needs of large vehicles	M – may be difficult with high volumes & high % heavies, but could help minimise braking	L- subject to design for turning and conflict with cyclists

Traffic Management	Roundabouts	Signals
Route or area strategies: - Adjacent to linked signals - Isolated locations - Adjacent sites controlled with roundabouts - Control of traffic through a local area e.g. to reduce rat-running, allow for gaps in traffic, manage traffic flow	U L L U	L M M L
Traffic volumes and capacity - Balanced flows - Unbalanced flows - Significant turning volumes	L M – with metering signals L	M M M – with adequate turn lane capacity

Traffic Management	Roundabouts	Signals
Minimising off-peak delays	L	U
Public transport (Light Rail) Trams - Bus lane/ priority lanes on corridor - Bus priority needed on intersection approach - Adjacent to a railway level crossing	U M – if LOS acceptable for 2-lane circulating roundabout (terminate bus/ priority lane in advance of roundabout) U U	L L L L L

Legend:

L = Likely to be an appropriate treatment

M = May be an appropriate treatment

U = Unlikely to be an appropriate treatment

Intersection Operational Performance

Table A2.3: Intersection SIDRA Results – 2048+ model year

Intersection Summary											
Intersection	Proposed Form	AM			IP			PM			Commentary
		LOS	DOS	Delay (s)	LOS	DOS	Delay (s)	LOS	DOS	Delay (s)	
Manuia Road/ Great South Road	Signals	C	0.91	29.4	C	0.91	29.2	C	0.83	23.2	Acceptable
Manuia Road/ Oakleigh Avenue	Roundabout	B	0.93	16.5	B	0.76	11.2	B	0.78	10.9	Acceptable
Walters Road/ Arion Road	Signals	B	0.68	14	B	0.53	14.4	B	0.50	15.7	Acceptable

Appendix 3: KPI Development Methodology

Investment Objectives and KPIs for Takaanini Level Crossings

The KPIs for the Takaanini Level Crossings investment objectives allows a qualitative and quantitative assessment to be made of how well the recommended network performs compared to a Do-min scenario where the projects outlined in the recommended network are not implemented.

The investment objectives for each of the problem themes were developed, and specific benefits and KPIs for identified for each objective. The KPI's and measures were pulled from a programme wide 'bank' of KPIs and measures developed internally within Te Tupu Ngātahi.

The problem themes and subsequent investment objectives, benefits and KPI's were agreed upon by the relevant stakeholders.

Investment Objectives

Table A3.1 below summarises the Investment Objectives for the Level Crossings within the Takaanini recommended network.

Table A3.1: Takaanini Level Crossings Investment Objectives

Investment Objectives	Takaanini Level Crossings	
	Safety: Provide improvements at level crossings that contribute to a transport network that is free from deaths and serious injuries	
	Travel Choice: Support mode share by improving active mode facilities and rail capacity.	
	Resilience: Support network resilience for Takaanini and improved reliability for the southern rail line.	
	Access: Improve east-west connections to enable access to economic and social opportunities.	

Table A3.2 below summarises the key performance indicators and measures for the Level Crossings within the Takaanini recommended network.

Table A3.2: Takaanini Level Crossings Investment Objectives

Investment Objective	Takaanini Level Crossings	
	KPI	Measure
Safety	Deaths and serious injuries (DSIs)	Number of level crossing related incidents
	Effectiveness of the Transport Corridor	People throughput of pedestrians and cyclists
Travel Choice	Emissions	CO ₂ emissions – Tonnes of CO ₂ equivalents emitted

Investment Objective	Takaanini Level Crossings	
	KPI	Measure
	Vehicle Kilometres Travelled (VKT)	Reduction in vehicle kilometres travelled in the network
	Mode Share	Mode shift from single occupancy private vehicles
Resilience	Reduction of vulnerability in the system	Number of faults/ incidents
	Travel Time	Travel time variability
Access	Job Access	Proportion of employment accessible within 15,30,45 mins accessible by public transport
		Proportion of employment accessible within 15,30,45 mins accessible by active modes
		Proportion of employment accessible within 15,30,45 mins accessible by car

Appendix 4: Modelling Specifications

Do Minimum Closure Context

The following changes between the Do minimum closure and recommended transport network are noted below:

Level Crossings:

The following changes to the below level crossing closures will be made:

- **Spartan Road:** Upgrade from a cul-de-sac to a grade-separated walking and cycling bridge connecting Spartan Road across the NIMT corridor
- **Manuia Road:** Upgrade from a cul-de-sac to a new multi-modal grade-separated bridge connecting Great South Road and Oakleigh Avenue over the NIMT corridor
- **Manuroa Road:** Upgrade from a cul-de-sac to a grade-separated walking and cycling bridge connecting Manuroa Road across the NIMT corridor
- **Taka Street:** Upgrade from a cul-de-sac to a grade-separated multi-modal bridge connecting Taka Street across the NIMT corridor
- **Walters Road:** Upgrade from a cul-de-sac to a grade-separated multi-modal bridge connecting Walters Road across the NIMT corridor

Takaanini FUZ Network:

- **Wastney Road:** There is a new N-S collector through the Takaanini FUZ, connecting the existing Wastney Road at Alfriston Road in the north, with Airfield Road in the South. This N-S collector through the Takaanini FUZ is present in both the Do minimum closure and recommended 2048+ network.
- **Popes Road urbanisation project:** The Popes Road east-west connection between Takaanini School Road (in the west) and Mill Road (in the east), is expected to urbanise to a two lane multi-modal connection with separated walking and cycling facilities. This is consistent across both the Do minimum closure and recommended network. Modelling assumes Popes Road will urbanise from 2048 onwards.

South arterial projects:

- **Mill Road:** Four-lane, lower speed Mill Road corridor project is included in both the 2048 and 2048+ Do minimum closure and recommended network. The two-lane Mill Road corridor safety project is included in the interim years (2028 and 2038), across both the Do minimum closure and recommended network
- **Opaeke N-S Arterial:** Opaeke N-S arterial is included in both 2048+ Do minimum closure and recommended network. The arterial is not included in the interim model years in both the Do minimum closure and recommended network.
- **Croskery Road urbanisation project:** Croskery Road (between Hunua Road and Mill Road) is expected to urbanise to a two lane multi-modal connection with separated walking and cycling facilities. This is consistent across both the Do minimum closure and recommended network. Modelling assumes Croskery Road will urbanise from 2048 onwards.

PT Services

- The recommended network shows the bus service between Papakura Station and Manurewa Station, routes through Taka Street. However, this bus service is rerouted onto Porchester Road and Alfriston Road since no east-west connection is provided at Taka Street in the Do minimum closure scenario.

- **Great South Road FTN:** No difference in the frequency of buses. GSR bus lanes are consistent in both the Do minimum closure and recommended network. Bus lanes are present through the Great South Road FTN route from Manukau Station Road to the proposed Drury Central Station. Bus lanes are not modelled through the Manurewa town centre and Papakura metropolitan centre. Intersection improvements recommended by the South FTN project, are consistent across both the Do minimum closure and recommended network.
- **Takaanini FTN:** No difference in the frequency of buses. Bus lanes on Alfriston Road are consistent in both the Do-min and recommended network. Intersection improvements recommended by the South FTN project, are consistent across both the Do-min and recommended network.
- **Active Mode Connections:** On-road protected bi-directional cycle lanes are proposed along Spartan Road, Manuia Road, Manuroa Road, Taka Street and Walters Road in the recommended network. The connections present in the Do-min network are existing facilities that connect with future active mode facilities recommended on Great South Road and Porchester Road (South FTN project). Separated walking and cycling facilities are proposed along the corridors in the South FTN routes on Great South Road, Alfriston Road, and Porchester Road. This is consistent across all scenarios.

Do Nothing Context

A 'Do nothing' was also considered to understand how the recommended network compares against a network where the existing Takaanini level crossings remain in the future network. The overall 'Do nothing' scenario is consistent with the Do-min (discussed above) apart from the level crossings context. The following changes between the 'Do nothing' and recommended transport network are noted below:

Level Crossings:

The following changes to the below level crossing closures will be made:

- **Spartan Road:** Upgrade from a level crossing to a grade-separated walking and cycling bridge connecting Spartan Road across the NIMT corridor
- **Manuia Road:** Upgrade from a cul-de-sac to a new multi-modal grade-separated bridge connecting Great South Road and Oakleigh Avenue over the NIMT corridor
- **Manuroa Road:** Upgrade from a level crossing to a grade-separated walking and cycling bridge connecting Manuroa Road across the NIMT corridor
- **Taka Street:** Upgrade from a level crossing to a grade-separated multi-modal bridge connecting Taka Street across the NIMT corridor
- **Walters Road:** Upgrade from a level crossing to a grade-separated multi-modal bridge connecting Walters Road across the NIMT corridor

MSM

The Macro Strategic Model (MSM) is a region-wide model which analyses the forecast land use and informs trip generation, trip distribution and mode choice at regional level. The MSM model responds

to the network assumptions, forecasted land use and regional economic policy inputs to predict regional traffic patterns and PT patronages. The outputs from the MSM model are used as:

- Demand inputs for the traffic simulation model SATURN, which analyses them at a mesoscopic level
- PT Patronage inputs for the MPT model, which analyses these at a strategic level
- Active mode inputs for the SAMM model, which analyses these at a mesoscopic level

The MSM is a four-step multi-modal model. This model was originally developed based on extensive data collected in 2006. Using observed data, and a full model validation exercise it was recently updated to reflect 2016 inputs and data. The MSM produces demands for five periods of the day, and separate assignment models exist for the morning (AM) and evening (PM) peak and weekday inter-peak (IP) periods.

- The model itself comprises of the following key modules:
 - Trip generation: This is where the number of person-trips are estimated as a function of the land use data (population, employment, school roll etc.)
 - Mode Choice: This is where the choice of recommended travel mode is determined, based on the relative costs of the various modes. The MSM modes for mode choice are car (driver and passenger combined) and passenger transport. Trips by car are converted into vehicle trips later in the model. The model also estimates the number of active mode trips, such as walking and cycling, although these are not fully modelled through to link flows.
 - Trip Distribution: This is where the trips produced in each zone (generally by households), are matched to a recommended destination. This distribution is predicted as a function of the relative attractiveness for each destination zone and the travel costs to reach each destination.
 - Time of Day: This is where the proportion of daily trip making occurring in each period is calculated. These proportions change in response to changes in travel costs to represent peak spreading.
 - Trip Assignment: This is where the resulting travel demand, in the form of origin to destination trip tables, are loaded to the road and public transport networks. For the road assignment, an iterative process is used to firstly identify the lowest-cost route between each origin and destination followed by an estimation of the speeds and delays on each route between origin and destination, followed by an estimation of speeds and delays on each route associated with the predicted traffic flows on the route.

General Network Assumptions

The following general network assumption have been made in the MSM model:

- All committed developments and respective infrastructure upgrades planned as outlined in the ATAP (Auckland Transport Alignment Project) 2.0 and RLTP (Regional Land Transport Plan) have been coded in the future MSM model
- The access points (MSM zone connectors) for each model option scenarios in the business case areas were reviewed and refined accordingly to reflect the future infrastructure upgrades

The future local bus services for each model option scenarios, were updated based on inputs from the AT Metro, specifically related to routes, frequencies, bus capacities and bus speeds.

MSM Outputs

There are a number of outputs from the transport modelling, including:

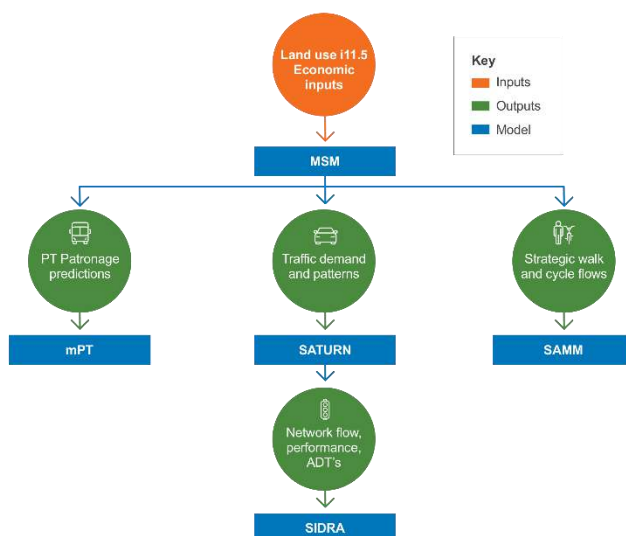
- Demand patterns (Origin-Destination travel) and facility usage (flows)
- Network performance
- Travel times and costs (real and perceived) for economic analysis
- Delays, queues and Level of Service (LoS) for design and assessment
- Aggregate travel statistics on travel such as Vehicle Kilometres Travelled (VKT), Passenger Kilometres Travelled (PKT) and total travel costs
- Flow and performance for environmental analysis
- Inputs to vehicle emissions models
- Inputs to noise analysis

SATURN

SATURN is a mesoscopic traffic simulation and assignment model used to undertake a variety of area wide strategic assessments through to more detailed local area assessments. It can be used as a conventional model for the analysis of traffic-management schemes over localised networks as well as for major investment improvements at a regional level. The SATURN model ensures factual representation of vehicle flow patterns and congestion on midblock sections and intersections in the form of 'arrival' flows rather than 'demand' flows. Additionally, it is used as a high-level junction simulation model that evaluates the traffic flow behaviour on junctions.

It represents 'congested assignment' of multiple user classes modelled separately, including bus priority and high occupancy vehicle lanes. Figure A4.1 provides an overview of the SATURN model is used and its interdependencies with other models, showing the modelling hierarchy.

Figure A4.1: Modelling Hierarchy and Associated Outputs



SATURN Outputs

There are a number of outputs from the SATURN model, including:

- Vehicular flow pattern -Actual flow, Demand flow, Queued flow
- Network performance- Link and Node delays, Queue Statistics, V/C Ratios
- Mid-block capacities and speeds
- Aggregate travel statistics on travel such as Total Travel Time(hrs), Distance Travelled (kms)

SAMM

The Strategic Active Mode Model (SAMM) has been developed to fit within the existing suite of regional travel demand models operated by the Auckland Forecasting Centre (AFC). It derives land use and network data directly from the Macro Strategic Model (MSM) while using the same refined zone system as used in the Macro PT Model (MPT). The model has a strong interface with MSM to provide key inputs but can be operated independently to assess specific changes to the active mode network.

Both the walk and cycle models adopt a fairly traditional '4-step' demand model structure including trip generation, distribution, mode shift and assignment

The purpose of the model was identified by the AFC as follows:

- To enable an objective measure of walk and cycle responses to infrastructure changes, demographic changes and to changes in other modes at a regional level.

The scope of travel represented in the model is as follows:

- It only represents active travel where walking or cycling are the primary mode used. Multi-modal trips using active modes and either PT or car modes remain represented via the MSM and MPT models, and are generally not included in SAMM (with the exception of active trips that use a Ferry to cross the harbour)
- A trip based model that represents movement via Origin-to-Destination trip matrices
- Represents typical weekday, daily trips (based on March data)
- Represents travel done for transportation reasons, rather than recreational or sport. However, it does estimate additional 'recreational' flows on key high-amenity coastal cycle routes
- It covers the whole Auckland Region, consistent with the MSM and MPT models

The model is targeted as a 'strategic demand' model, with a focus on estimating active-mode travel from demographic and network inputs, rather than via the direct use of observed travel patterns. This requirement means it is focussed more on developing a robust process to estimate overall demand patterns, rather than detailed calibration to count data. This approach means it is also suitable for use in greenfield areas where existing activity and data would not reflect the planned future state. The model provides a suitable platform for localised refinement and calibration as may be required for assessment of specific projects.

SAMM specifications and details

The SAMM requires export of network and trip data from MSM. After the network import the local or regional cycle network are coded in SAMM, the links are made less/more attractive for the active mode trips by specifying an added attribute termed as 'cycle facility'. The following inputs are imported from MSM:

- Land use data
- Active trip ends by purpose
- Network
- Link speed
- Auxiliary volumes
- Home based Work Car and PT generalised cost and daily person matrix

After the import from MSM the following refinement is done in SAMM for assignment of Active Modes

- Coding of cycle and walk links
- Assigning cycle facility type to the cycle network
- Hilliness factor and amenity factor
- Refinement of zone connectors

The trip generation, distribution, mode shift and assignment models all attempt to replicate travel choices using 'perceived' travel costs. These costs are equivalent to the 'Generalised' costs used in the MSM multi-modal model and are based on actual travel times with adjustments to account for user perceptions. For cyclists this includes perceptions of facility provided, the type of road it operates on and the amenity and hilliness of the route. The walk model uses a similar approach but with fixed walk speed and without differentiation by facility or road type. Use of such costs mean that the cycle demands will respond to changes in the speed, quality, amenity and hilliness of each section, while walking will respond to amenity and hilliness.

Station Access Modelling

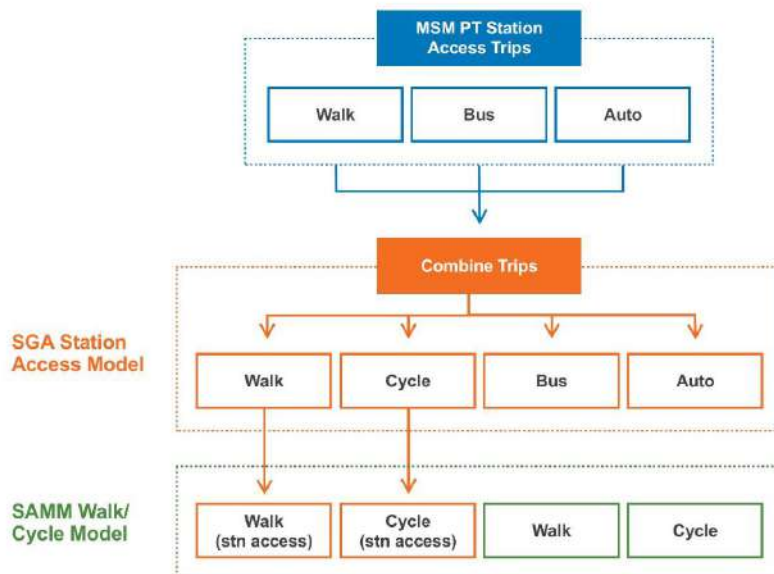
Te Tupu Ngātahi uses the Auckland Forecasting Centre's Strategic Active Mode Model (SAMM) to estimate volumes of walking and cycling trips on the future networks. As mentioned above SAMM only includes where walking and cycling is the main mode. Public transport trips are estimated using the Macro Strategic Model (MSM), which uses simple functions to represent access to stations. Access to stations is represented in MSM as:

- Direct walk-up trips
- Transfer trips from other PT services, such as local buses
- Auto-access trips, representing kiss-and-ride and park-and-ride. This access mode is only represented at major stations with formal Park and Ride facilities

The approach to this work is to develop a new tool that estimates the potential walk and cycle trips accessing major stations. The primary tool for estimating PT trips remains the MSM. For economic analysis purposes, the station-access tools are ignored, as station access is included in PT benefits extracted from MSM.

The total trips accessing stations from MSM is retained, with the station access tool effectively only reallocating them between sub-modes. The walk and cycle station-access trips are then passed to the SAMM model (as origin-destination matrices). This concept is indicated in Figure A4.2 below.

Figure A4.2: Structure of Station-Access Model



The MSM and SAMM models are operated by the AFC and have been through detailed review processes. The Te Tupu Ngātahi Station-access tool is only used to provide estimates of cycle/walk demand near major stations specific to Te Tupu Ngātahi areas. As such, it is not part of the formal AFC-owned models and it has not been independently reviewed.

The key steps in its operation are as follows:

- Obtain station access trips from MSM peak-period models. Including from direct walk-up and auto-access links)
- Combine to daily estimates (SAMM operates only at a daily level)
- Obtain car and bus travel times from MSM
- Get walk and cycle perceived travel costs from SAMM
- Create generalised costs for each mode, by applying assumed modal constants
- Allow for impact of electric bikes as a sub-mode of cycling
- Apply a logit choice model that re-estimates the split between the four access modes
- Extract car and cycle station access trips and assign in SAMM to get link flows

SIDRA

Signalised (and unsignalised) Intersection Design and Research Aid (SIDRA) is a micro-analytical tool used for evaluating intersection performance. It has a comprehensive, lane-based network modelling

approach applicable to all types of intersections-signal, priority or sign control and roundabouts. SIDRA allows the modelling of various movement classes (Light vehicle, Heavy vehicle, Buses, Bicycle, Large Trucks, Light Rail/ Trams) with distinctive vehicle features to be assigned to designated lanes, segments and signal phases.

The Te Tupu Ngātahi SIDRA model is used to analyse the form and function of proposed intersections along strategic corridors. Based on the demand flow outputs from the SATURN Model, the intersection turning flows are determined. The performance measures of the intersection in terms of capacity, delay, Level of Service (LOS), queue length on approach lanes and optimum vehicle-pedestrian signal phasing is calculated.

Capacity Analysis

The capacity of an intersection to operate satisfactorily depends on the volumes of turning traffic and the distribution of traffic on the various approach legs at the intersection. Capacity analysis and intersection performance has been adjusted for the Business Case given the brownfields context of the project. The key output measures which determine the operational performance of an intersection are as follows:

- LOS- The Level of Service measures 'control delay' on intersections in seconds. For satisfactory intersection performance the LOS for major movement should be lower than 'D' and for minor movement LOS should be lower than 'E'. The LOS definition (Highway Capacity Manual 2010) used are given below:

Table A4.1: LOS Categories for Intersections

Level of Service	Control delay per vehicle in seconds (d) including geometric delay	
	Signalised Intersections	Priority Controlled and Roundabouts
A	$d \leq 10$	$d \leq 10$
B	$10 < d < 20$	$10 < d < 15$
C	$20 < d < 35$	$15 < d < 25$
D	$35 < d < 55$	$25 < d < 35$
E	$55 < d \leq 80$	$35 < d \leq 50$
F	$d > 80$	$d > 50$

- DOS- The Degree of Saturation is the ratio of demand flow to capacity. The movement DOS is the largest DOS for any lane of the movement. The desirable degree of saturation for Signalised Intersection should be less than 0.9 and for Roundabouts it should be less than 0.85
- Queue Length- It is used to determine the length of auxiliary through lanes or storage in turn lanes.

Takaanini Level Crossings

Appendix H – Design report

October 2023

Version 1.0

Document Status

Responsibility	Name
Author	
Reviewer	
Approver	

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Acronym/Term	Description
AC	Auckland Council
AGRD	Austrorads Guide to Road Design
AMC	Active Modes Corridor/Connection
ASD	Approach Sight Distance
AUP	Auckland Unitary Plan
AT	Auckland Transport
DBC	Detailed Business Case
LIDAR	Light Detection and Ranging
MSE	Mechanically Stabilised Earth
NIMT	Northern Island Main Trunk (Rail)
NZGD	New Zealand Geotechnical Database
NZTA / WK	Waka Kotahi New Zealand Transport Agency
NZTM	New Zealand Transverse Mercator
SGA	Te Tupu Ngātahi Supporting Growth Alliance
SMAF	Stormwater Management Area Flow
SSD	Stopping Sight Distance
TDM	Transport Design Manual

1 Introduction

This document has been prepared as Appendix H of the Takaanini Level Crossings Detailed Business Case. It has been prepared to document the design development principles behind the concept designs within the Takaanini Level Crossings transport network. The concept design is then used as a basis of designation setting as it provides the likely footprint of the new infrastructure.

The design report has been developed with technical inputs from a wide range of engineering design specialities including traffic, geometric, geotechnical, stormwater, urban design, road safety and structures.

The Takaanini Level Crossings detailed business case identifies the construction of the transport network to occur within a 10-15 year time frame. It is therefore anticipated the concept design contained in this document will be revised and reconfirmed at that time of implementation to reflect any changes in standards, planning conditions, network demands, and/or any other construction related matters.

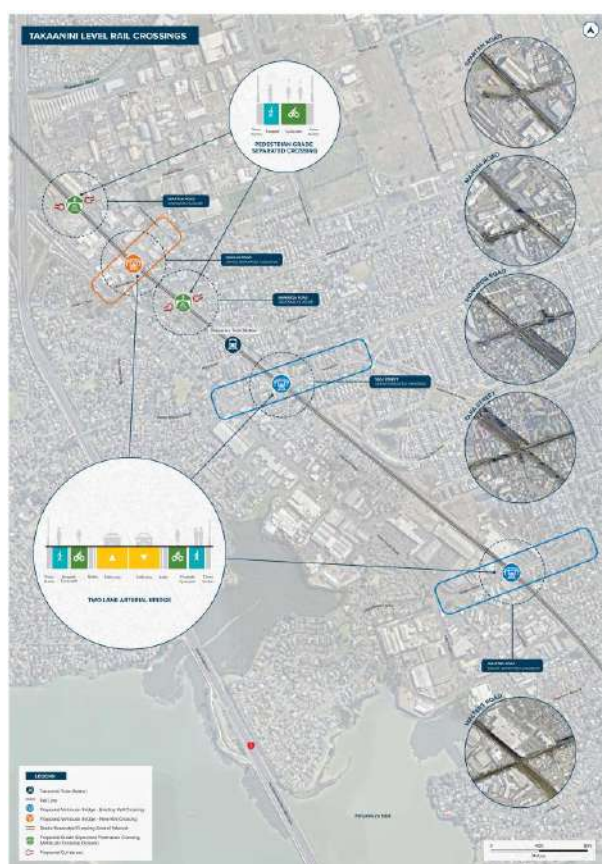


Figure 1-1 Level crossings transport network map

2 Approach to design

Te Tupu Ngātahi Supporting Growth Alliance (the Alliance) has been established to provide route protection of strategic transport infrastructure to support the future growth of Auckland. As such, most of the projects within the Programme will not be constructed for several years, and it is anticipated that the preliminary design will need to be revised at that time to reflect the standards, transport demands, and requirements. Therefore, the design to support the option assessment process and the cost estimate will be limited to a level that supports the designation footprint, effects, and a number of generic assumptions will be made.

There are several design elements that will not be considered in the development of designs for both the concept and recommended option design development as they will not inform the assessment of effects. The design elements where there will be no specific design developed are as follows:

- Pavement design and road surfacing
- Street lighting
- Road safety barriers
- Utilities design
- Signs and line markings
- Traffic signal design
- Advanced Traffic Management Systems (ATMS) requirements
- Intelligent Traffic Systems (ITS)
- Landscape design, and
- Urban streetscape design features.

2.1 Topographical survey and aerial photography

2.1.1 Topographical survey

Light detection and ranging (LiDAR) is an optical remote-sensing technique that uses laser light to densely sample the surface of the earth, producing highly accurate x, y, z measurements. LiDAR data was provided by Land Information New Zealand (LINZ) and has been used to develop the preliminary design for the road corridors part of this package.

New Zealand Transverse Mercator (NZTM) projection is the coordinate system for the project. The vertical datum is named AUK46, obtained from Auckland Council.

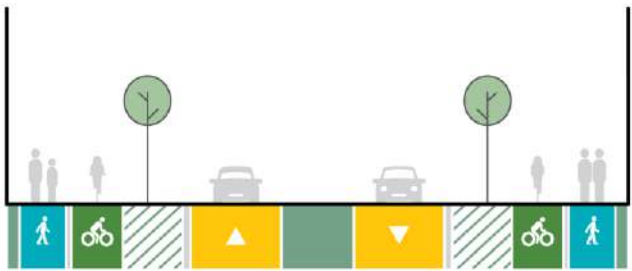
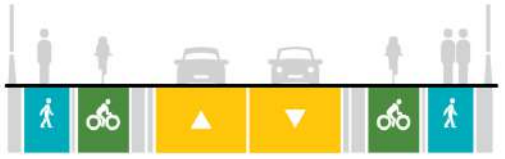
2.1.2 Aerial photography

The aerial photography is provided by Nearmap Ltd. The orthophotography flown over the southern area twice yearly, imagery at present is from March 2022. Imagery supplied as 7.5cm pixel resolution – resampled to 10cm pixel resolution for download.

2.2 Corridor form and function

The **Table 1** provides a summary of the form and function of the corridors.

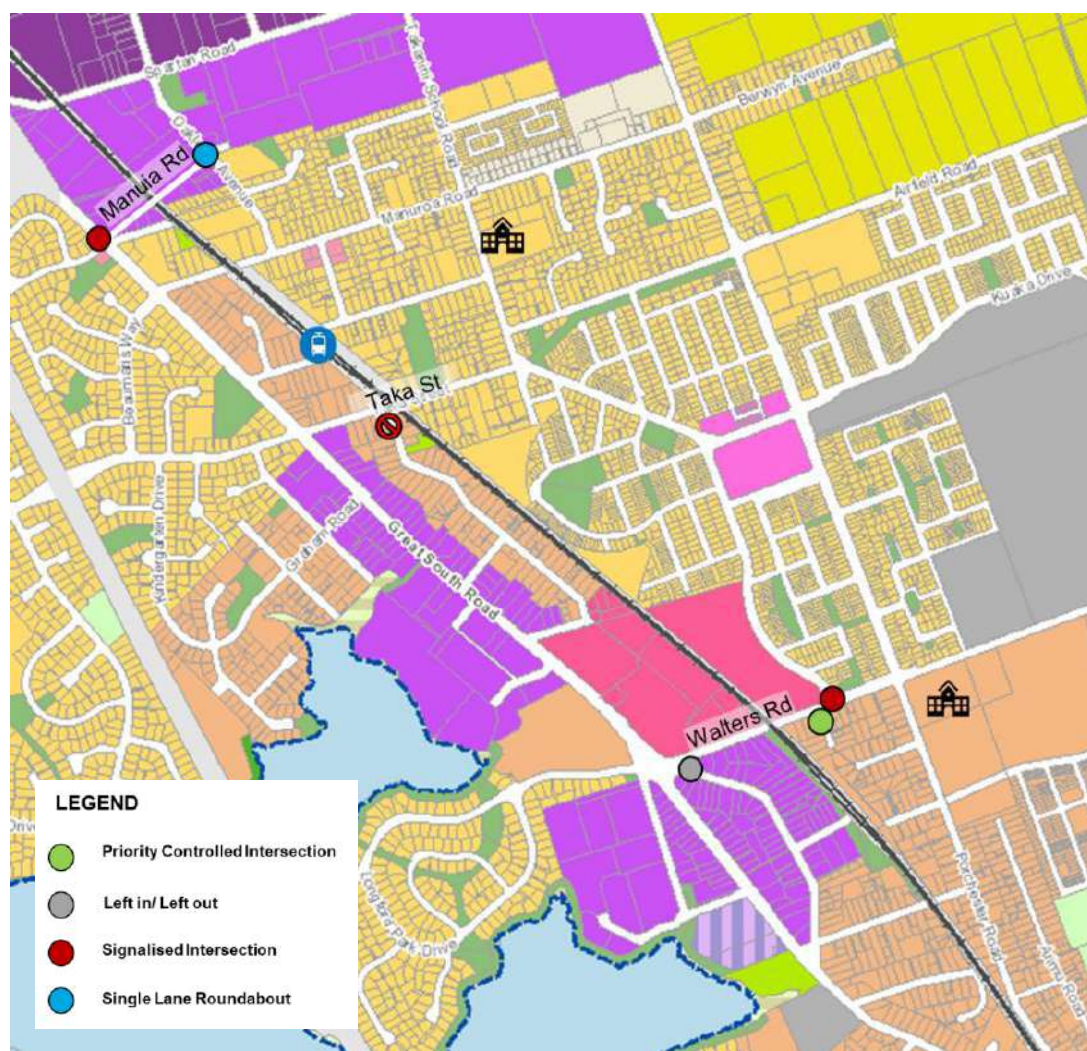
Table 1 Summary of the form and function

Typical section areas	Typical cross section
Mainline corridor typical section	 TWO LANE ARTERIAL - 24M
Bridge typical section	 TWO LANE ARTERIAL BRIDGE - 18M
Active modes bridge typical cross section	 ACTIVE MODE BRIDGE - 4.6M

2.3 Intersection Form and Function

Figure 2-1 provides a summary of the proposed intersection forms. Refer to the Appendix G Transport Outcomes Report within the Detailed Business Case for further details regarding intersection form and function of the corridor.

Figure 2-1: Takaanini level crossings indicative intersection forms



2.4 Access and driveways

All existing alignments and the new alignment at Manuia Road are required to provide access to the adjacent lots, to prevent the landlocking of parcels. Where this is not possible, the full parcel is included in a designation. Service lanes are to be provided in areas where access is being restricted due to vertical level differences of the new vertical alignment (bridge) over the rail line. In other locations where there is limited change to vertical levels, accessways are generally to be retained and modified to suit changes to the roadside including active modes.

The approach to turn movements into and out of accessways varies. Various options exist, including restriction of turn movements into accessways to left-in left-out only, allowing unrestricted access (no flush median) or unrestricted access (with flush median). Some safety benefits can be achieved by restricting right turn movements, although this may create distance delays for drivers. Provision of a full width flush median for sheltering of turning vehicles would further increase the size of the designation. The design provides flexibility for future exploration of different solutions as best suited for the location, at implementation.

Design checks for accessways onto the proposed road corridor have been carried out in accordance with the Auckland Unitary Plan (AUP) E27. Transport.

2.5 Clearance envelope

The following clearance envelopes are to be taken into consideration when designing the grade separated corridors, as set out in Table 2.

Table 2 Clearance envelope

Items	Clearance envelope	Considerations
Road over rail	Allow for 26.8 or 28.8m* minimum horizontal clearance and 7.8m vertical clearance to road surface envelope <i>* Horizontal width of four-tracking is dependent on assumed alignment of future tracks in relation to existing tracks, see Table 3.</i>	Horizontal clearance to accommodate rail four tracking, consisting of: 4m between paired rail tracks (existing rail tracks or future rail tracks when on a single side of existing tracks) 6m between existing rail tracks and future rail tracks 6.4m beyond outside track centrelines Vertical clearance consisting of: 0.2m rail height above sleepers/ballast 5.5m rail vertical clearance envelope, according to KiwiRail standards* 2.1m for bridge superstructure (deck + beam) and surfacing <i>* Vertical clearance can taper down from 5.5m clearance for the extent of horizontal envelope, at 0.5m from outermost rail centreline down to 3.25m height above rail at 2.3 m from centreline of track. Refer to KiwiRail Track Standard: T-ST-DE-5212 Clearances, Appendix 1 Fixed Structure Gauge - Standard Drawing 300157.</i>
Active modes bridge over rail	Allow for 26.8 or 28.8m* minimum horizontal clearance and 7.8m vertical clearance to road surface envelope <i>* Horizontal width of four-tracking is dependent on assumed alignment of future tracks in relation to existing tracks, see Table 3.</i>	Horizontal clearance to accommodate rail four tracking, consisting of: 4m between paired rail tracks (existing rail tracks or future rail tracks when on a single side of existing tracks) 6m between existing rail tracks and future rail tracks 6.4m beyond outside track centrelines Vertical clearance consisting of: 0.2m rail height above sleepers/ballast 5.5m rail vertical clearance envelope, according to KiwiRail standards* 2.1m for bridge superstructure (deck + beam) and surfacing <i>* Vertical clearance can taper down from 5.5m clearance for the extent of horizontal envelope, at 0.5m from outermost rail centreline down to 3.25m height above rail at 2.3 m from centreline of track. Refer to KiwiRail Track Standard: T-ST-DE-5212 Clearances, Appendix 1 Fixed Structure Gauge - Standard Drawing 300157.</i>
Vehicle passage under bridge	Allow 10m horizontal clearance and 7m vertical clearance to road surface envelope	Horizontal clearance to accommodate two lane service lane with allowance for active modes and vehicle tracking. 5m vertical clearance envelope including surfacing according to AT TDM GD0001

Items	Clearance envelope	Considerations
Pedestrian and cyclist passage under bridge	Allow passage under the bridge otherwise blocked by physical fencing or retaining.	

The clearance required for both the road and the active mode crossings of the NIMT is based on the clearance envelope in Table 2 above and Figure 2-2 below. The horizontal envelope consists of 4m between existing track centrelines and 4m between future track centrelines when on a single side of the existing tracks. A 6m offset is provided between existing tracks and future tracks. A 2.75m minimum offset is required beyond the track centreline as per KiwiRail Track Standard: T-ST-DE-5212 Clearances, Appendix 1 Fixed Structure Gauge - Standard Drawing 300157. An additional 3.65m width is provided beyond this for a total width of 6.4m from outside track centreline. This allows an increased width of 3.5m from track centreline to an access track of 2.5m width, with 400mm buffer. The buffer is sufficient to allow physical separation between rail track and access track, if required.



Figure 2-2 General clearance requirements for four-tracking, with two future tracks to one side of existing tracks (top) and a future track to either side of existing tracks (bottom).

The assumed future track alignment at each of the rail crossings is summarised in Table 3 below.

Table 3 Assumed future rail track alignments.

Rail crossing	Assumed future track arrangement	Minimum horizontal clearance
Spartan Road	New track to either side of existing tracks	28.8m
Manuia Road	New track to either side of existing tracks	28.8m
Manuroa Road	New track to either side of existing tracks	28.8m
Taka Street	Two new tracks to the east of existing tracks	26.8m
Walters Road	New track to either side of existing tracks	28.8m

The constraints and designation do not preclude improvements to clearance envelopes as required during design. Further flexibility should be explored during next phase of the design, based on the structural design, KiwiRail standards, and future improvements on the rail line. A possible solution to improve horizontal clearance is inclusion of a bridge pier within the rail corridor, subject to KiwiRail approval. This would allow a rail clearance envelope to either side of the pier, increasing the total horizontal clearance. A further alternative option is to reduce the width of, or exclude, the NIMT access tracks from the clearance envelope beneath the clear span over the NIMT and instead locate on the outer sides of the piers.

2.6 Geometric design

2.6.1 Roothing geometric design

The **Table 4** describes the key elements of the geometric design from a roading point of view.

Table 4 Approach to geometric design

Design element	Approach to design	Comments
Cross section	As per section 2.2 of this report	N/A
Posted Speed	50km/hr	N/A
Design Speed	Horizontal – 50km/hr Vertical – 50km/hr	As per TDM Geometric design
Horizontal alignment* *Excludes design specific to intersections and accessways	Minimum radius 120m for minimum curve length of 70m. This allows 3.0% adverse crossfall to be applied.	As per AGRD Part 3

Design element	Approach to design	Comments
Vertical alignment	Grade: - Desirable maximum grade of 8% Minimum crest curve: - K=6.8 Minimum sag curve: - K=6	Maximum grade as per TDM without requiring specific treatment for pedestrian routes. Minimum crest curve as per AGRD Part 3. Governed by sight distance requirements. Minimum sag curve as per AGRD Part 3. Governed by comfort requirement and conforms with increased design speed of 60km/h.
Clearance envelope	As per section 2.5 of this report	N/A
Accessway and driveways	As per section 2.40 of this report	N/A
Signalised intersections	Intersection form and stacking lanes details are as per Appendix G Transport Outcomes Report.	Splitter islands are to be added on the mainline corridor in a case by case scenario assessed by the designer.
Single lane roundabout	ICD of 41m for single lane roundabout within existing urbanised area.	The typical section of an ICD of 41m consists of the following: 11m central island radius 9.25m circulating carriageway width. Roadside width of 5.75m: 1.25m front berm/buffer 2m cycleway 2m footpath 0.5m back berm
Uncontrolled intersections	To utilise the existing geometry as much as possible.	N/A
Slope embankment and retaining walls	As per section 2.7 of this report.	N/A
Cul-de-sac	- Horizontal and vertical alignment to be retained except minimal changes as required to construct cul-de-sac - Allow for semi-trailer (industrial) for all level crossing closures (width, radii and rounded turning head)	As per TDM Geometric design

2.6.2 Active modes bridge and ramp design

Table 5 describes the key elements of the geometric design for the active modes bridge and ramp.

Table 5 Approach to active modes bridge and ramps design

Design element	Approach to design	Comments
Cross section	As per section 2.2 of this report	N/A
Clearance envelope	As per section 2.5 of this report	N/A
Ramps	Consisting of 9m* ramps at 1:12 vertical grade and 5m* landings at 1:50 vertical grade. Design has considered ramp width of 4m with 300mm allowance on sides for fencing, as per Table 1. <i>*Includes 1m transition curve at each interface for transition curves of 2m total length.</i>	As per New Zealand Standards for Access and Mobility and AT TDM. Design is to take conservative elements from both standards to provide a design suitable for both wheelchairs and cyclists.
Stairs	Stairways assumed to consist of four flights of stairs at 3.3m length with landings of 1.8m minimum between flights. Design has considered stairway width of 4m.	Design to be developed further as per building code and AT TDM.

2.7 Geotechnical design

2.7.1 Slope stability

No numerical analysis has been carried out in this phase of design, with assessment based on review of recent and historic investigation data. Stability of slopes has been assessed based on the mapped geomorphology, and the performance of similar geological areas.

1V:3H slopes have been adopted as the default batter for cut and fill slopes to meet maintenance requirements. Within the Auckland region, similar slopes have been widely utilised successfully in soils that do not have known slope instability issues.

1V:5H slopes have been adopted in areas underlain by soft soils/peat with the maximum embankment height of 2m. Mechanically stabilised earth walls or bridge structure is to be provided once maximum height is achieved.

2.7.2 Retaining walls

Vertical retaining walls have been placed where necessary to limit impact on properties and manage topographic constraints. Fill walls have been assumed to be constructed using generic mechanically stabilised earth techniques.

Given the limited geotechnical information available, retaining walls were detailed as typical with the most suitable wall types identified to inform the construction method statement and cost estimation.

Final decisions around wall type will be undertaken during subsequent design phases once further site investigation is carried out.

2.7.3 Bridge abutments

Vertical abutment walls have been adopted as the default approach to bridge abutments within the existing urbanised/industrial area. The vertical abutment walls have been assumed to be constructed using mechanically stabilised earth walls.

No specific design of abutment walls slope stability has been carried out during this phase of design.

2.8 Structures design

Given the high-level nature of design input, the route protection philosophy is that no preliminary or detailed design is undertaken for the structures, but the basic structural form (Span, deck type and substructure configuration) defined to confirm viability of the chosen alignment and designation. Abutment forms are designed as vertical walls and bench-type atop cut faces. Refer also to section 2.7.3 for information at bridge abutments.

The philosophy with regards to bridge superstructure form is to utilise standard precast concrete girders with cast in-situ topping slabs. This is to ensure that the bridges can be designed and constructed using readily available building materials and standard forms.

Bridge skew angles are limited to a maximum of 30 degrees relative to the service being crossed. This is to ensure that no standard bridge design is precluded from future detailed design. Typically, girder type and box type bridge decks are only suitable up to skews of 30 degrees.

The design approach is to provide equal spans for road over road and road over rail bridges to have backspan to mainspan ratios of between 0.6 and 0.8. The chosen structural articulation is as follows:

- Single span bridges up to a maximum structure length of 35 m
- Multi-span bridges for structure lengths exceeding 35 m, or as dictated by geometric constraints.

For pedestrian and active mode bridges, the approach to design is very similar to that for vehicular bridges. Access ramps consist of both stairs and ramps to ensure universal access across the service being spanned. Refer to section 2.6.2 for geometric design considerations towards ramps, clearance and stairs.

2.9 Stormwater Design and Flooding

Stormwater design includes four separate yet related considerations:

- stormwater runoff capture / conveyance system design,
- treatment design (water quality mitigation),
- water quantity design (hydrologic mitigation) and
- flood effect mitigation (peak flow increase and displacement effects).

Each of these stormwater design features are prescribed for management within Auckland Council Guidelines and/or required by the Unitary Plan - Operative in Part (AUP:OP). The Auckland Design Manual, the Auckland Transport Design Manuals and the Unitary Plan are the key documents that govern the stormwater design approach.

In general, the key stormwater objectives are to provide stormwater treatment and retention/detention for new impervious surfaces, re-use and re-purpose existing infrastructure, enhance with green

infrastructure and provide treatment of existing surfaces where possible, including where existing runoff mixes with new prioritising high loading areas such as intersections.

2.9.1 Stormwater runoff capture and conveyance

The Road Drainage chapter of the Auckland Transport Design Manual sets out the performance requirements for stormwater capture and conveyance systems for local roads in Auckland. The details of this system shall be developed and confirmed at the resource consent application phase of the project. The approach for each new road section will require a kerb and channel along the road edge with a concrete barrier at the bridge sections to intercept road runoff. The intercepted flow will be captured in catchpits and conveyed via a new piped network to a stormwater treatment, detention, and attenuation system.

2.9.2 Stormwater treatment and hydraulic mitigation

Stormwater runoff is considered polluted when flowing from high vehicle use impervious areas. The Auckland Unitary Plan (AUP), chapter E9 considers the construction of roads, up to 5000m² of new impervious road area, as a permitted activity and treatment is required in accordance with Guidance Document 2017/001 Stormwater Management Devices in the Auckland Region (GD01). Raingardens/bioretention systems, planted or grassed swales, wetlands and proprietary cartridge treatment systems are common practice to meet this requirement.

Hydrologic mitigation refers to the detention and slow release of stormwater runoff to prevent downstream erosion. The Auckland Unitary Plan E10 defines the approach detention as either SMAF1 or SMAF 2. SMAF is an acronym for Stormwater Management Area Flow and generally refers to control overlay in the unitary plan where the requirement is identified based on downstream environment sensitivity. However, AUP:OP chapter E8 contains a trigger for restricted discretionary activities that require SMAF 1 hydrologic mitigation regardless of being in the SMAF control overlay or not.

Each of the three rail overpass road sections are under the 5000m² of new impervious area and are considered permitted activities if consented individually. This would mean only road runoff treatment is required. If consented as a whole and the areas of new impervious surface are combined, this will trigger the restricted discretionary activity controls and require hydrologic mitigation. In this event, treatment and detention will be required.

2.9.3 Flood effect mitigation

Flood effects can arise by blocking overland flowpaths, adding new impervious area (reducing the soil storage capacity) and by displacing flood storage, typically by filling earth in the floodplain. Two approaches are available to assessing and mitigating flood effects:

1. Utilising the existing Auckland Council Flood model to calculate the effects and iterate a mitigation solution that could include, offset storage, culverts or both.
2. Providing a compensatory volume of 1m³ of fill in the floodplain equal to 1m³ of offset storage as compensation.

The floodmaps shown on the Auckland Council GIS indicate that there is extensive floodplain upstream (northeast) of the Northern Island Main Trunk (NIMT) railway line. However, modelling by the SGA team as part of a nearby project had indicated that the Auckland Council GIS is not accurate, and the official Council model show considerably less flooding in each of the three project locations.

further commentary is made in each road section. All earthworks in flooded regions are potential sources of flood effects and may require mitigation.

3 Spartan Road

The level crossing removal at Spartan Road requires a cul-de-sac head on either side of the rail corridor to allow vehicles to turn. A grade separated active mode connection (AMC) is proposed to replace existing facilities at grade. Figure 3-1 highlights the vertical clearance provided between the AMC and the NIMT. Vertical transition curves are not illustrated in the figure below.

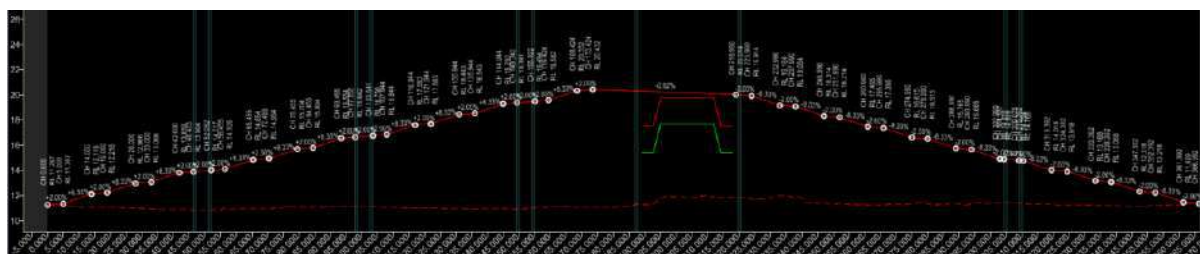


Figure 3-1 Spartan Road AMC vertical alignment.

Table 6 describes the key elements of the works at Spartan Road.

Table 6 Spartan Road design road closure and active modes bridge

Design item	Comments
Cul-de-sac	Turning head dimensions adopted as per Table 4 . The design also includes a 1.25m front berm, 4m shared use path and 0.5m back berm.
Active modes bridge	Bridge across future 4-tracked NIMT, crossing the railway line perpendicular to minimise the bridge span. 30m minimum span to suit horizontal clearance requirements as per Table 2. Bridge structure consisting of precast Super-T beams with in-situ topping slab. Piers are single column-type with a capping beam at the top All supports are founded on piles. Main bridge span across the railway line to be fitted with compliant electrification / anti-throw screens
Ramps	Designed as per Table 5. West: - Three lengths of three ramps, beginning at cul-de-sac - One length of one ramp, connecting to rail crossing East: - One length of four ramps, beginning at cul-de-sac - One length of six ramps, connecting to rail crossing The same structure form for the bridge is applied at the ramps. 1.8m high pedestrian railings are to be provided at both edges of the path.
Stairs	Designed as per Table 5.

No stormwater system has been designed as part of the cul-de-sac and active modes bridge work.

Geological maps indicate that the entire alignment is underlain by undifferentiated sedimentary deposits of the Takaanini Formation (refer to Appendix B on this report), which is the proposed new name for what has formerly been called the Puketoka Formation and is assigned to the broader classification, the Tauranga Group. In the Takaanini area these deposits are characterised by the presence of some rhyolitic pumice originating from volcanic airfall but are likely to be dominated by alluvial clays and silts of variable stiffness, with minor layers of sands and organic materials. At depth below these strata will lie interbedded sandstones and siltstones of the East Coast Bays Formation. The maps indicate that the western limit of the soft and compressible peat soils characteristic of eastern areas of Takaanini (the Ardmere Peat) does not encroach on the alignment.

Historic geotechnical investigation logs obtained from the New Zealand Geotechnical Database (NZGD) confirm the interpretation from the geological maps. The log of a drillhole (BH_89130) sunk 125m to the west of the rail crossing (at the Southern Motorway offramp bridge) proved stiff clayey silt with minor sand of the Tauranga Group extending to 4.5m depth. This is underlain by weathered East Coast Bays Formation, transitioning into sandstone rock at 8.5m depth. The nearest hole in the NZGD to the east of the level crossing is a hand auger 340m away (HA_DCP_138313) which proved very stiff silt, either clayey or sandy, of the Tauranga Group (Takaanini Formation), to at least 5m depth.

The available geological information supports the default design for earthworks. Piled foundations into the East Coast Bays Formation will work easily if needed. Should design only impart light loads to the ground, the possible use of shallow foundations might be achievable if confirmed by targeted local geotechnical investigations.

4 Manuia Road

The Manuia Road road/rail grade separation is a new East-West crossing of the NIMT that connects Great South Road at Challen Close to Oakleigh Avenue at Hitchcock Road. The new link is approximately 300m long and consists of a single span bridge crossing the NIMT.

Works on Manuia Road include an upgrade of the Great South Road intersection to a signalised intersection, improvements to capacity with changes to the lane arrangement and improvements to active modes. The intersection of the Manuia Road crossing with Oakleigh Avenue is proposed as a four-legged roundabout including Hitchcock Road.

The existing Manuia Road alignment services several properties. The new Manuia Road alignment will include a left-in left-out intersection with the historical alignment to retain access to the properties.

Figure 4-1 below shows the Manuia Road design with works on adjacent intersections. Figure 4-2 highlights the Manuia Road grade separation vertical alignment achieving clearance requirements.



Figure 4-1 Manuia Road design

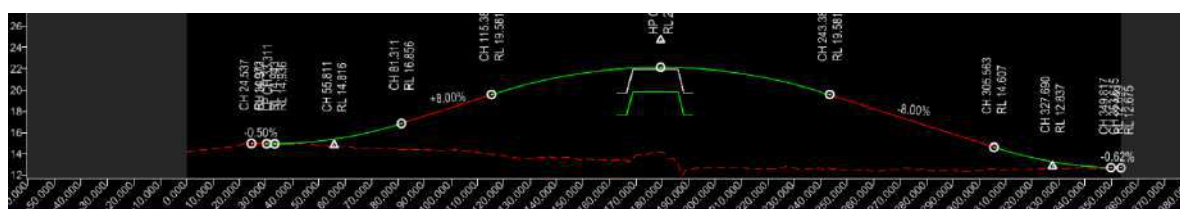


Figure 4-2 Manuia Road vertical alignment

The **Table 7** describes the key design elements of the Manuia Road

Table 7 Manuia Road design

Design item	Comments
Cross section	24m two lane arterial as per Table 1 for new corridor. Median and berm widths to vary along corridor to tie into adjacent intersections and bridge.
Horizontal alignment	Single tangent connecting intersection of Great South Road and Challen Close with Oakleigh Avenue and Hitchcock Road.
Vertical alignment	Grades: 8% maximum 0.5% minimum Transition curves: - Crest K-value of 8 - Sag K-value of 6
Intersections	Great South Road (and Challen Close) - Intersection to be signalised - Manuia Road to be realigned and widened with two approach lanes - Great South Road lane arrangement to be revised with some road widening and active mode improvements - Intersection sight distance requirements remain achieved based on proposed Manuia Road vertical alignment Manuia Road (existing) - Existing Manuia Road to be realigned and connected to new Manuia Road alignment - New priority controlled intersection - Intersection sight distance requirements achieved based on proposed Manuia Road vertical alignment Oakleigh Avenue (and Hitchcock Road) New roundabout with four-legs - Active mode roadside and crossing improvements - Intersection sight distance requirements achieved based on proposed Manuia Road vertical alignment
Accessways	Existing accessways along Manuia Road to be retained and limited access are to be maintained along the new road corridor.
Manuia Road (existing road segment)	Left-in left-out priority controlled intersection with new Manuia Road alignment.
Embankment slope	Geological maps indicate that the entire alignment is underlain by undifferentiated sedimentary deposits of the Takaanini Formation (formerly the Puketoka Formation) and is assigned to the broader classification, the Tauranga Group. In the Takaanini area these deposits are characterised by the presence of some rhyolitic pumice originating from volcanic airfall but are likely to be dominated by alluvial clays and silts of variable stiffness, with minor layers of sands and organic materials. At depth below these strata will lie interbedded sandstones and siltstones of the East Coast Bays Formation. The

Design item	Comments
	maps indicate that the western limit of the soft and compressible peat soils characteristic of eastern areas of Takaanini (the Ardmore Peat) does not encroach on the alignment. The NZGD log from a historic geotechnical investigation hole (BH_70547) lying 100m south of where the proposed bridge crosses the railway is consistent with the interpretation from the geological maps.). Firm to stiff clay, of the Tauranga Group (Takaanini Formation), was proved to at least 6m depth. There are no other holes shown on the NZGD within 300m. The available geological information supports the default design for earthworks, i.e. embankment batters of 1V:3H. Piled foundations into the East Coast Bays Formation should be feasible. Local geotechnical investigations will be needed to assess the geotechnical characteristics of the Takaanini Formation soils, indicate what depths foundations may need to be taken to and confirm the earthworks design approach. The possible presence of some soft soils beneath the approach embankments will potentially require some ground improvement, for example preloading with wick drains to reduce residual settlement to an acceptable degree. Monitoring with geotechnical instruments will be needed during and post-construction to track the rate of settlement and confirm that that ground distortion stays within tolerance. Refer to Appendix B for Geological map and historic geotechnical investigation logs from NZGD.
Bridge design	35m single span bridge crossing of NIMT. Maximum span of 35m and maximum skew of 30° (designed at 5° over NIMT). Single span to provide clearance as per Table 2 and structural design to comply with structural requirements Section 2.8.
Stormwater runoff capture and conveyance	Stormwater network designed as per item 2.9.1 of this report. The general solution for this design will be to intercept flow in the kerb and channel on either side of the road as it flows away from the road high point over the railway line. The water will be captured in a linear treatment system such as a raingarden, tree pit or a landscape integrated solution that may include both. The treated flow and bypassing flow in larger events will flow into the existing stormwater pipe network.
Stormwater treatment	Water quality treatment and detention is required by the Auckland Unitary Plan, Activity A1 of Chapter E8 and Activity A5 of Chapter E9. Based on this, raingardens, swales and wetlands are the best options to manage the pollutants of concern as discussed in GD01, propriety systems such as Filterra or cartridge systems will not perform the detention component of the solution needed. Raingardens integrated with a larger landscape plan would be the preferred solution, sized and spaced in accordance with the calculations and principles of GD01.
Flood effect mitigation	Flood mitigation will be assessed, and mitigation proposed at a more advanced design phase. Figure 4-3 shows the modelled output from the latest Auckland Council InfoWorks ICM model for the Papakura Streat catchment. The flood extents and depths shown in this figure are for all depths greater than 50mm, depths less than this amount are considered sheet flow and not a flood hazard. This was previously written into the Auckland Council Stormwater Modelling Specification. However, this publication is no longer in effect ad no new criteria defines this threshold. The displacement effect of earthworks in this floodplain will be minimal and mitigation will be minor if required at all.

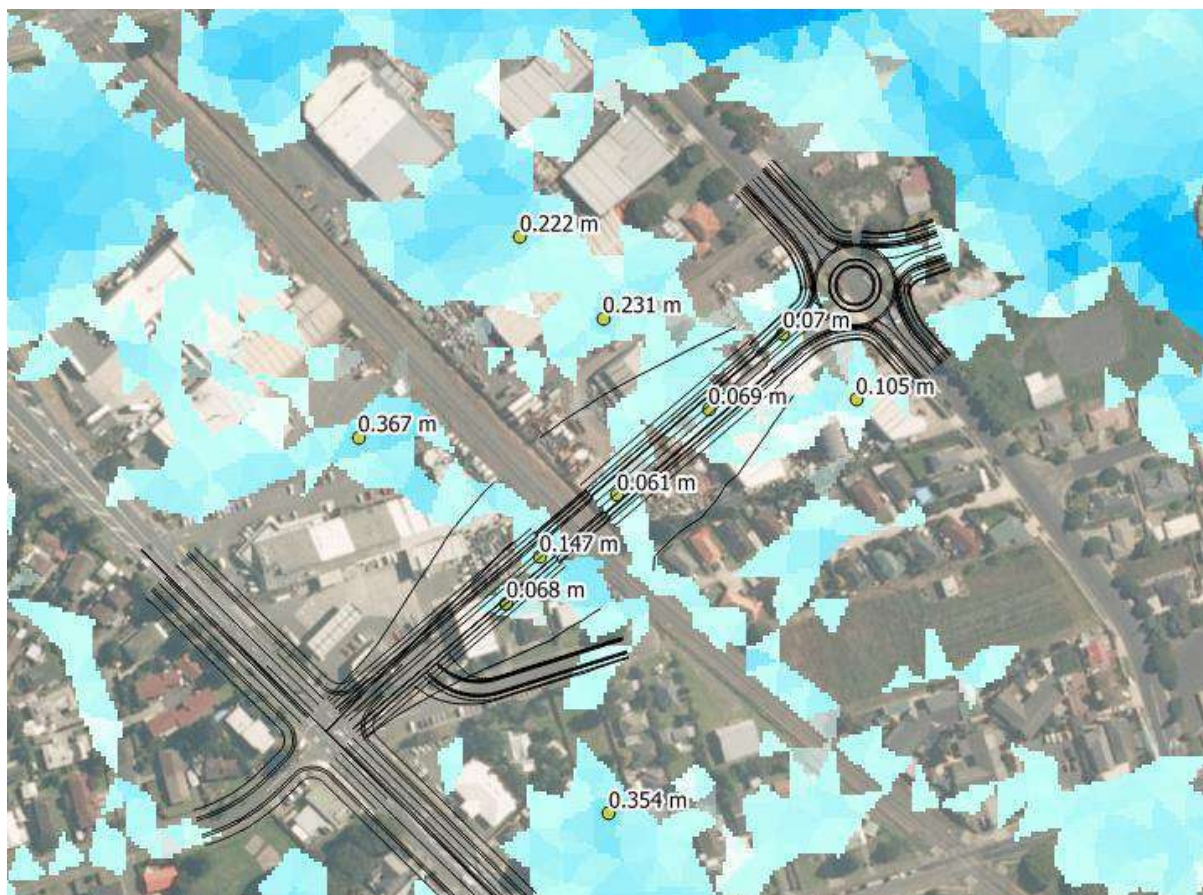


Figure 4-3: 1% AEP with climate change modelled flood depths >50mm

5 Manuroa Road

The level crossing removal at Manuroa Road requires a cul-de-sac head on either side of the rail corridor to allow vehicles to turn. A grade separated active mode connection (AMC) is proposed to replace existing facilities at grade. Figure 5-1 highlights the vertical clearance provided between the AMC and the NIMT. Vertical transition curves are not illustrated in the figure below.

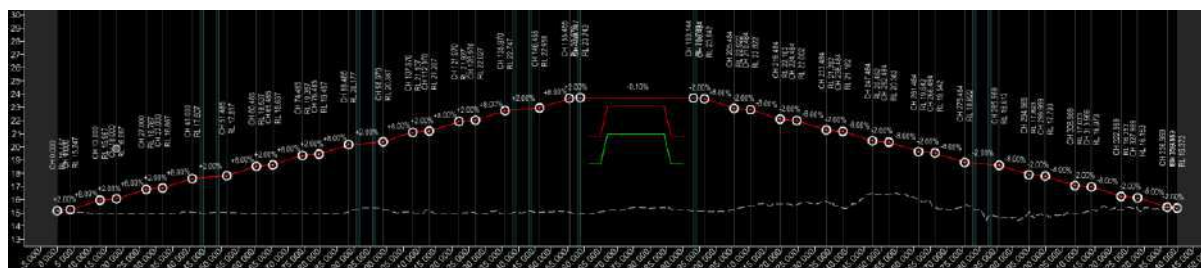


Figure 5-1 Manuroa Road AMC vertical alignment.

Table 8 describes the key elements of the works at Manuroa Road.

Table 8 Manuroa Road design road closure and active modes bridge

Design item	Comments
Cul-de-sac	Turning head dimensions adopted as per Table 4. The design also includes a 1.25m front berm, 4m shared use path and 0.5m back berm.
Active modes bridge	Bridge across future 4-tracked NIMT, crossing the railway line perpendicular to minimise the bridge span. 30m minimum span to suit horizontal clearance requirements as per Table 2. The bridge deck consists of precast Super-T beams with in-situ topping slab Piers are single column-type with a capping beam at the top All supports are founded on piles. Main bridge span across the railway line to be fitted with compliant electrification / anti-throw screens
Ramps	Designed as per Table 5. West: - Three lengths of three ramps, beginning at cul-de-sac - One length of one ramp, connecting to rail crossing East: - One length of four ramps, beginning at cul-de-sac - One length of six ramps, connecting to rail crossing The same structure form for the bridge is applied at the ramps. 1.8m high pedestrian railings are to be provided at both edges of the path.
Stairs	Designed as per Table 5.

No stormwater system has been designed as part of the cul-de-sac and active modes bridge work.

Geological maps indicate that the entire alignment is underlain by undifferentiated sedimentary deposits of the Takaanini Formation (formerly the Puketoka Formation and belonging to the larger scale Tauranga Group), refer to Appendix B on this report. The maps indicate that the soft and compressible peat soils characteristic of eastern areas of Takaanini (the Ardmore Peat) does not encroach on the alignment. However, a historic drillhole undertaken on the west side of Great South Road (BH_70546 in the NZGD) logged firm organic silt with fibrous organics from 2.4m depth to the base of the hole at 6.0m. Although these materials may not be as poor quality as in the centre of the deposit, this log implies that the western margin of the Ardmore Peat lies much further to the SW than shown on the geological maps and that the Manuroa Road pedestrian / cycle bridge is sited on the peat body.

The materials above and below the peat are likely to be stiff alluvial clays and silts of the Takaanini Formation (Tauranga Group) with some pumiceous content. At depth below these strata will lie interbedded sandstones and siltstones of the East Coast Bays Formation, the upper part of which may be weathered to a soil condition.

The potential presence of soft compressible organic soils under the bridge site and its approaches indicates that any foundations will need to be taken on piles down into the East Coast Bays Formation. This also means that earthwork embankments will need to be kept below 2m height and constructed with side slopes of 1V:5H if any earthworks are to be undertaken. Local geotechnical investigations will be needed to prove the geological sequence, confirm the ground properties, and identify the depths of suitable founding materials.

6 Taka Street

The Taka Street Road/rail grade separation will replace the existing level crossing of Taka Street. Taka Street is approximately 520m long and the crossing of the NIMT is proposed as a 230m multi-span structure.

Works on Taka Street exclude improvements to the Great South Road intersection or on the Kauri Heart Avenue/ Takanini School Road roundabout. The intersection of Taka Street with Takanini Road is proposed to be closed to the vertical level differences between the new Taka Street alignment and the existing Takanini Road alignment. Alternative options to raise the existing Takanini Road alignment were not progressed due to geometric issues, safety concerns, increased structural complexity, access restrictions and cost. As a mitigation for active mode users, an active mode passage is proposed to connect Takanini Road to the north to Maru Street and Takanini Station, and alongside Taka Street on the north to allow access to Great South Road or access to the new grade separated crossing.

The existing Taka Street alignment provides access to several properties. Service lanes are proposed to provide access to parcels that are vertically separated from the raised Taka Street alignment.

Figure 6-1 shows the Taka Street design. Figure 6-2 highlights the Taka Street grade separation vertical alignment achieving clearance requirements.



Figure 6-1 Taka Street design

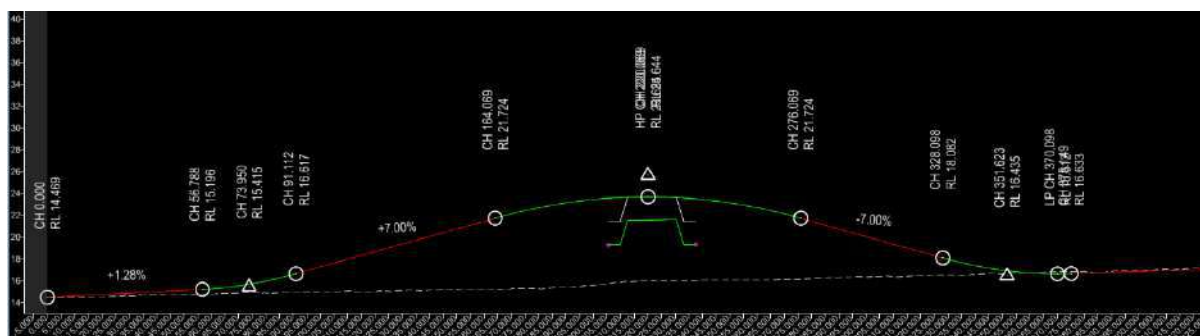


Figure 6-2 Taka Street vertical alignment

Table 9 describes the key elements of the works at Taka Street.

Table 9 Taka Street grade separated design

Design item	Comments
Cross section	3.8m traffic lanes, 2m cycleway and 2m footpath widths as per Table 1. Median and berm widths to vary along corridor to tie into adjacent intersections and bridge. Corridor at grade to the east of the NIMT widened to include a median of 1.8m width, allowing implementation of median island and tie into splitter island at roundabout. Walking, cycling and berms generally of 5.25m width, to be within existing road reserve where appropriate.
Horizontal alignment	Single tangent following existing centreline connecting intersection of Great South Road with Kauri Heart Avenue/ Takanini School Road.
Vertical alignment	Grades: • 7% maximum • 0.5% minimum Transition curves: • Crest K-value of 8 • Sag K-value of 6
Intersections	Great South Road (and Walter Strevens Drive) • Signalised intersection to be retained in its current form • Intersection sight distance requirements remain achieved based on proposed Taka Street vertical alignment Takanini Road • Existing priority controlled intersection to be closed • Takanini Road to be closed near existing intersection with a new cul-de-sac head • Cul-de-sac head to be sized as per AT TDM for a residential design vehicle Kauri Heart Avenue and Takanini School Road • Existing roundabout to be retained in its current form • Intersection sight distance requirements remain achieved based on proposed Taka Street vertical alignment
Service lanes	North-western service lane

Design item	Comments
	- Required to provide access to parcels grade separated from Taka Street on the north-west - Culminated with turning head as per AT TDM for a residential design vehicle - Median of sufficient width for further investigation of right turn pockets or left-in left-out restrictions South-western service lane - Required to provide access to parcels grade separated from Taka Street on the south-west - Provides secondary access to a single parcel - No turning head proposed - Median of sufficient width for further investigation of right turn pockets or left-in left-out restrictions Eastern service lane (North and South loop) - Required to provide access to parcels grade separated from Taka Street on the east - Service lane to be connected north to south by a link underneath Taka Street multi-span structure - Median of sufficient width for left-in left-out restrictions
Accessways & driveways	All other accessways at or near grade with Taka Street to be retained and reconstructed to suit active mode improvements.
Embankment slope	Geological maps indicate that the alignment to the west of the railway line is underlain by undifferentiated sedimentary deposits of the Takaanini Formation (formerly the Puketoka Formation and belonging to the larger scale Tauranga Group). The eastern side of the alignment is shown as extending over the area of swamp deposits classified as the Ardmore Peat. The NZGD records a line of hand augers through Taka Reserve. HA_130413, about 80m east of the railway records soft, wet peat from 0.9m to the base of the hole at 3.0m. Another line of boreholes recorded by NZGD straddling the rail line 275m to the SE and drilled for the Takaanini Wastewater project also confirm the presence of peat. For example, BH_71368 records amorphous peat from 1.95m depth to the base of the hole at 6.0m, initially stiff it becomes soft below 3.1m and with varying fibrous content. Interpolation between these holes and drillhole BH_70546 in St Aidan's Reserve 475m to the west indicates that the boundary of the swamp deposits is further west than mapped and that the Ardmore Peat body potentially underlies much of the alignment. Where the material is not peat it is likely to be stiff alluvial clays and silts of the Takaanini Formation (Tauranga Group) with some pumiceous content. At depth below these strata will lie interbedded sandstones and siltstones of the East Coast Bays Formation, the upper part of which may be weathered to a soil condition. The potential presence of soft compressible organic soils under the bridge site and its approaches indicates that any foundations will need to be taken on piles down into the underlying East Coast Bays Formation. Soft soils will also govern the height of earthwork embankments, which will need to be kept below 2m height and constructed with side slopes of 1V:5H. Even with embankment height restricted to maintain slope stability, it is likely that additional ground improvement measures will be needed to mitigate the effects of settlement, such as by installing wick drains or by stabilising the soils with rigid inclusions or stone columns. Local geotechnical investigations will be needed to confirm the indications from the NZGD, prove the geological sequence, measure the ground properties and identify the depths of

Design item	Comments
	suitable founding materials. Long-term monitoring will be required with geotechnical instruments to track post-construction settlement and confirm that the ground distortions are within tolerance. Refer to Appendix B for Geological map and historic geotechnical investigation logs from NZGD.
Bridge design	230m multi-span bridge crossing of NIMT. Multi-span structure to have maximum spans of 35m and maximum skew of 30° (designed at 30° over NIMT). Clear span over NIMT to provide clearance as per Table 2 and structural design to comply with structural requirements Section 2.8. Structure to provide clearance as per Table 2 for active mode connection (west) and service lane crossing of Taka Street alignment (east).
Stormwater runoff capture and conveyance	Stormwater network designed as per item 2.9.1 of this report. The general solution for this design will be to intercept flow in the kerb and channel on either side of the road as it flows away from the road high point over the railway line. The water will be captured in a linear treatment system such as a raingarden, tree pit or a landscape integrated solution that may include both. The treated flow and bypassing flow in larger events will flow into the existing stormwater pipe network.
Stormwater treatment	Water quality treatment and detention is required by the Auckland Unitary Plan, Activity A1 of Chapter E8 and Activity A5 of Chapter E9. Based on this, raingardens, swales and wetlands are the best options to manage the pollutants of concern as discussed in GD01, propriety systems such as Filterra or cartridge systems will not perform the detention component of the solution needed. Raingardens integrated with a larger landscape plan would be the preferred solution, sized and spaced in accordance with the calculations and principles of GD01.
Flood effect mitigation	Flood mitigation will be assessed, and mitigation proposed at a more advanced design phase. Figure 6-3 shows the modelled output from the latest Auckland Council InfoWorks ICM model for the Papakura Streat catchment. The flood extents and depths shown in this figure are for all depths greater than 50mm, depths less than this amount are considered sheet flow and not a flood hazard. This was previously written into the Auckland Council Stormwater Modelling Specification. However, this publication is no longer in effect and no new criteria defines this threshold. The displacement effect of earthworks in this floodplain will be minimal and mitigation will be minor is required at all.



Figure 6-3: 1% AEP with climate change modelled flood depths >50mm

7 Walters Road

The Walters Road road/rail grade separation will replace the existing level crossing of Walters Road. Walters Road between Great South Road and Porchester Road is approximately 590m long and the crossing of the NIMT is proposed as a 250m multi-span structure. Of the structure, 55m is proposed wider than as in Table 1 due to intersection lane requirements.

Works on Walters Road exclude changes to the Great South Road roundabout or Porchester Road roundabout. The intersection of Walters Road with Tironui Road is proposed to be modified to left-in left-out. The intersections of Walters Road with Arion Road and Braeburn Place are to be modified to provide sufficient width for intersection lanes and active modes.

The existing Walters Road alignment provides access to several properties. A two-way service lane is proposed to provide access to parcels that are vertically separated from the raised Walters Road alignment, with the ability to loop under the structure to provide connectivity.

Figure 7-1 below shows the Walters Road design. Figure 7-2 highlights the Walters Road grade separation vertical alignment achieving clearance requirements.



Figure 7-1 Walters Road design.

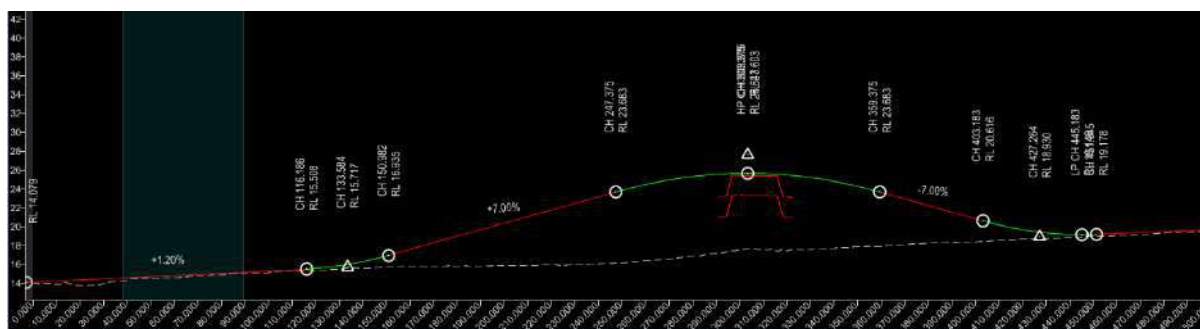


Figure 7-2 Walters Road vertical alignment.

Table 10 describes the key elements of the works at Walters Road.

Table 10 Walters Road grade separated design

Design item	Comments
Cross section	3.8m traffic lanes, 2m cycleway and 2m footpath widths as per Table 1. Median and berm widths to vary along corridor to tie into adjacent intersections and bridge. Berm generally of 5.25m width, as per 20m SGA generic cross section
Horizontal alignment	Single tangent following existing centreline connecting intersection of Great South Road through to Porchester Road.
Vertical alignment	Grades: 7% maximum 0.5% minimum Transition curves: - Crest K-value of 8 - Sag K-value of 6
Intersections	Great South Road (and side roads) - Existing roundabout to be retained in its current form - Intersection sight distance requirements remain achieved based on proposed Walters Road vertical alignment Tironui Road - Existing priority controlled intersection to be modified - Tironui Road to be made left-in left-out - Walters Road right turn pocket to be removed and replaced by raised median - Intersection sight distance requirements remain achieved based on proposed Walters Road vertical alignment Braeburn Place - Existing priority controlled intersection to be modified - Intersection of Braeburn Place to be shifted further south to suit Walters Road proposed edge of seal - Braeburn Place vertical profile to be raised to allow tie into proposed Walters Road vertical levels

Design item	Comments
	- Median along Walters Road of sufficient width to provide right turn pocket or raised island for left-in left-out restrictions - Intersection sight distance requirements remain achieved based on proposed Walters Road vertical alignment Arion Road - Existing signalised intersection to be modified to allow intersection lane development and active mode improvements - Intersection sight distance requirements remain achieved based on proposed Walters Road vertical alignment Porchester Road - Existing roundabout to be retained in its current form for grade separation works - Future form of intersection under investigation as part of Takaanini Frequent Transit Network scope - Intersection sight distance requirements remain achieved based on proposed Walters Road vertical alignment
Service lanes	Western service lane (North and South loop) - Required to provide access to parcels grade separated from Walters Road on the west - Service lane to be connected north to south by a link underneath Walters Road multi-span structure - Median of sufficient width for left-in left-out restrictions
Accessways & driveways	Access to the south-eastern parcels between NIMT and Braeburn Place cannot be provided without impacting on buildings. A new accessway may be designed in the future to provide access off Braeburn Place based on decisions around residual land use. All other accessways at or near grade with Walters Road to be retained and reconstructed to suit active mode improvements.
Embankment slope	Geological maps indicate that the entire alignment at Walters Road lies on an area of swamp deposits classified as the Ardmore Peat. The mapped western limit of these deposits is the roundabout with Great South Road. Although there are no exploratory holes along Walters Road itself, geological logs held in the NZGD for holes drilled in a complete arc around the site confirm the presence of soft compressible peat at each location. Consistent with the geological map it can be inferred that soft ground conditions apply throughout the alignment. Those holes in the NZGD which encountered peat were not taken deep enough to prove the base of the deposit. Only in Borehole_69660 on Great South Road, 250m to the south, was the base of the peat encountered at 1.4m depth. All the other holes were terminated without bottoming it at depths varying between 3.0m and 8.5m. It is interpreted that Borehole_69660 lies close to the edge of the deposit and that the base of the peat deepens to the east. For example, at Swamp Kauri Grove, 900m east, BH_138725 showed the soft peat transitioning into firm alluvial organic silt at 10.0m whereas at Papakura Military camp (1.1km away) BH_142677 indicates this transition is at 17.0m depth. In the area of the swamp deposits layers of other materials from the Takaanini Formation (Tauranga Group) are interlayered with the peat, especially near the surface, base and sides. These include silts and clays of varying stiffness and sands, which may be pumiceous. The East Coast Bays Formation occurs at depth; how deep this will be at the

Design item	Comments
	Walters Road site is unknown but at Swamp Kauri Grove it was first encountered at 17.2m, transitioning into a rock condition at 25.0m. The presence of soft compressible organic soils under the bridge site and its approaches indicates that any foundations will need to be taken on piles down into the underlying East Coast Bays Formation. Soft soils will also govern the height of earthwork embankments, which will need to be kept below 2m height and constructed with side slopes of 1V:5H. Even with embankment height restricted to maintain slope stability, it is likely that additional ground improvement measures will be needed to mitigate the effects of settlement, such as by installing wick drains or by stabilising the soils with rigid inclusions or stone columns. Where the site boundary is too close to allow the embankment toe to be 10m from the slope crest, an MSE retaining wall will be required. Local geotechnical investigations will be needed to prove the geological sequence, measure the ground properties and identify the depths of suitable founding materials. Long-term monitoring with geotechnical instruments will be required to track post-construction settlement and confirm that the ground distortions are within tolerance. Refer to Appendix B for Geological map and historic geotechnical investigation logs from NZGD.
Bridge design	250m (total length) multi-span bridge crossing of NIMT. Multi-span structure to have maximum spans of 35m and maximum skew of 30° (designed at 27° over NIMT). 55m minimum of total span at eastern extent of structure to be widened to allow road widening for intersection lane arrangement on Walters western approach to intersection with Arion Place. Clear span over NIMT to provide clearance as per Table 2 and structural design to comply with structural requirements Section 2.8. Structure to provide clearance as per Table 2 for service lane crossing of Walters Road alignment (west).
Stormwater runoff capture and conveyance	Stormwater network designed as per item 2.9.1 of this report. The general solution for this design will be to intercept flow in the kerb and channel on either side of the road as it flows away from the road high point over the railway line. The water will be captured in a linear treatment system such as a raingarden, tree pit or a landscape integrated solution that may include both. The treated flow and bypassing flow in larger events will flow into the existing stormwater pipe network.
Stormwater treatment	Water quality treatment and detention is required by the Auckland Unitary Plan, Activity A1 of Chapter E8 and Activity A5 of Chapter E9. Based on this, raingardens, swales and wetlands are the best options to manage the pollutants of concern as discussed in GD01, proprietary systems such as Filterra or cartridge systems will not perform the detention component of the solution needed. Raingardens integrated with a larger landscape plan would be the preferred solution, sized and spaced in accordance with the calculations and principles of GD01.
Flood effect mitigation	Flood mitigation will be assessed, and mitigation proposed at a more advanced design phase. Figure 7-3 shows the modelled output from the latest Auckland Council InfoWorks ICM model for the Papakura Street catchment. The flood extents and depths shown in this figure are for all depths greater than 50mm, depths less than this amount are considered sheet flow and not a flood hazard. This was previously written into the Auckland Council Stormwater Modelling Specification. However, this publication is no longer in effect and no new criteria defines this threshold.

Design item	Comments
	The displacement effect of earthworks in this floodplain will be minimal and mitigation will be minor is required at all.

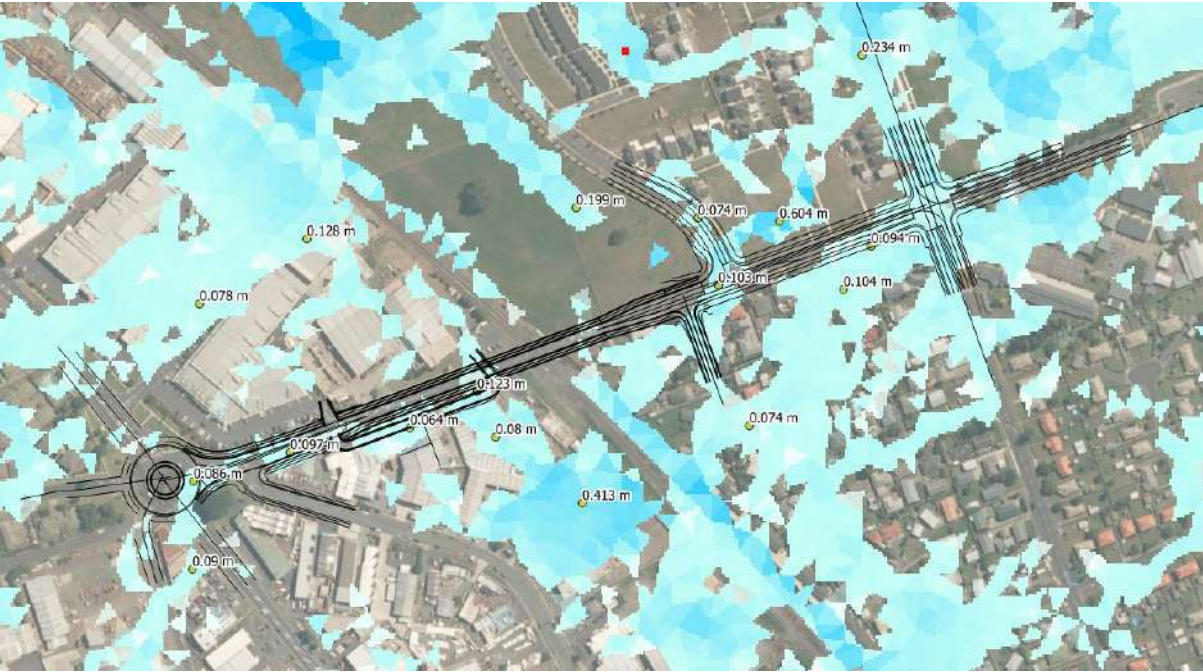


Figure 7-3: 1% AEP with climate change modelled flood depths >50mm

Appendix A - General arrangement plan



REV	REVISIONS	DRAWN	DATE	SURVEYED	N/A
				DRAWN	
				DRAWING CHECK	
				DESIGN	
				DESIGN REVIEW	
				APPROVED	

**TE TUPU NGĀTAHI**
Supporting Growth



**WAKA KOTAHI**
NZ TRANSPORT
AGENCY

Project: **SUPPORTING GROWTH PROGRAMME**
TAKAANINI LEVEL CROSSING DBC/NOR

Drawing Title: **OVERALL LAYOUT PLAN**

Original in colour

"AERIAL IMAGERY SUPPLIED BY
NEARMAP AUSTRALIA PTY LTD"

NOT FOR CONSTRUCTION

Drawing Status: **PRELIMINARY DESIGN**

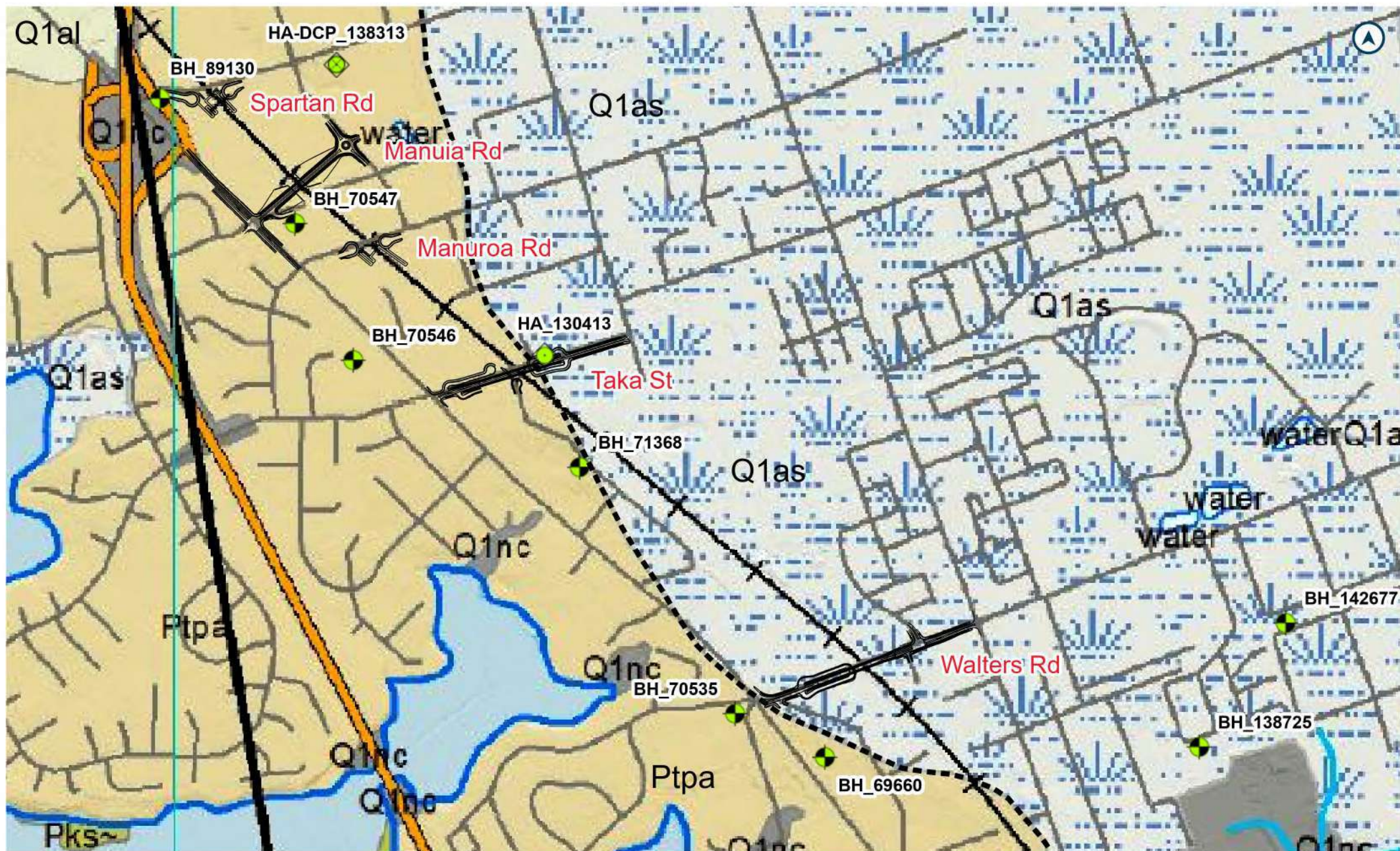
Drawing Date: 21.06.2022

A1 Scales: NTS A3 Scales: NTS

Drawing No. SGA-DRG-STH-05-GE-1000

Revision: **B**

Appendix B - Geological map and historic geotechnical investigation logs (NZGD)



LEGEND

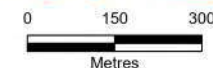
-  Borehole
-  Hand Auger
-  Hand Auger Scala

— Options Design

Key

Q1as Swamp Deposits (Ardmore Peat)
 Q1nc Anthropogenic Deposits (man-made fill)
 Q1al Alluvial Deposits (unconsolidated material)
 Ptpa Takaanini Formation (mixed sediments)

Excerpt from Geological Map (1:50,000 Pukekohe, Draft 2021) showing locations of key investigation holes extracted from NZ Geotechnical Database.



Appendix C - Safety in design (SiD)

Safety in Design Risk Assessment Register

Author (Role): Vinay Maan (TLC Engineering Lead)
Approved By: Bruno Busnardo (SGA Engineering Lead) Date: 1 February 2023

Takaanini Level Crossings - Detailed Business Case

Revision: Project Name: Takaanini Level Crossings Detailed Business Case Stage of Design / Project: Preliminary Design
A (Note: minimum of 2 reviews per project)

RISKS ASSOCIATED WITH DESIGN ELEMENTS								Risk Matrix			PROPOSED & APPROVED MITIGATION MEASURES					Mitigated Risk & Resolution				RESIDUAL RISK	
Ref	Hazard (Guideword)	Cause & Outcome	Are Human Factors (HF) involved?	Existing controls, if any	L	C	R	Proposed Control (1 Eliminate, 2 Substitute, 3 Reduce, 4 Control)					L	C	LR	Risk Owner	Client Approved	Design Status	Date	Risk Owner	Action Required
1 Construction Phase																					
1.01	Load / Force / Energy	Proximity to electrified rail and overhead cables - potential plant strike and electrification of workers. Potential EMF transfer to conductive materials within close proximity to Pylon.	Yes - plant operators working too close to power sources.	KiwiRail rules and regulations for safe work distances, Contractors Safe Work Methodology																	
					3	5	E							2	5	H	Detailed Designer / Construction Contractor		Open		
1.02	Load / Force / Energy	Damage to existing utility services (water, gas, power, comms, etc) during construction leading to potential gas leak / fire / electrocution / explosion.	-	Utility company stand over procedures and Contractors safe work methodology.																	
					3	5	E							2	5	H	Detailed Designer / Construction Contractor		Open		
1.03	Load / Force / Energy	Injury to members of the public from construction plant / operations.	Yes - inattentive / irresponsible plant operators and members of public	N/A																	
					3	4	H							1	3	M	Detailed Designer / Construction Contractor		Open		
1.04	Position / Location	Construction of new retaining walls/bridge structure, particularly in soft soils (e.g. peat) leading to potential instability / settlement of structure and adjacent structures/properties. Potential injuries if embankments/bridge elements were to collapse.	No	Design standards, site investigations to inform ground conditions																	
					3	4	H							2	4	H	Detailed Designer		Open		
1.05	Hazardous Materials	Contaminated land - potential Asbestos risk, and other potential contaminants. Illness / death as a result.	No	N/A																	
					4	5	E							2	5	H	Detailed Designer / Construction Contractor / Client		Open		
1.06	Heights / Depths	Construction workers falling from height during bridge / retaining wall construction works, leading to potential injury / death.	Yes - inattentive construction workers	N/A																	
					3	5	E							1	3	M	Detailed Designer / Construction Contractor		Open		
1.07	External safety interfaces	Working in close proximity to the existing rail tracks - injury to construction workers/equipment as a result of working adjacent to the rail tracks	Yes - inattentive construction workers	N/A																	
					3	4	H							1	3	M	Detailed Designer / Construction Contractor		Open		
1.08	External safety interfaces	Road users attempting to cross rail corridor at grade/ignoring construction and rail traffic management - potential for death	Yes - inattentive / irresponsible members of public	Existing level crossing gates, warnings etc																	
					3	5	E							2	5	H	Detailed Designer / Construction Contractor				
2 Operation & Maintenance Phase																					
2.01	Egress / Access	Berms and planted areas require regular maintenance works - increasing risk of maintenance related injuries.	Yes - maintenance workers taking risks	N/A																	
					2	3	M							2	2	L	Detailed Designer		Open		
2.02	Movement Direction	Road users loss of control incidents resulting in vehicle leaving the road and either falling off edge of bridge structure - potential for injury / death.	Yes - drunk / speeding / inattentive drivers	Road rules																	
					3	5	E							2	3	M	Detailed Designer		Open		
2.03	External safety interfaces	Pavement deterioration leading to premature maintenance works - potential for disruption to local traffic network and exposure of maintenance workers to incidents - potential injury. Also potential for differential settlement at edge of bridged structure leading to bump in road and hence additional maintenance needs.	Yes - inattentive drivers hitting maintenance worker	N/A																	
					2	4	H							1	4	M	Detailed Designer		Open		
2.04	Egress / Access	Road users attempting to cross rail corridor at grade - potential for death	Yes - inattentive / irresponsible members of public	Existing level crossing gates, warnings etc																	
					3	5	E							2	5	H	Detailed Designer				
2.05	Heights / Depths	Objects thrown onto rail corridor, pedestrian electrification, suicide - potential for death	Yes - inattentive / irresponsible members of public	N/A																	
					2	4	H							1	4	M	Detailed Designer				
2.06	Position / Location	Intersections located below steep grades - potential for injury	Yes - inattentive / irresponsible members of public	N/A																	
					3	3	H							3	2	M	Detailed Designer				
3 Demolition Phase																					
3.01		Demolition of existing dwellings, sheds, minor structures, and live services leading to injury or death of construction worker.	Yes - inattentive / irresponsible plant operators and members of public																		
					2	3	M							2	3	M			Open		

Key:
C= **Consequence** 1) Low 2) Moderate 3) Significant 4) Major 5) Critical
L= **Likelihood** 1) Rare 2) Unlikely 3) Possible 4) Likely 5) Almost Certain

LR = **Level** L) Low M) Moderate H) High E) Extreme

Notes: Hazards / risks considered are those that are project / site specific, non-standard / bespoke designs, special processes, high hazard risks (e.g. non 'business as usual' hazards) that have been identified at the time of the review(s). Other risks will continue to appear during the design life of the project and should be assessed and managed by appropriate parties.

Appendix D – Road Safety Audit Exemption

Road Safety Audit Exemption Form



File reference	SGA-900-DBC-WPL-Road Safety Exemption Form
Project name	Supporting Growth Alliance (SGA)
Project stage	Detailed Business Case for Route Protection
RCA	Auckland Transport/ Waka Kotahi (NZ Transport Agency)

Brief project description and location:

The Supporting Growth Programme is a collaboration between Auckland Transport and Waka Kotahi NZ Transport Agency to plan transport investment in Auckland's future urban zoned areas over the next 10 to 30 years. The programme includes numerous transport corridors proposed within the Auckland Region over a 30+ year timeframe

The scope of the SGA programme where Safety Audit Exemption is sought includes all transport corridors where construction funding is **not** being sought (i.e. a route protection designation only).

Exemption rationale:

The Supporting Growth Business Cases are being developed to enable a designation footprint to be identified for future projects, and the design effort has been limited to that which will inform the designation footprint and Assessment of Environmental Effects for designation (i.e. the deliverable is the designation boundary rather than the design itself). The footprint will include sufficient land requirement to allow for construction and this will provide flexibility for design development to be made in future. It is expected that the future design will achieve a safe system outcome which will align with AT's Vision Zero for Tamaki Makaurau, Unitary Plan and Road and Street Framework.

As pre-implementation and construction funding is not being sought from this business case, several typical design tasks (intersection tracking, drainage design, geotechnical investigation and topographical survey) are not being carried out at this stage. The primary objective of a road safety audit is to help ensure a project achieves an outcome consistent with Safer Journeys and the Safe System approach – that is, minimisation of death and serious injury. It is considered that there is insufficient development of the design to undertake a safety audit at this point in time. An 'Implementation Business Case' will subsequently be required at some time in the future when construction is imminent to identify and confirm funding. The design for this business case will incorporate the latest design principles and standards that are relevant at the time, and there is a high likelihood that these will differ from today's requirements. Therefore, a Concept (Stage 1) Safety Audit is not proposed for the current route protection process and will be deferred until the project is ready to progress to implementation. A Concept Safety Audit will be required at that time regardless of whether one is carried out now.

To adequately incorporate safety into our route protection business case, consultation with various AT's department to ensure adequate footprint is being secured. We will be applying the Safe System Assessment Framework to our programme and will also carry out a Safety in Design review during the pre-implementation design stage.

Declaration:

Having checked the above project with reference to the relevant procedures as laid down in Road Safety Audit Procedures for Projects - Guidelines, 2013, I consider that an independent road safety audit is not required for this stage subject to the following:

1. A Safety in Design Register is included in the Design Report
2. Safe System Principles to be applied to all design development and are documented in the design Report
3. A Concept (Stage 1) Safety Audit is undertaken for the subsequent Detailed Business Case required for implementation funding

Recommended by (Auckland Transport Owner Interface Manager):

Name	Alastair Lovell
Position	SGA Auckland Transport Owner Interface Manager
Signature	
Date	28 August 2020

Recommended by (Waka Kotahi - NZ Transport Agency Owner Interface Manager):

Name	Deepak Rama
Position	SGA Waka Kotahi Owner Interface Manager
Signature	
Date	28 August 2020

Endorsed by (Auckland Transport Safety Engineer):

Name	Irene Tse
Position	Technical Lead Road Safety Engineering
Signature	
Date	28 August 2020

Endorsed by (Waka Kotahi -NZ Transport Agency Safety Engineer):

Name	Shashi Lakshminarasimhaiah
Position	Senior Safety Engineer
Signature	
Date	17 August 2020

Takaanini Level Crossings Appendix I – Property Overview

October 2023

Version 1.0

Document Status

Responsibility	Name
Author	Kuan-Wen Sang, Business Case Lead
Reviewer	Tony Innes, Business Case Discipline Lead
Approver	Georgia Cottrell, Project Lead

Revision Status

Version	Date	Reason for Issue
0.1	21/10/2022	Issue for Te Tupu Ngātahi Review and Verification
0.2	04/11/2022	Issue for Owner Participant Subject Matter Expert Review
0.3	01/02/2023	Issue for IQA review
1.0	31/10/23	Final

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Appendix

Appendix A - Original Base Property Cost Details

Appendix B – Assumed Acquisition Profiles

Appendix C – Key Initiatives

1 Introduction

The Takaanini Level Crossing DBC follows on from the solutions and outcomes identified at both the Programme Business Case (PBC) and Indicative Business Case (IBC). It confirms the need for removal and/or replacement of the four existing level crossings in Takaanini to improve safety, improve network resilience and efficiency and enable rail improvements to promote and encourage the uptake of low carbon transport modes.

1.1 Purpose of the Property Overview

This Property Overview has been developed to outline the anticipated property requirements for the Takaanini Level Crossings Detailed Business Case (DBC).

It is important to note that whilst this has been developed for the DBC, its primary purpose is for **route protection**. Typically, there will be a subsequent Implementation Business Case to seek approval for implementation funding. Although, in this case the Auckland Network Level Crossings SSBC may determine when and how implementation occurs for the level crossings. It will also include more detailed analysis of the property issues.

The Te Tupu Ngātahi programme has developed a Programme Wide Property Strategy that outlines the principles for property acquisition for the entire programme. The Te Tupu Ngātahi programme includes both Waka Kotahi and Auckland Transport (AT) projects and both property teams have been part of the development of programme wide guidance and approaches. For this DBC, it is AT's project thus a focus on AT in this document but note that Waka Kotahi have been involved in the review of processes and approaches. These principles have guided the development of the property approach with the key points being:

- The programme is about long-term affordability and property will be generally acquired closer to implementation.
- It is recognised there will potentially be an early property acquisition liability as soon as the NoR is lodged for each project.
- The Requiring Authority will take the lead on property negotiations for that specific project, utilising the current processes of that organisation (Auckland Transport (AT)).
- AT's Early Acquisition Guideline processes will apply.
- Where there is opportunity for strategically important properties to be acquired, these should be taken.
- Opportunities for resultant value capture from residual land will be considered as part of the land use integration.

[REDACTED]. This Property Overview outlines the analysis and approach to providing as much certainty as possible to what this early property acquisition liability could be into the future.

It is a living document developed for the route protection detailed business case phase. Given the long-term timeframes envisaged for this route protection, the Property Overview will need to be revisited, reviewed and updated in the lead up to project implementation. The acquisition programme is dependent on detailed design and land requirement plans being completed.

This Property Overview is intended to sit alongside the Route Protection Strategy and a strategy to commence a dialogue with developers at resource consent subdivision pre application stage to secure additional arterial road widths.

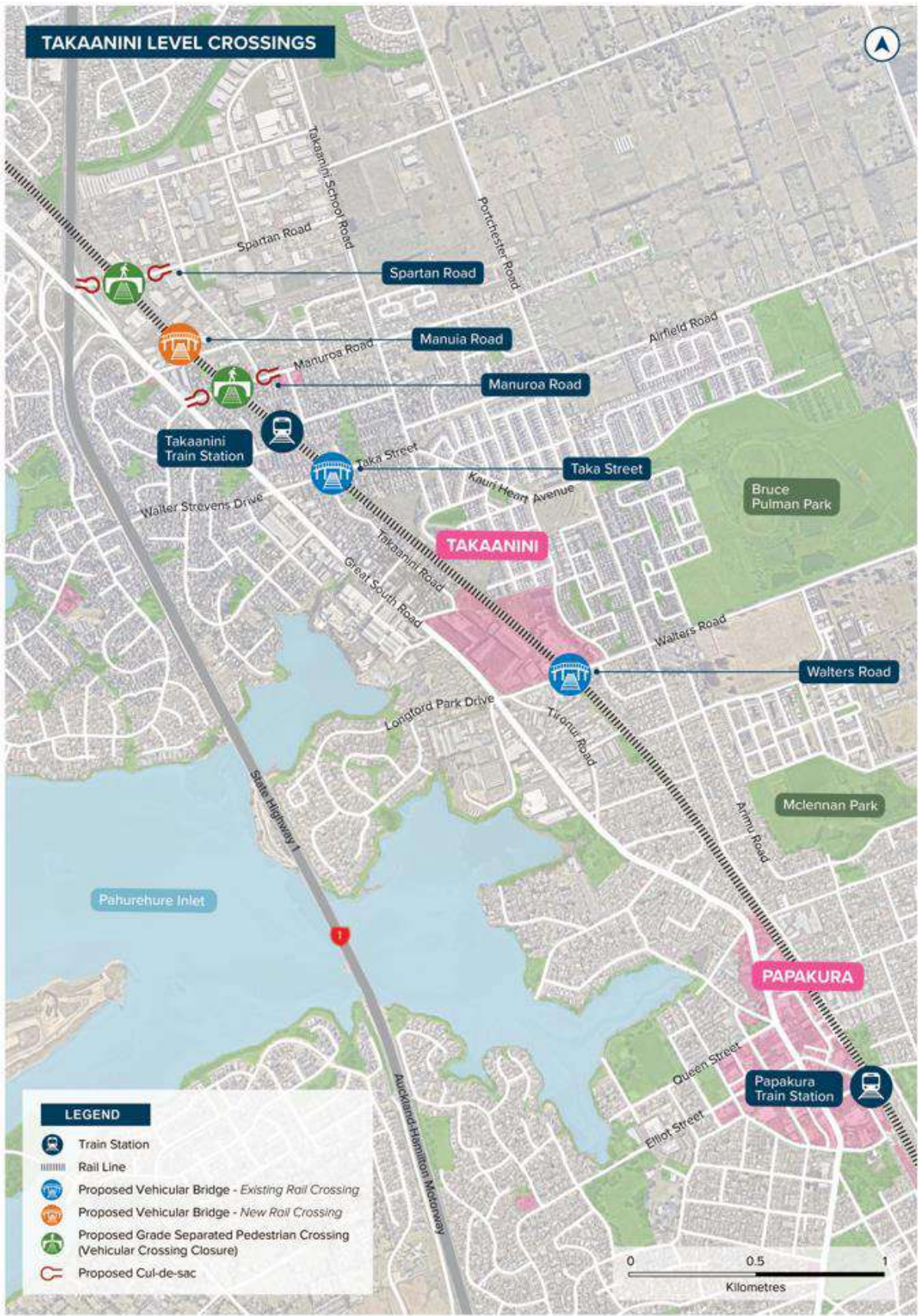
1.2 The Takaanini Level Crossings

The recommended option for the Takaanini Level Crossings is shown in **Figure 1-1**. This includes:

- **Spartan Road:** Closure of level crossings with an active mode connection provided.
- **Manuroa Road:** Closure of level crossings with an active mode connection provided.
- **Manuia Road:** New connection from Great South Road through to Oakleigh Ave.
- **Taka Street:** Grade separation via a road bridge replacing the existing level crossing.
- **Walters Road:** Grade separation via a road bridge replacing the existing level crossing.

The Route Protection Strategy has identified route protection will be delivered in 1 package for the recommended option (**Figure 1-1**). Refer to **Appendix L: Route Protection Strategy** of the DBC report for information.

Figure 1-1 : Recommended option



1.2.1 Timing

The planned date for implementation is heavily reliant on the outcomes of the Auckland Network Level Crossings SSBC and funding availability. A much more detailed project specific property assessment will be undertaken as part of the SSBC development. For the purpose of this report and the DBC, a number of different scenarios of staging and timing is assumed.

Table 1-1 summarises the staging and timing scenarios assumed as part of the DBC.

Table 1-1 : Staging and Timing Scenario for Takaanini Level Crossings

No.	Scenario	Description
1	Earliest possible implementation date – FY 25/26	This assumes that instead of undertaking route protection now, the project will proceed to consenting and have the project referred via Covid Fast-Track legislation. Thus, lodgement in May 2023 and potential start date in 2025. The likelihood of this eventuating is low. However, this provides an indication of the cashflow required if implementation is to finish within 10 years. For this scenario, the staging assumed is as below: 1. Walters Road and Manuia Road grade separation 2. Taka Street grade separation 3. Spartan Road and Manuroa Road closure and active mode bridge connection
1b	As above but Walters and Manuia Road are staged	This assumes Walters Road is built first before Manuia Road bridge as to spread out the financial pressure.
2	'Likely' scenario with implementation starting FY 28/29	This pushes out the implementation to a more realistic date in which all planning i.e. consenting and design etc are undertaken in the standard way. For the purpose of this document, implementation start date in FY28/29 is assumed. Noting that this will be influenced by a number of factors i.e. appeals which could mean an earlier or later start date. This scenario assumes the same staging as Scenario 1.
2b	As per Scenario 2 with different staging	Given that there is limited funding under the 2021-2031 RLTP, this scenario presents what could likely be funded under this RLTP. This assumes: • Walters Road is implemented within this RLTP • Implementation property cost and construction cost for all other corridors is pushed out to the next RLTP • Implementation will be in stages, Walters Road then Manuia Road then Taka then closures and active mode bridge connection.

2 Affected Properties

2.1 Indicative Land Requirements

A detailed analysis of the number of properties and what type of resultant property purchase is required (full, partial, partial and temporary or temporary) has been undertaken by Auckland Transport for the project.

A total of 363 property interests have been identified for acquisition as outlined in **Table 2-1**. Once property duplications (e.g. properties that might have partial land acquisition and temporary rental charges) are taken into account this results in a total of 191 individual properties.

Table 2-1 : Property Acquisition Summary

Corridor	Total Property Interest	Full	Partial	Temporary Occupation	Partial & Temporary Occupation	Total Individual Property Interest
Spartan Road	20	0	11	8	19	12
Manuia Road	73	9	30	27	57	30
Manuroa Road	24	3	9	9	18	13
Taka Street	136	12	63	52	115	56
Walters Road	110	13	47	42	89	40
Total	363	37	160	138	298	191

The above shows that only 10% of property of interest are full purchases and most purchases are partial and/or temporary occupations. A small number of properties do not require acquisition as they are already owned e.g., road.

2.2 Development in the area

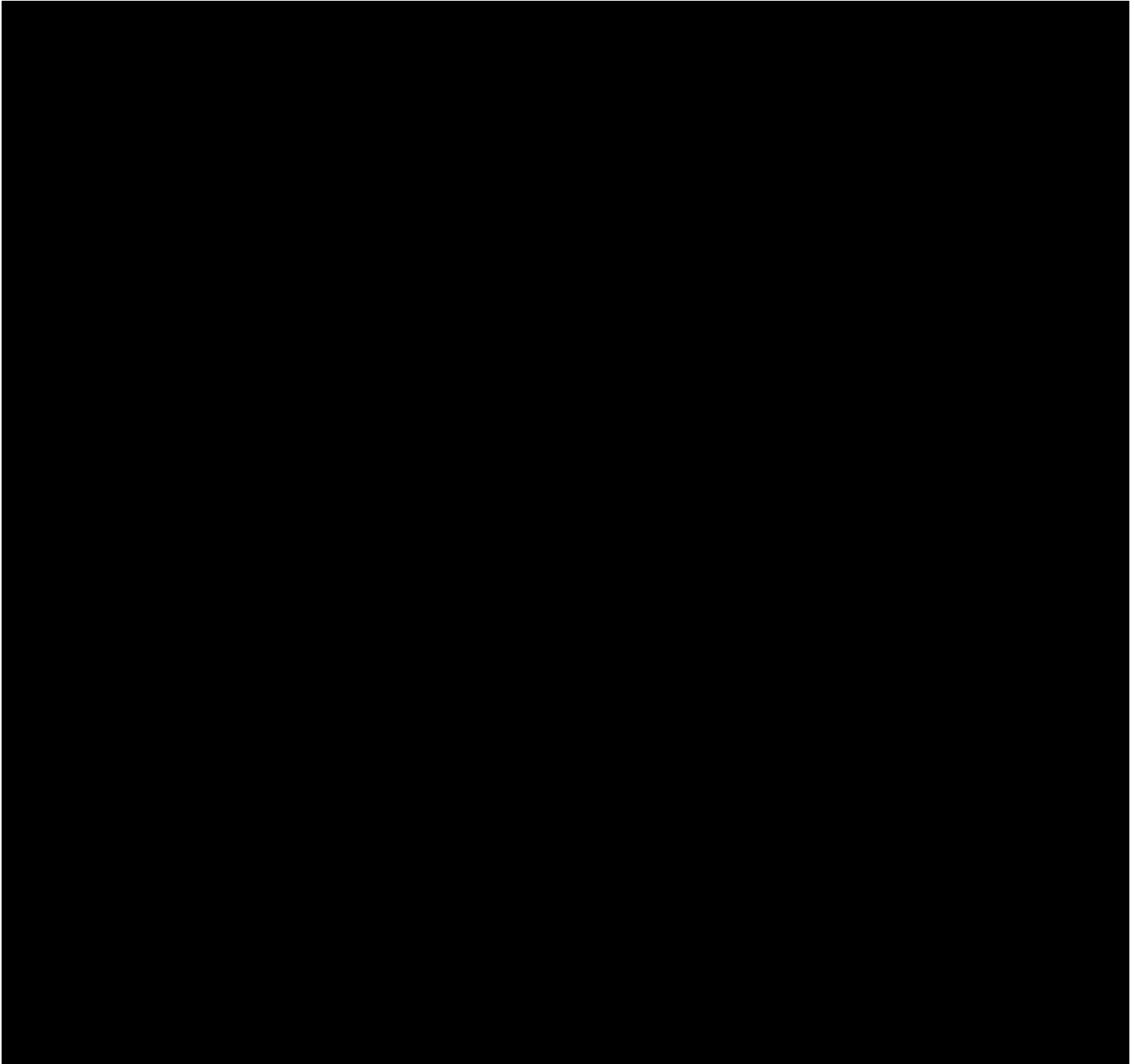
No specific development opportunities have been identified in the area. However, Plan Change 78 is currently progressing its application. This will allow more intensification within the area of interest and will impact property value.

2.3 Acquisition Issues and Risks

An assessment of the key risks has been undertaken. A three-tiered risk assessment scale has been used:

- **High** – Significant risk that will require sustained and active management.
- **Medium** – Moderate risk that will require active mitigation.
- **Low** – Minimum risk that can be appropriately managed.

Table 2-2 summarises the key risks identified for the project.



2.4 Access

All properties will retain access to the transport system, A number of properties will require their access to be modified during the acquisition process. The details of this will be worked through in the later design stages of the project. The land identified for acquisition has taken this access principle into account and is reflected in the scale of land to be acquired. Where it is unlikely that access can be maintained then the property has been identified for full acquisition.

For some of the properties, temporary access may be required and will be investigated during the project development phases in the future. It is recommended that this temporary investigative access be obtained as early as possible for any property identified for future acquisition.

2.5 Land Tenure Issues

This assessment has not been undertaken at this time due to the route protection nature of this DBC. It is anticipated that this will be considered as part of the Auckland Network Level Crossings SSBC.

3 Compensation

3.1 Base Price Methodology

The AT property team have undertaken the property cost estimate for the project on behalf of Te Tupu Ngātahi. This section of the Property Overview outlines the methodology adopted by the AT property team in developing the property cost estimate.

The level of information provided to AT to inform the base cost estimate is commensurate with the business case, which is for NoR route protection purposes.

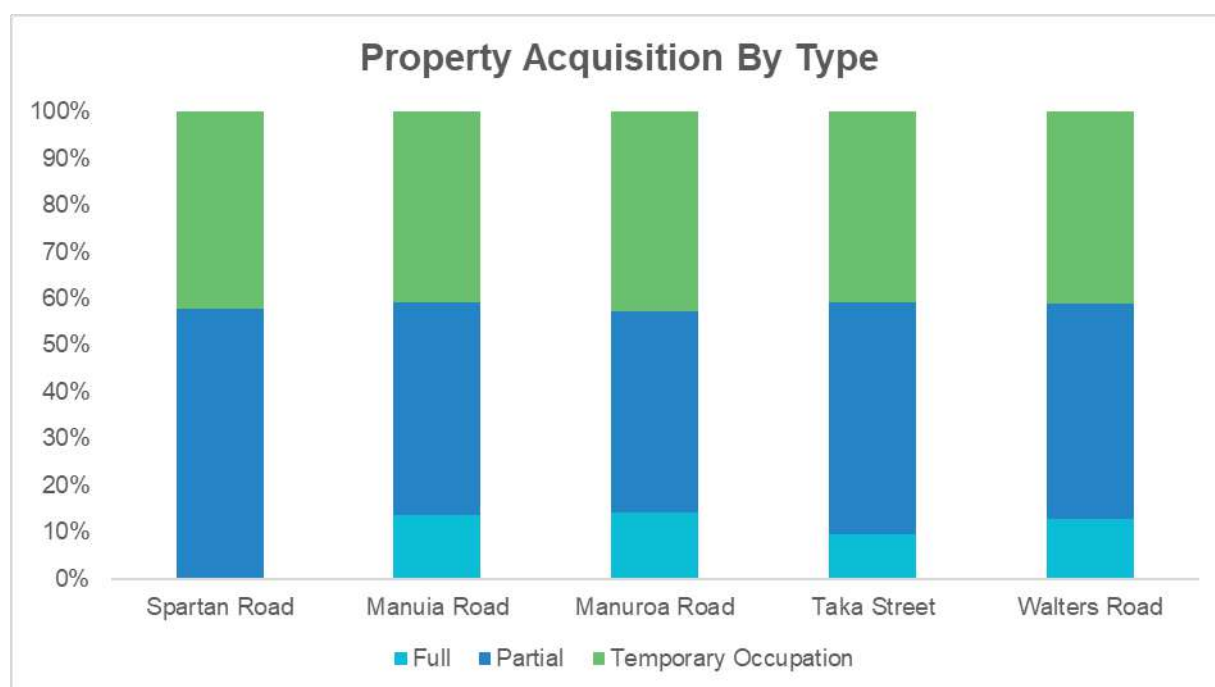
AT assessed the design files provided by Te Tupu Ngātahi for route protection which did not include detailed investigation of property impacts, for example topographical and geotechnical impacts.

Informing the base cost estimate are the following assumptions:

- The existing zoning and land use in respect of the properties has been assumed to remain the same until the time of acquisition.
- Details of the individual properties and the improvements have been predominantly assessed from 'desktop' analysis using Property Guru data, with some limited site inspections.
- No allowance has been made for demolition or removal of improvements where required, nor for other remediation works. This is typically allowed for within project construction cost estimates.
- Property access arrangements – There are some uncertainties at present on the extent of the impact of the route alignment on some property access arrangements. Evolving design detail may amend final acquisition requirements and/ or construction methodology.
- Injurious affection which is an estimate of the adverse effect that a partial acquisition of land will have on the remainder of the land. No allowance has been made and will need to be considered once the design has been further refined.
- Registered interests – review of all registered memorials on the affected titles has not been carried out. This review will inform how many more interests are required for the Project and will need to be considered during future stages.

Figure 3-1 shows the type of property acquisition by each corridor. This confirms most acquisitions are partial with very few full acquisitions envisaged. All corridors will have some full acquisitions except for Spartan Road but full acquisition only accounts for 10% of total properties to be acquired.

Figure 3-1 : Property acquisition by type by corridor



The exercise undertaken for providing the based cost estimate is as below:

Task	Additional information
AT undertook a desktop assessment of land values expressed on a rate per square metre basis for raw (un-subdivided) Takaanini block land (i.e., land requiring earthworks, roading and servicing prior to any development) for the different zonings including Light Industry, Mixed housing suburban, Town Centre and Heavy Industry. The valuation inputs were provided by independent registered valuers.	Adopted: - Light Industrial rate of [REDACTED] - Heavy Industrial rate of [REDACTED] - Town Centre rate of [REDACTED] - Mixed housing suburban rate of [REDACTED] - Mixed housing urban rate of [REDACTED]
Property aggregated into appropriate parcels by considering current and future environment, current and future zoning and any particular property intricacies.	The existing zoning and land use in respect of the properties has been assumed to remain the same until the time of acquisition.
Develop price for each parcel	A property price is identified for each parcel considering the same type of land use according to the Auckland Unitary Plan (AUP) Zones and in using the adopted rates.
PWA cost estimates have been assessed on a parcel-by-parcel basis.	- Section 72 costs. - Section 66 costs have been forecasted based on either a full or partial acquisition. For Temporary rent, it has been assumed that the owner's costs are captured in the partial acquisition s66 costs. The costs have been moderated where the partial acquisition area is minor. - Costs of acquisition including legal and negotiator costs have been allowed for. Negotiator cost has been allowed for, an amount of \$25,000 has been assumed

Task	Additional information
	for both full and partial acquisitions with \$10,000 allowed for minor partial acquisitions. [REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED]
Stage 2 PWA compulsory acquisition and Land Valuation Tribunal (LVT) proceeding costs.	An allowance has been made on an aggregate basis based on the following assumptions: [REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED]

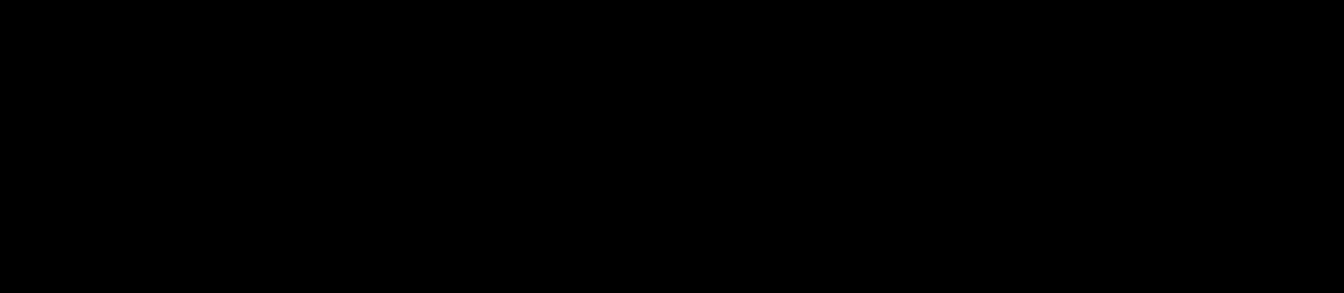
3.2 Base Property Internal Quality Assurance

The base property cost estimate was benchmarked against the current pricing and was also reviewed by senior experienced valuation experts.

3.3 Base Property Estimate

The base property estimates which includes the estimated gross costs, S66 costs, S72 costs and negotiator costs are shown in [REDACTED]

The total base property estimate, using the methodology outlined above, as at present dollar value is [REDACTED] excluding land cost contingency and PWA cost contingencies and annual temporary occupation rental. The temporary occupation costs are shown separately per annum.



3.4 Stage Two PWA and LVT Cost Estimate

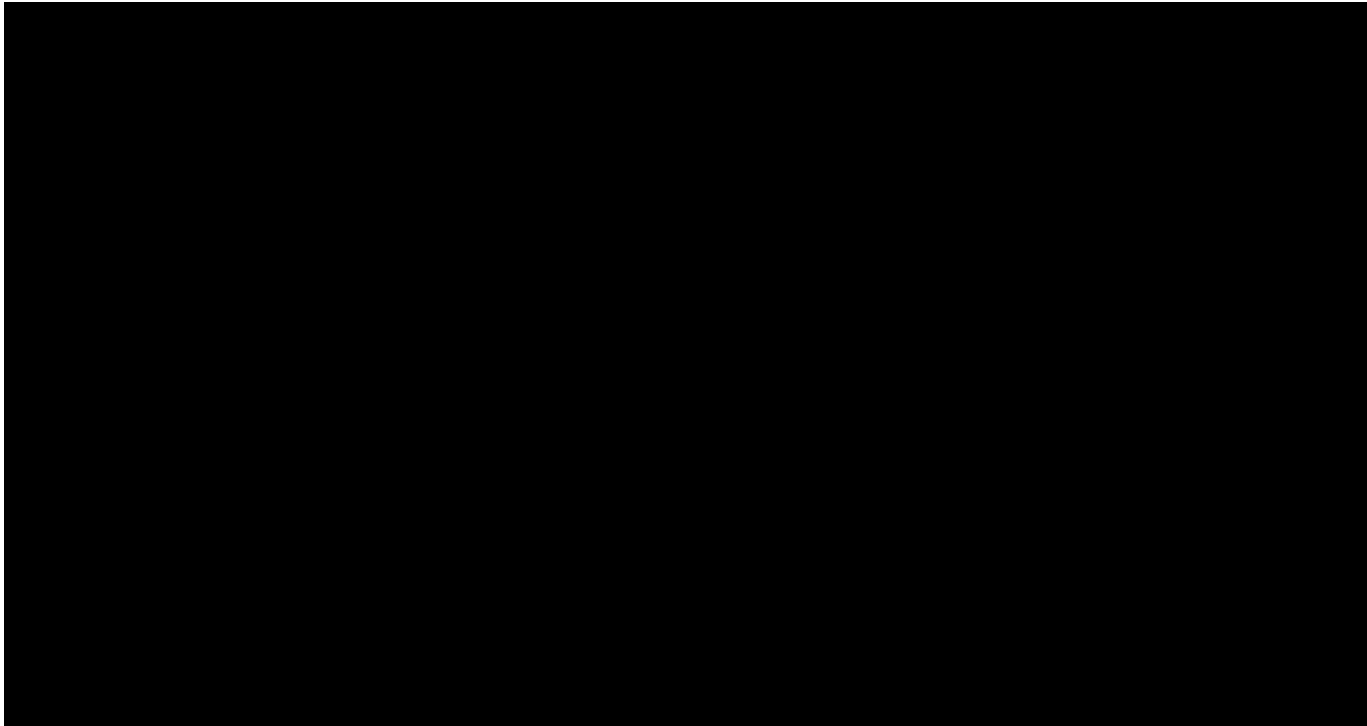
To the base property estimate above, AT then added an allowance of [REDACTED] to the overall acquisition programme for the estimated section s23 and 26 PWA and LVT proceeding costs.

3.5 Expected P50 and P95 Property Costs

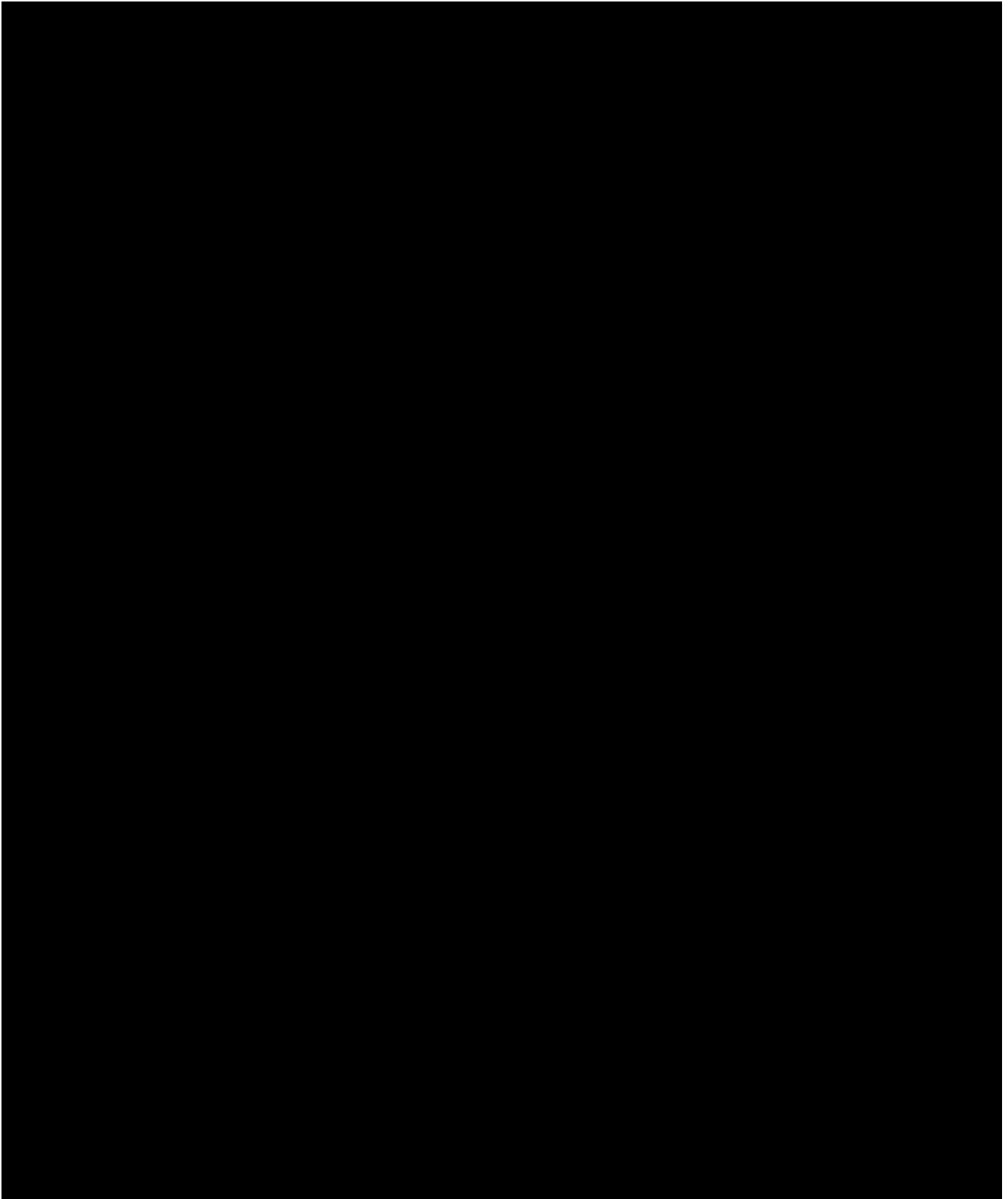
A contingency is applied to identify the expected estimate, or P50 and then a further contingency to identify the P95 cost.

A 15% contingency was applied to the base estimate to provide for uncertainty in relation to the estimate inputs and specific project threats and opportunities with a cost impact to derive the expected estimate (P50).

A further 20% was then applied as funding risk contingency to derive the (P95) which align with the physical works allowance.



4 Package property acquisition approach



¹ <https://www.infrastructureaustralia.gov.au/sites/default/files/2019-06/CorridorProtection.pdf>

5 Future Property Appreciation

5.1 Challenges of appreciation in long term growth areas

A designation prevents physical/capital development of the land the designated areas, and therefore any inflation arising from that, it does not completely freeze the value uplift. From a PWA perspective, the value of compensation paid is assessed as at the date it is purchased and is evaluated with reference to surrounding comparable market values. Given the uncertainty of when the project may be implemented, estimation of future costs is extremely unreliable. Property inflation can only sensibly be estimated three to five years into the future and even then, there is uncertainty given the current volatile macroeconomic market.

This risk is mitigated by reviewing the property estimates as part of the Auckland Network Level Crossings SSBC as well as closer to implementation date.

5.2 Risk Profile

At a macro level the dynamism of the surrounding land-use changes will have an impact as this will result in land value appreciation. Route protection will occur over a range of land zonings, each with different potential for land value inflation. Areas that have the least potential for change to a more intensive zoning will have the least potential for land value inflation. For example, those with a current urban or rural zoning that will remain the same or similar over the project period will only be subject to inflation at the rate standard for that land-use class. In contrast, areas that are transitioning from a FUZ to an urban zoning will significantly increase in value.

Although for this project, there are no FUZ zonings, there are however areas where properties are within Plan Change 78. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

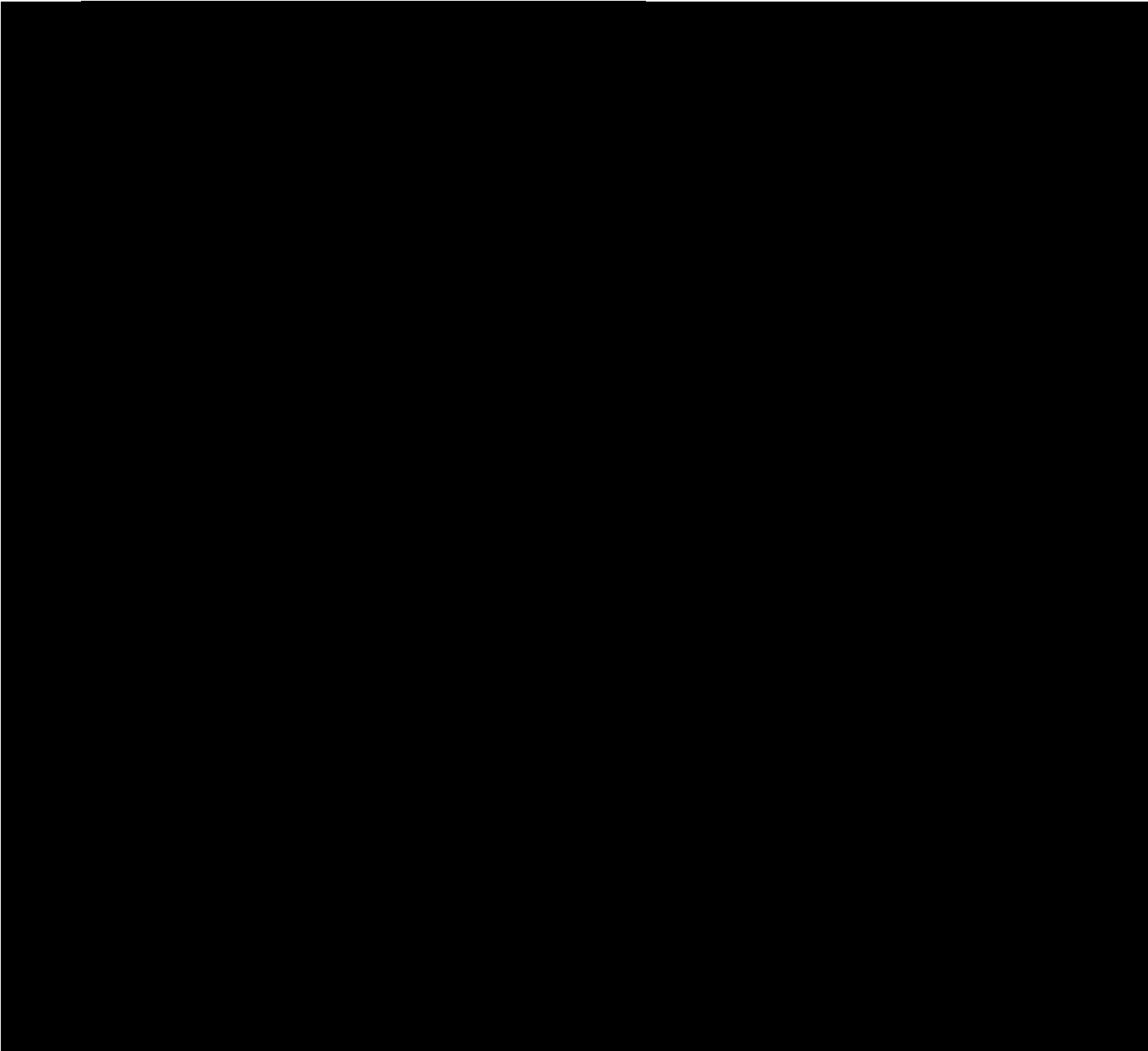
[REDACTED]

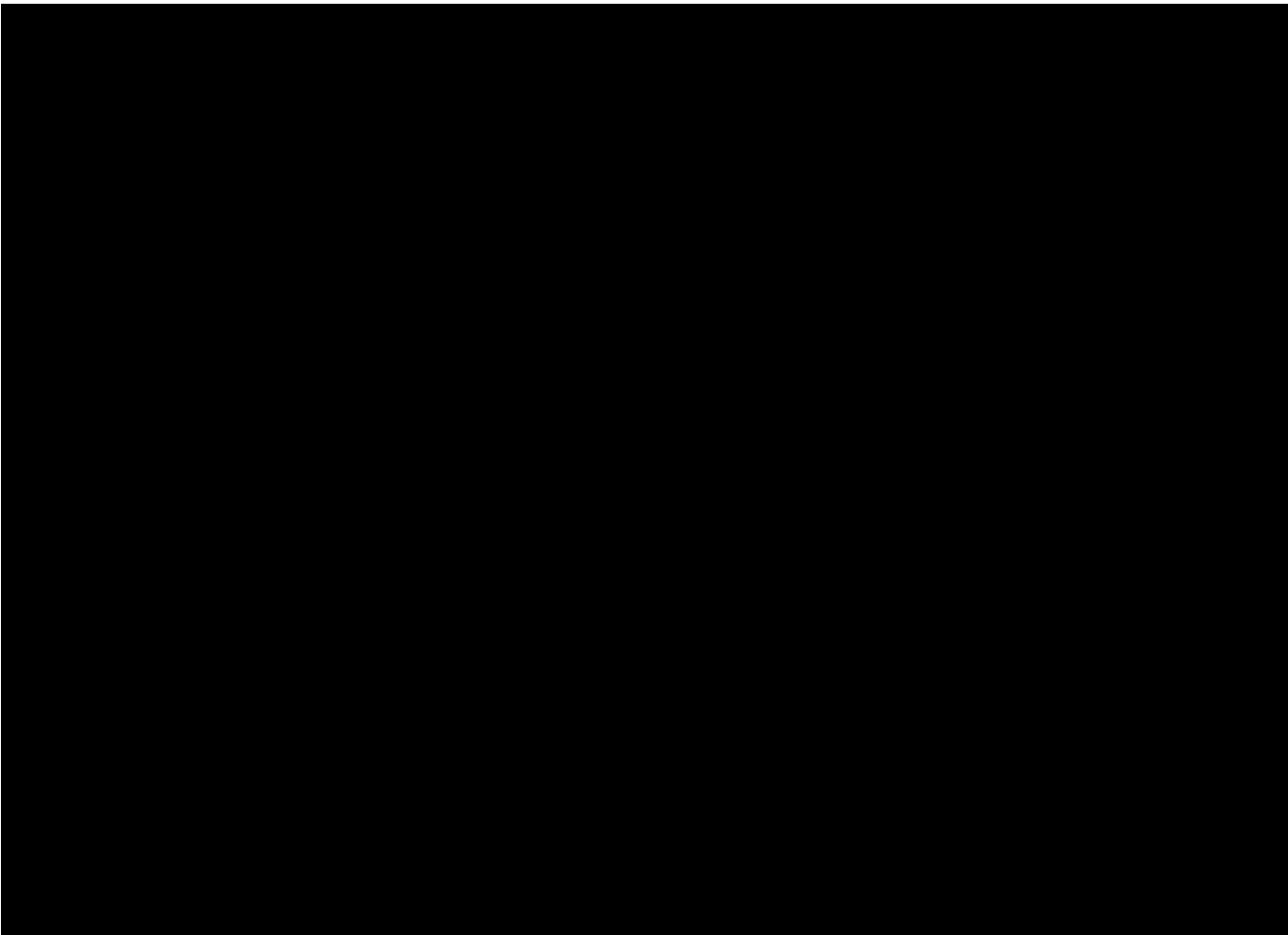
[REDACTED]

[REDACTED]

- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]

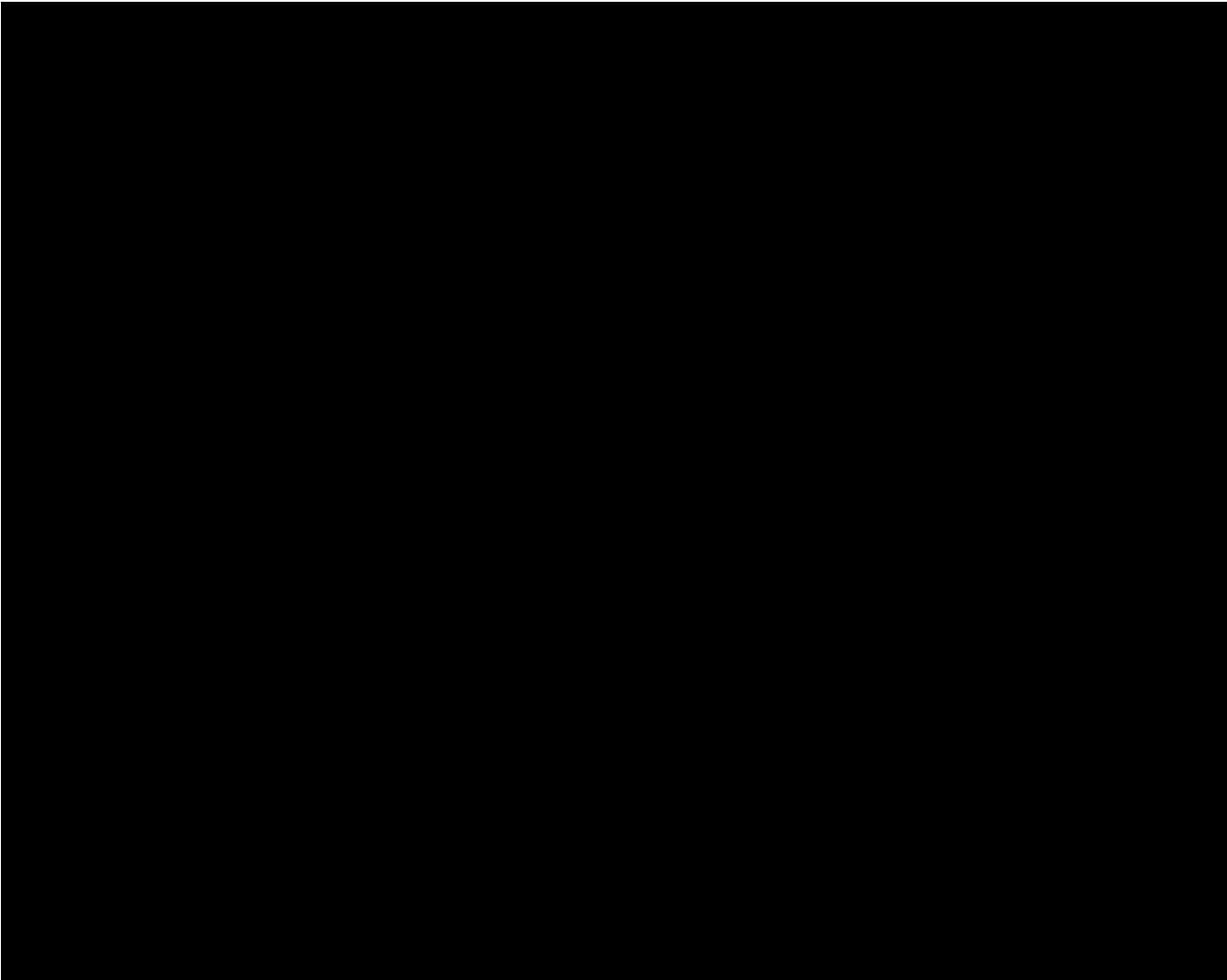
[REDACTED]





We acknowledge this approach is simplistic. However, given the uncertainty of the timing of the project and a more detailed analysis will be undertaken as part of the Auckland Network Level Crossings SSBC, it is considered the above is appropriate as an indication for the DBC.


. These are significant costs and other scenarios will only see these numbers increase over the project life cycle as appreciation continues.



6 Early Acquisition Liability

In addition to the future property appreciation risk, implementing a route protection strategy that aligns implementation of the property acquisition programme with future project delivery that is programmed in future decades, creates:

- The need for the Requiring Authority to respond to demand for early property acquisition.
- An obligation to acquire the protected land in some instances under section 185 of the RMA.

[REDACTED]

6.1 Demand for Purchase of land with NoR in place

The timing of the demand for early purchase of land within the protected route will be driven by both the individual landowners' various land-use decisions and the anticipated construction date. This assumes the NoR is in place.

The project is in a built-up brownfield environment spanning across different land uses i.e. residential and industrial. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

Again, it is noted the majority of properties of interest are partial purchases.

6.2 Section 185 RMA Purchase Obligation

Requiring Authorities can be compelled to purchase route protected land pursuant to s185 RMA. Section 185 allows an owner to apply for an order obliging the Requiring Authority to purchase the land in certain circumstances. The Environment Court is empowered to make such orders, where the owner establishes that they have been unable to sell their property at the same value they could have if the property was not subject to the NoR. If the landowner was not the owner when the NoR was placed on the property, they also have to establish the NoR prevents their reasonable use of the land.

[REDACTED]

Authority to purchase land in a limited subset of cases, where the NoR and prospect of the project undermines the value, the owner derives from the property.

6.3 Risk Analysis

[illegible]

6.4 Early Acquisition Approach

AT have guidelines for managing early acquisition of property in advance of the project implementation phase, and in particular clarify the criteria and outline decision making processes for assessing each early acquisition on a case by case basis.

These guidelines anticipate the s185 process but are a less formal negotiated process. The process takes into account personal circumstances and recognises the NoR may have a blighting impact on property.

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

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[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

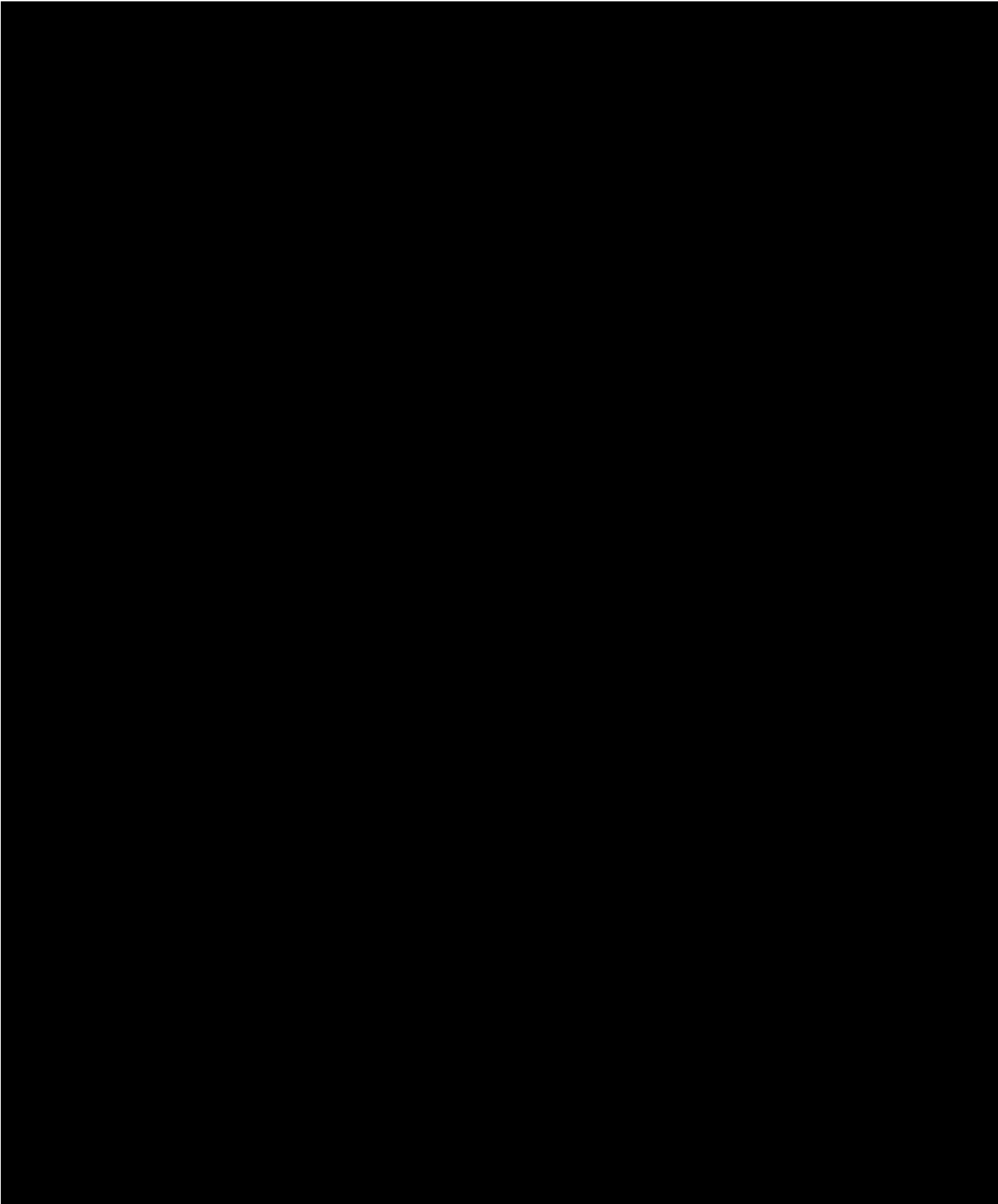
7 Potential Implications on Acquisition Cashflow

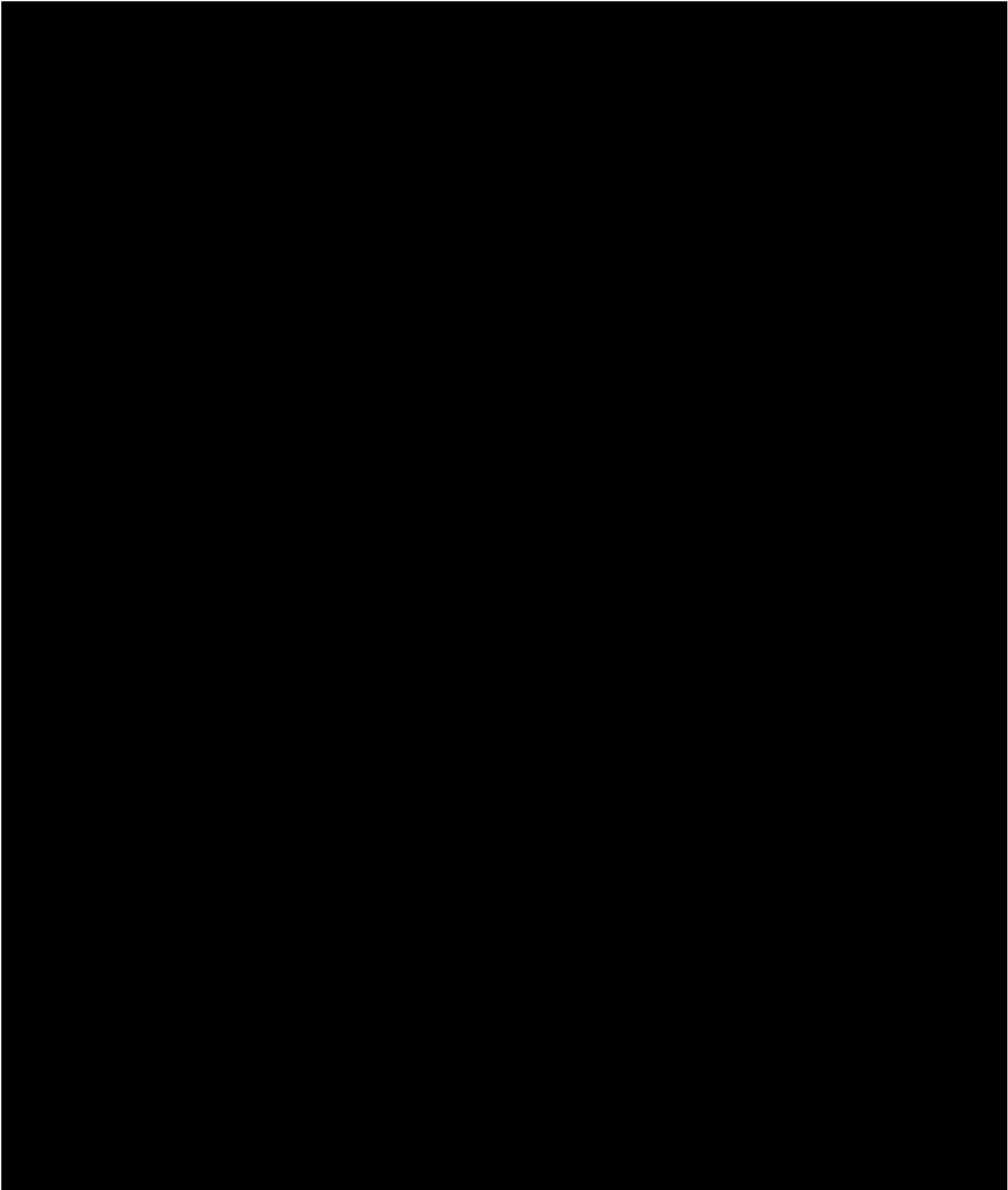
This section outlines the estimated annual property cashflow forecast between commencing the RMA designation processes and when the future project is programmed for delivery.

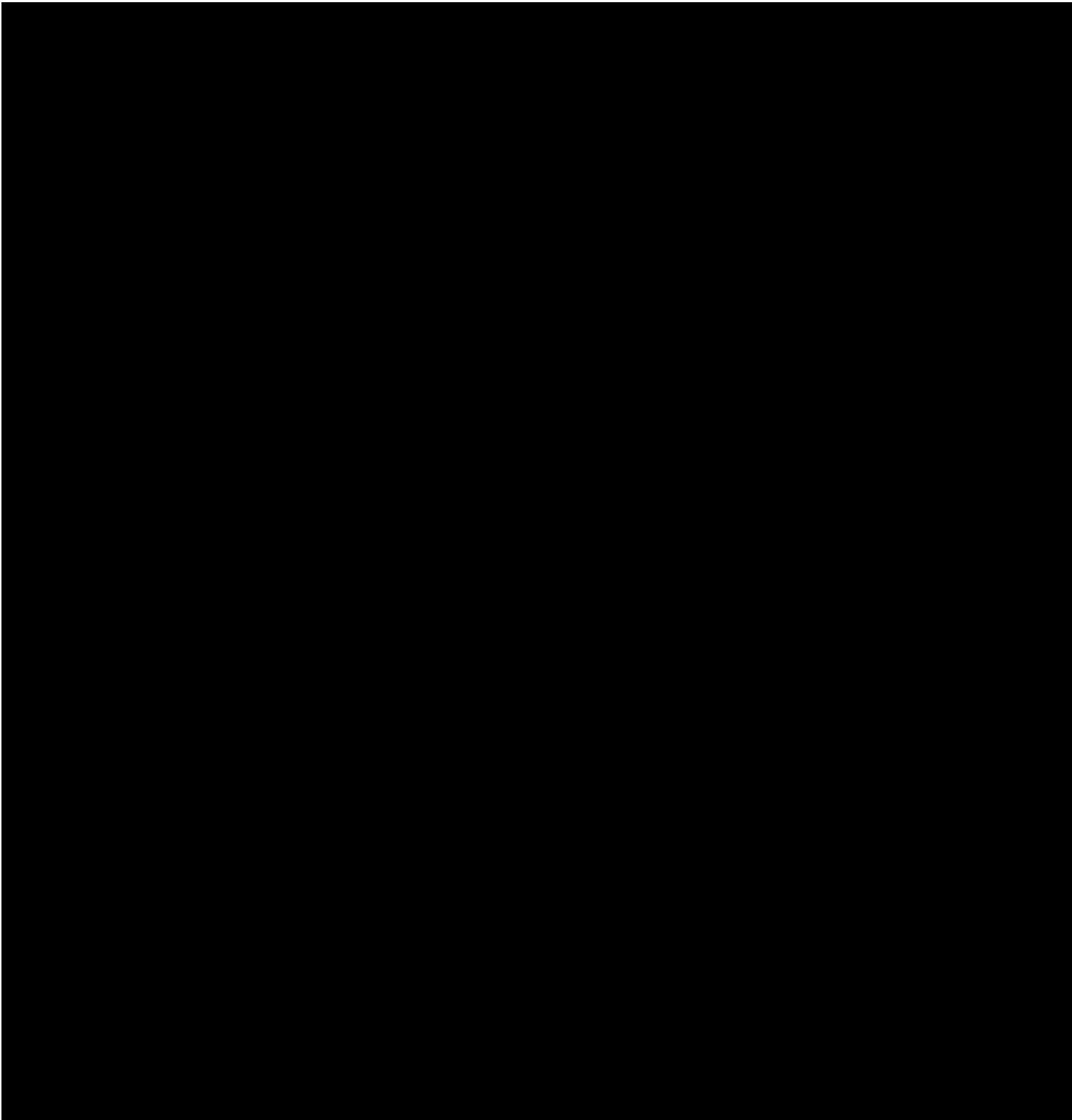
1. [REDACTED]
2. [REDACTED]

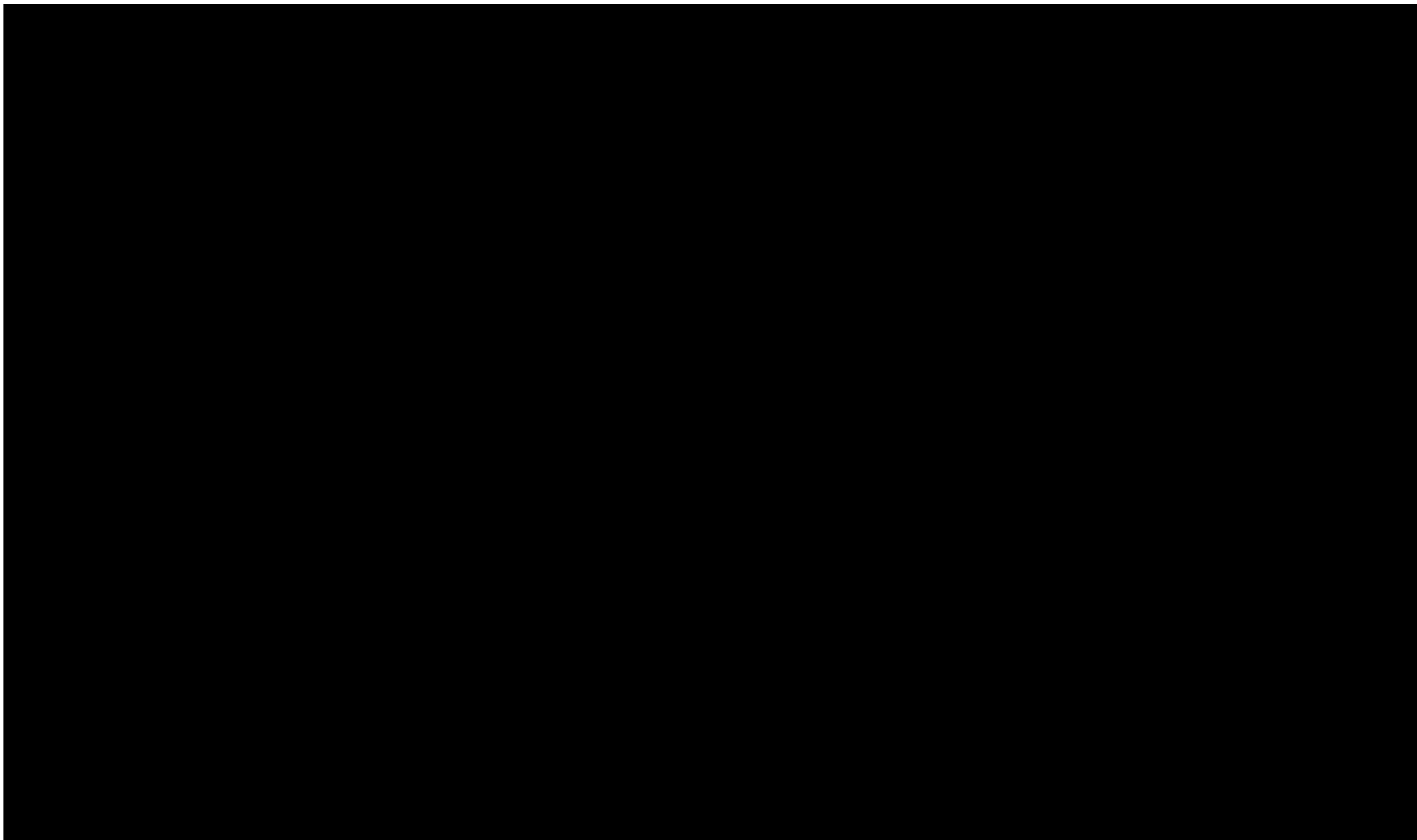
[REDACTED]
 [REDACTED]
 [REDACTED]
 [REDACTED]
 [REDACTED]
 [REDACTED]

[illegible]









8 Ongoing Management

8.1 Ongoing property management

Both Agencies have comprehensive processes and teams dedicated to the ongoing management of properties once purchased. It is assumed that these existing processes will be used to manage properties, where required. With only 10% of the total acquisition plan being full purchases the ongoing management is somewhat reduced.

Potential issues from an ongoing management perspective that have been considered and that will need more focus include:

- [REDACTED]
- **Healthy Homes** – There will likely be a need to comply with the latest legislative requirements for rental properties, including insulation, heating and draft (windows) management.
- **Asbestos** – There maybe asbestos in some of the properties that will require removal.

The standard approach of the Agencies in the testing, implementation and ongoing management of these issues (and any others) would be used. [REDACTED]

8.2 Disposal

This has not been addressed in this document as it is envisioned that the Auckland Network Level Crossings SSBC will provide a more comprehensive property approach as more details becomes available.

9 Contingent Project Liability

Various other cost elements, that are a cost to the physical works budget have also been identified including:

- [REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
- An annual temporary occupation rental, subject to adjustment by the project team to reflect the assumed construction duration.
- The risk of potential business relocation and business loss PWA claims. [REDACTED]
[REDACTED]
[REDACTED]
- Cost of reinstatement works.
- [REDACTED]
[REDACTED]
- Mitigation, where possible, of the potential effects of road construction, noise, dust and privacy issues etc.

10 Key Initiatives

The Te Tupu Ngātahi Programme gives consideration to improving ways of doing things including that of property acquisition. A Programme Wide Strategy sets out a number of initiatives to effectively manage the significant acquisition programme of the route protection approach. Key considerations include:

- Governance.
- Resourcing.
- Developer agreements.
- Strategic Property Acquisition Fund.

This is further detailed in **Appendix C: Key Initiatives**

11 Resource Consent and Public Consultation

11.1 Engagement

As part of this DBC's development, engagement has been undertaken with the community so there is an awareness of the project. Some affected property owners have been spoken to following individual requests for meeting. A summary of the outcomes of the engagement so far can be found within the engagement section of the DBC as well as in Appendix E: Engagement Summary. The next stage is for the designation to be sought. This will require further community engagement, and in particular, discussion and engagement with the affected property owners. The NoR development of documentation is currently underway.

11.2 Consents

Route protection for this project will be sought through the application of a designation for the new roads/ bridges and widening identified. Date for lodgement is scheduled for mid-2023. Resource consents will not be sought at this time.

12 Recommendations

The DBC is focussed on route protection. There remains uncertainty as to the exact timing of the property acquisition needs until the staging and implementation date is confirmed by the Auckland Network Level Crossings SSBC. [REDACTED]

To manage this risk and uncertainty appropriately and proactively, it is recommended that during the next phases of the project the following occurs:

- The Auckland Network Level Crossings SSBC reconfirm the property cost and requirements as design confidence is further developed.
- Any changes in design avoid the need for minor land requirements, where possible
- Value engineering is undertaken to minimise the land required
- Detailed property valuations are undertaken closer to implementation.

Appendix C: Key Initiatives

General



Governance

It is recommended that a joint property focussed decision making group be set up with a representative from each partner organisation. The purpose of this is that whilst individual property acquisitions will be managed on a day to day basis by the appropriate road controlling authority, overall joint governance is required to ensure that consistency of approach and priorities is maintained.

This joined up approach will provide increased certainty of outcome for all and a consistent approach across the programme.

Resourcing

There needs to be a dedicated resource of at least one person from each partner organisation who are focussed on the identification, acquisition and enhancement of strategic properties. There is a real risk that without this dedicated resourcing that a property specific approach in isolation is taken rather than an all of programme view. This will ensure that there is consistency in approach and issues will be addressed early and hopefully this will result in acquisitions only occurring when absolutely necessary.

The wider Te Tupu Ngātahi programme is also seeking a dedicated resource from each organisation and the role would be part of this overall programme resourcing rather than additional resourcing.

Developer Agreements

Focussing on getting alignment of various plan changes will assist in identifying infrastructure priorities. This will clarify the need for early and comprehensive developer agreements, particularly with the significant developers in the area, to assist an acquisition programme and cashflow phasing.

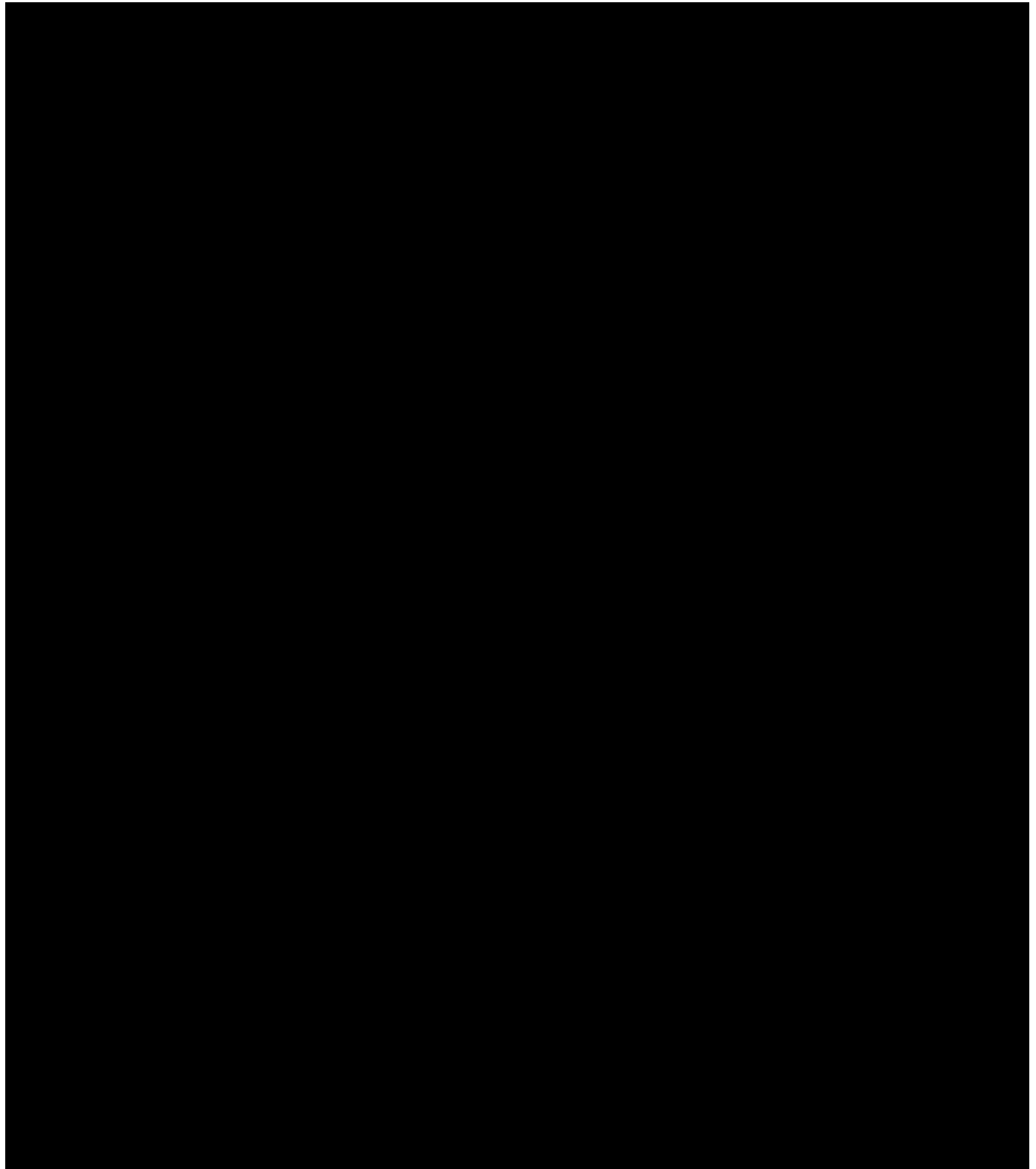
Wider Te Tupu Ngātahi Property Management

It is also important to outline that the Te Tupu Ngātahi Programme Wide Property Strategy sets out a number of initiatives to effectively manage the significant acquisition programme of the route protection approach. These are currently being considered and this Property Strategy is consistent with the aspirations of these wider approaches if successful.

At the heart of these initiatives is a Strategic Property Acquisition Fund.

In order to capture the transport and land use outcomes and to best address cashflow phasing it is proposed that a Strategic Property fund is ring fenced to facilitate the purchase of property that meets the criteria for early acquisition.

This approach is not new, however, to ensure the effectiveness of this Strategic Property fund, other changes to current practise in this area are also recommended.



Takaanini Level Crossings

Appendix J - Cost Report

October 2023

Version 1.0

Document Status

Responsibility	Name
Author	Bruno Busnardo Mark van der Ham
Reviewer	Christopher Gee Georgia Cottrell Jason Luo
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Revision Status

Version	Date	Reason for Issue
0.1	8 th September 2022	Issue for Te Tupu Ngātahi Review and Verification
0.2	4 th November 2022	Issue for Owner Participant Subject Matter Expert Review
0.3	1 st February 2023	Issue for IQA review
1.0	31 st October 2023	Final

Cost Estimate Summary Table

Category		Item	Unit	Quantity	Unit Price	Total Price
Construction	Foundation	Excavation	m³	100	150	15000
		Concrete	m³	50	300	15000
		Reinforcement	m	1000	10	10000
		Formwork	m²	200	50	10000
Roofing	Roof	Roofing	m²	1000	100	100000
		Trusses	m²	500	200	100000
		Insulation	m²	1000	50	50000
		Ventilation	m²	200	100	20000
Interior	Flooring	Flooring	m²	1000	100	100000
		Walls	m²	500	200	100000
		Windows	m²	100	1000	100000
		Doors	m²	50	2000	100000
Exterior	Landscaping	Landscaping	m²	1000	100	100000
		Drainage	m	100	1000	100000
		Lighting	m	100	1000	100000
		Security	m	100	1000	100000

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Acronym/Term	Description
AT	Auckland Transport
AUP	Auckland Unitary Plan
CEM	SM014 Cost Evaluation Manual
CH	Chainage
DBC	Detailed Business Case
SM014	SM014 Cost Evaluation Manual
WK	Waka Kotahi

1 Introduction

This estimate has been prepared to provide an indication of costs for future budget forecasting and for inclusion in the economic analysis, part of the Appendix K Economics assessment within the Takanini Level Crossings Detailed Business Case (DBC).

This document should be read in conjunction with the Appendix H Design report within the Takaanini Level Crossings (DBC) and appended general arrangement plan.

The costing of works has been based primarily on the revision A general arrangement drawing dated August 2022, the generic assumptions schedule outlined in Appendix B of this report, and indicative property cost outlined in the Appendix C. The estimates have been prepared to reflect the projects highlighted on the Figure 1. Sub-segments of the grade separated corridors have been costed separately.

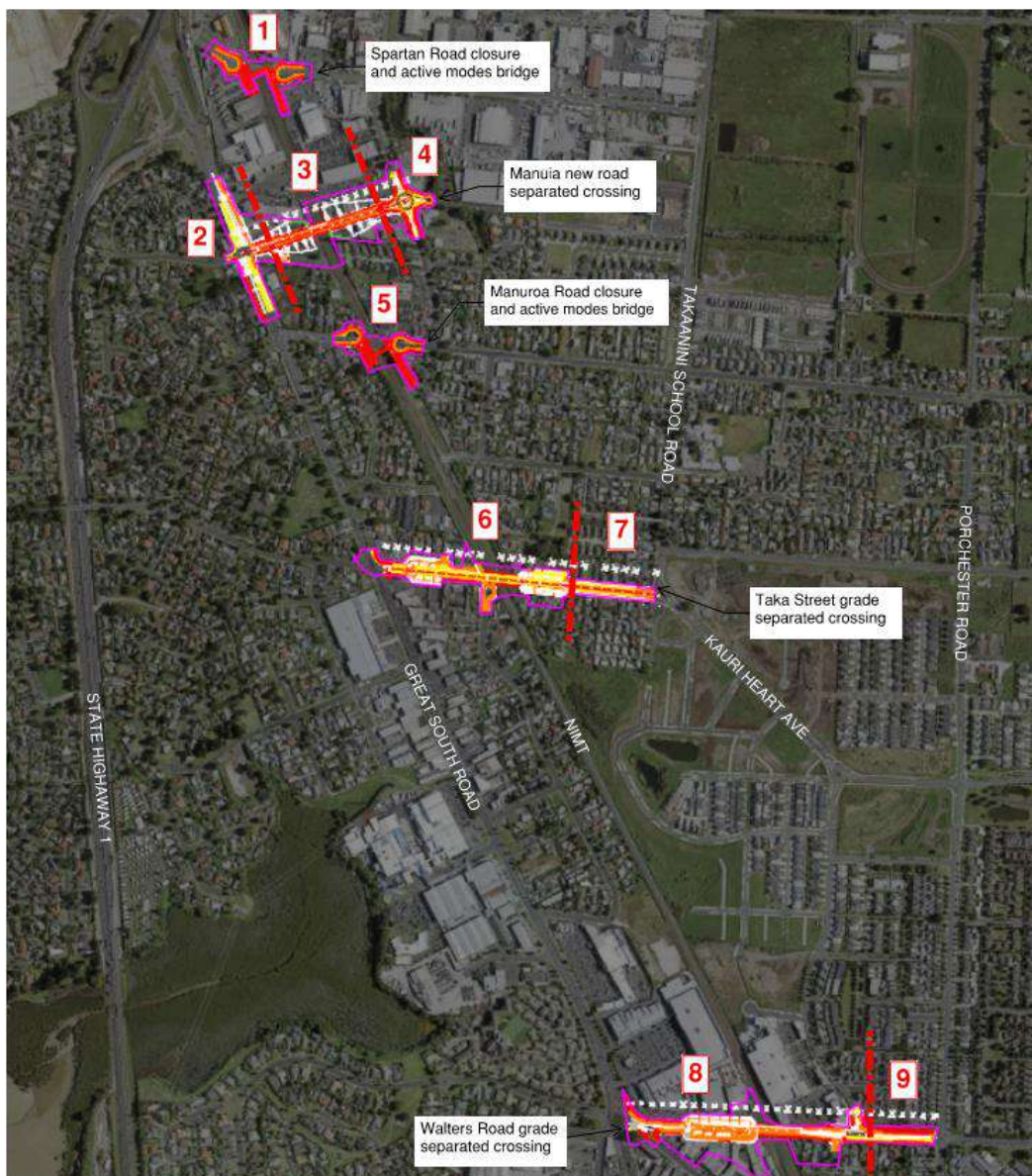


Figure 1 Takaanini level crossings costing scope of works

2 Approach to cost estimation

The cost allowances formatting has been developed consistent with the Waka Kotahi Cost Estimation Manual SM014 for a Detailed Business Case (DBC). However, no risk analysis has been undertaken.

2.1 Property

The cost of land forms a significant part of the estimate. Property cost estimates have been prepared by the Auckland Transport team on behalf of Te Tupu Ngātahi. These cost estimates have been prepared based on the land requirement (both temporary and permanent) represented by the proposed Designation boundary in the drawing set issued “For Approval”. The assumptions associated with the property cost estimates are attached in the Appendix C within this report.

The property costing approach is as follows:

- **Aggregate Property’s into parcels** – The Property team review the preferred project alignments and break the programme into appropriate parcels. This would consider type of current and future environment (e.g., Brownfields vs Greenfields), current and future zoning (e.g., rural vs commercial, FUZ vs THAB) and any particular property intricacies (could be area of reserve or challenging valuation)
- **Develop price for each parcel** – Develop a property price (for business case purposes) for the identified parcel rather than for each property. This would consider the same type of land use according to the Auckland Unitary Plan (AUP) Zones
- **Benchmark** – Use the current pricing to inform the validity of the parcel pricing
- **Review** – Property pricing reviewed by senior experienced valuation experts

Where it was found that a property requirement was on the boundary between two costing segments (refer to Appendix D), an assessment has been made as to which segment this cost should best be attributed to. It is for partly for this reason that the property cost estimates per “project corridor” in the property cost memorandums supplied do not necessarily align with those in Table 4.

The nett project property cost includes costs pertaining to both the temporary and permanent land requirement. [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

Table 2 Assumed temporary occupation by project corridor

Project corridor	Expected construction duration (years)	Assumed duration for temporary occupation (years)	
Spartan Road closure and active modes bridge	1	1	
Manuia Road new grade separated crossing	2.5-3	2	
Manuroa Road closure and active modes bridge	1	1	
Taka Street grade separated crossing	2.5-3	2	
Walters Road grade separated crossing	2.5-3	2	

Note: The above programme information was provided by the project team. [REDACTED]

2.2 Project development phase

An allowance of 2% of the sub total base physical works has been applied for project development phase. This includes the following:

- Consultant fees, including preliminary design, implementation business case
- Client managed costs.

2.3 Pre-implementation phase

An allowance of 9% of the sub total base physical works has been applied for pre-implementation phase. This includes the following:

- Consenting 1%, including environmental court risk
- Design fees 7%, including geotechnical investigation
- Client managed costs 1%, including IWI consultation

2.4 Implementation phase

2.4.1 Implementation fees

An allowance of 6% of the sub total base physical works has been applied for implementation fees within the Implementation phase. This includes the following:

- Consultancy fees 2%
- Client managed cost 4%

2.4.2 Physical works

Costs allowances for the physical works costs have been undertaken by the quantity surveying team based on assumptions scheduled as per the Appendix C per each corridor described in the Appendix D of this report. Quantity measurements are from the concept design shown on the General Arrangement drawing as part of the Appendix F Design report of the Takaanini Level Crossings DBC.

An allowance of the following physical works items has been made:

- Environmental Compliance
- Earthworks
- Ground Improvement
- Drainage
- Pavement and Surfacing
- Bridges
- Retaining Walls
- Traffic Services
- Utility Services
- Landscaping
- Traffic Management
- Preliminary and General
- Extraordinary construction cost

2.5 Risk and Contingencies

The physical works allowances include a 25% contingency (P50) and a funding risk contingency (P95) of 20%, reflecting the uncertainty in the final form of the projects.

The property cost allowances include a 15% contingency (P50), as described on section 2.1 and a funding risk contingency (P95) of 20% which align with the physical works allowance.

These contingencies are required for cost estimation in accordance with the CEM. Definitions for those are as follows:

Contingency (P50)

A financial provision added to the base estimate to provide for uncertainty in relation to the estimate inputs and specific project threats and opportunities with a cost impact to derive the expected estimate. The 'contingency' represents the statistical mean.

Funding Risk Contingency (P95)

An additional financial provision for uncertainty in relation to the estimate inputs and project related threats and opportunities (funding risk contingency)

Advanced approach toward risk is to be undertaken on the Implementation Business Case in the future.

2.6 Escalation

The cost allowances provide an indication of infrastructure funding requirements at a base date and do not reflect programming over time. Therefore, escalation is not included directly in this report.

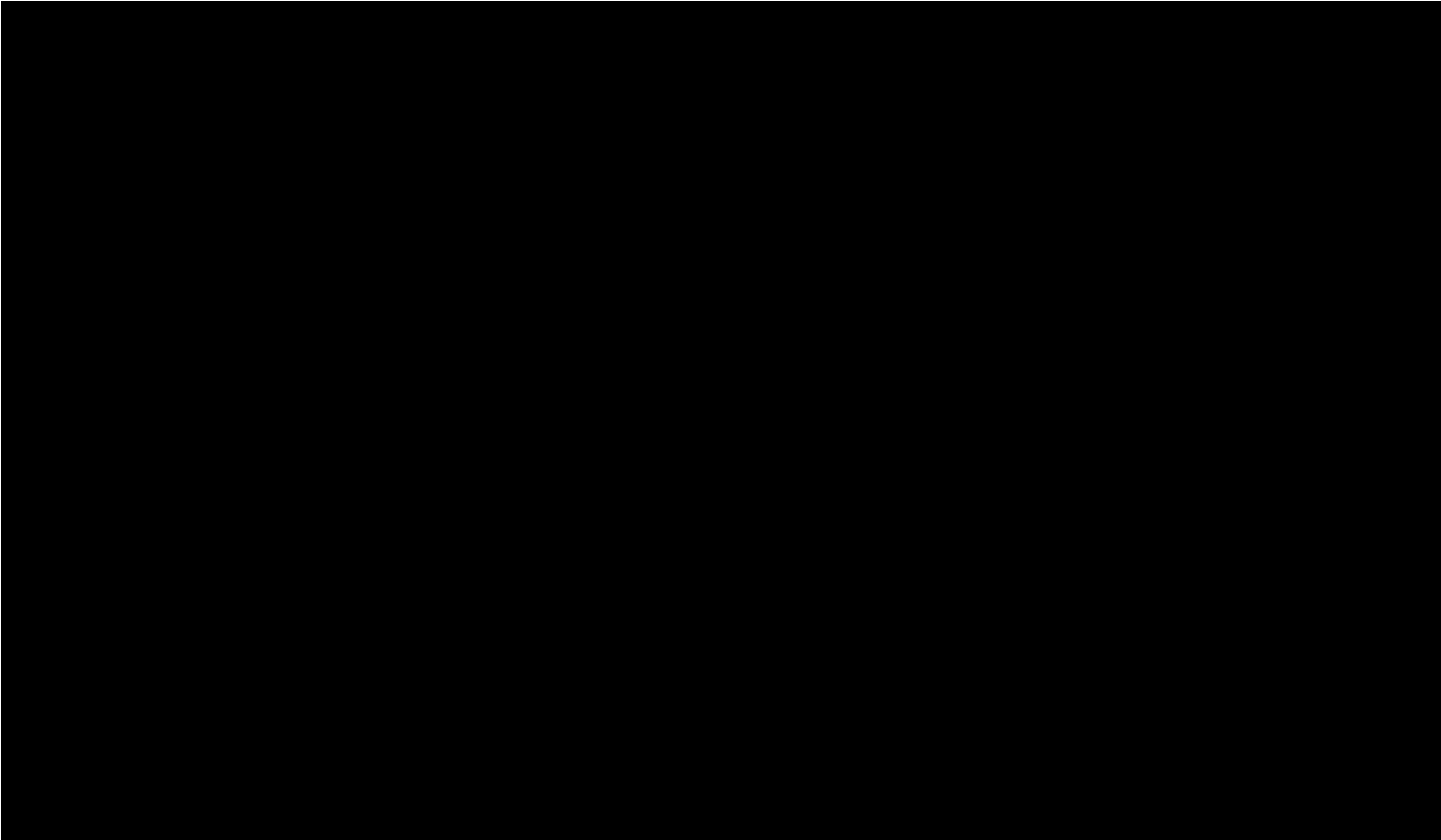
2.7 Verification

A Business Case of this scale would normally involve preparation of a parallel estimate by an independent estimator. However, as this Business Case is primarily focused on route protection and a subsequent stage will be undertaken to seek funding for implementation, the level of cost estimation accuracy is considered to be less than a typical DBC. Therefore, it has been agreed with both Auckland Transport and Waka Kotahi that the costs will be peer reviewed through 'cross verification' by a separate team within Te Tupu Ngātahi who were independent of the initial estimate preparation.

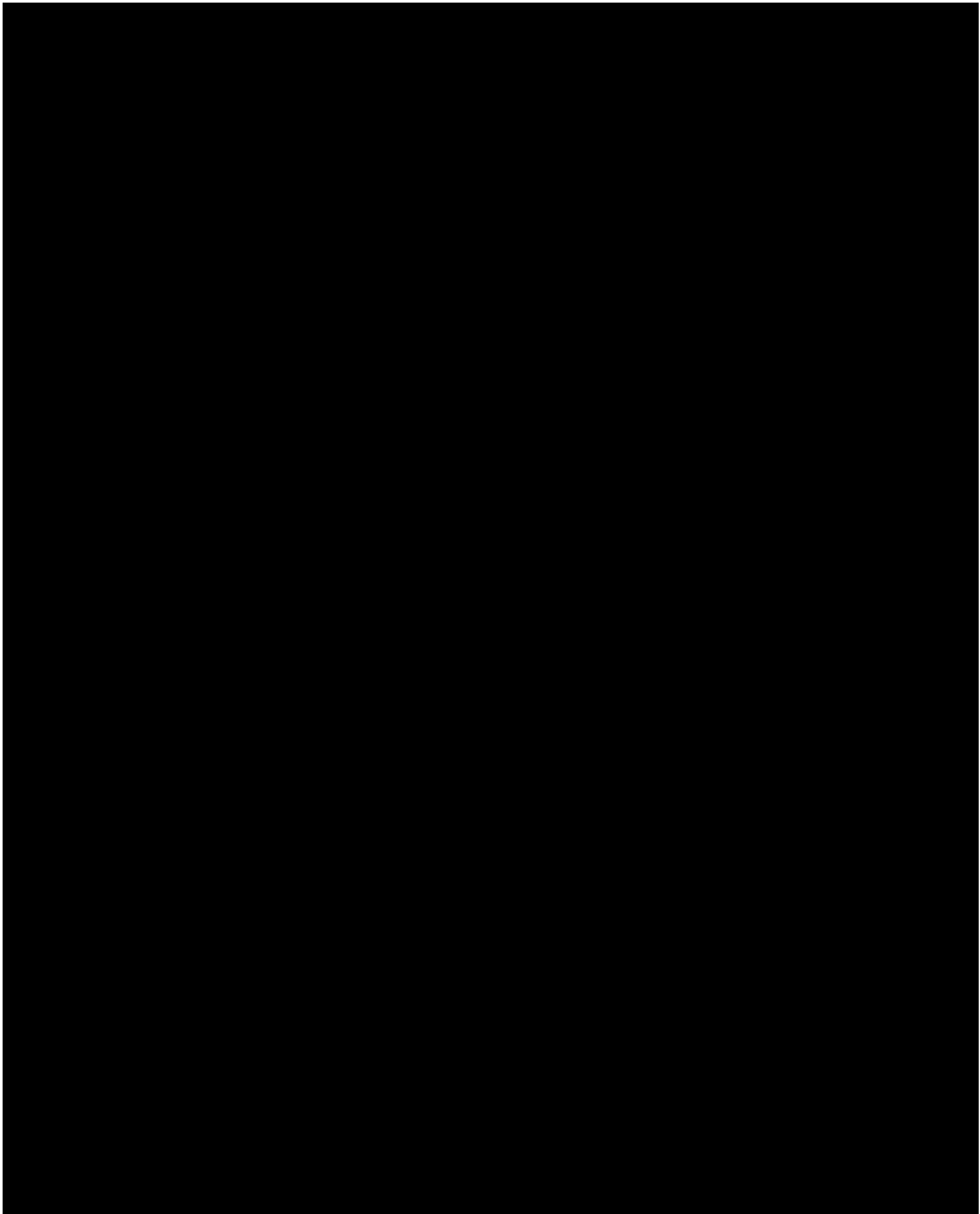
From a property point of view, verification is suited to a route protection business case to follow the approach outlined on the section 2.1 on this report involving the following:

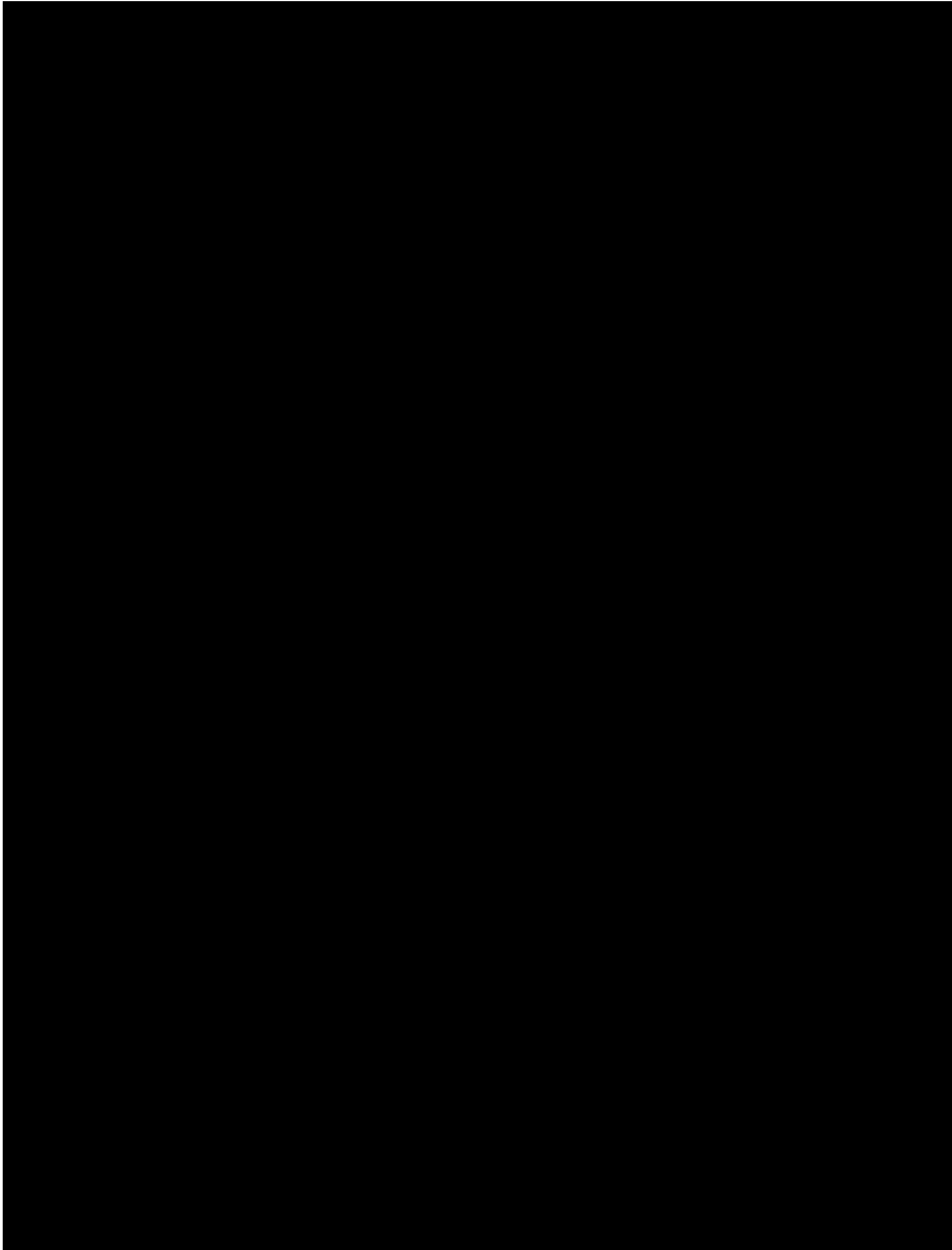
- Undertake a review of the methodology applied on the project
- Undertake a review of the rates/benchmarking used for different land uses and property types
- Internal review with AT and Waka Kotahi on property estimates

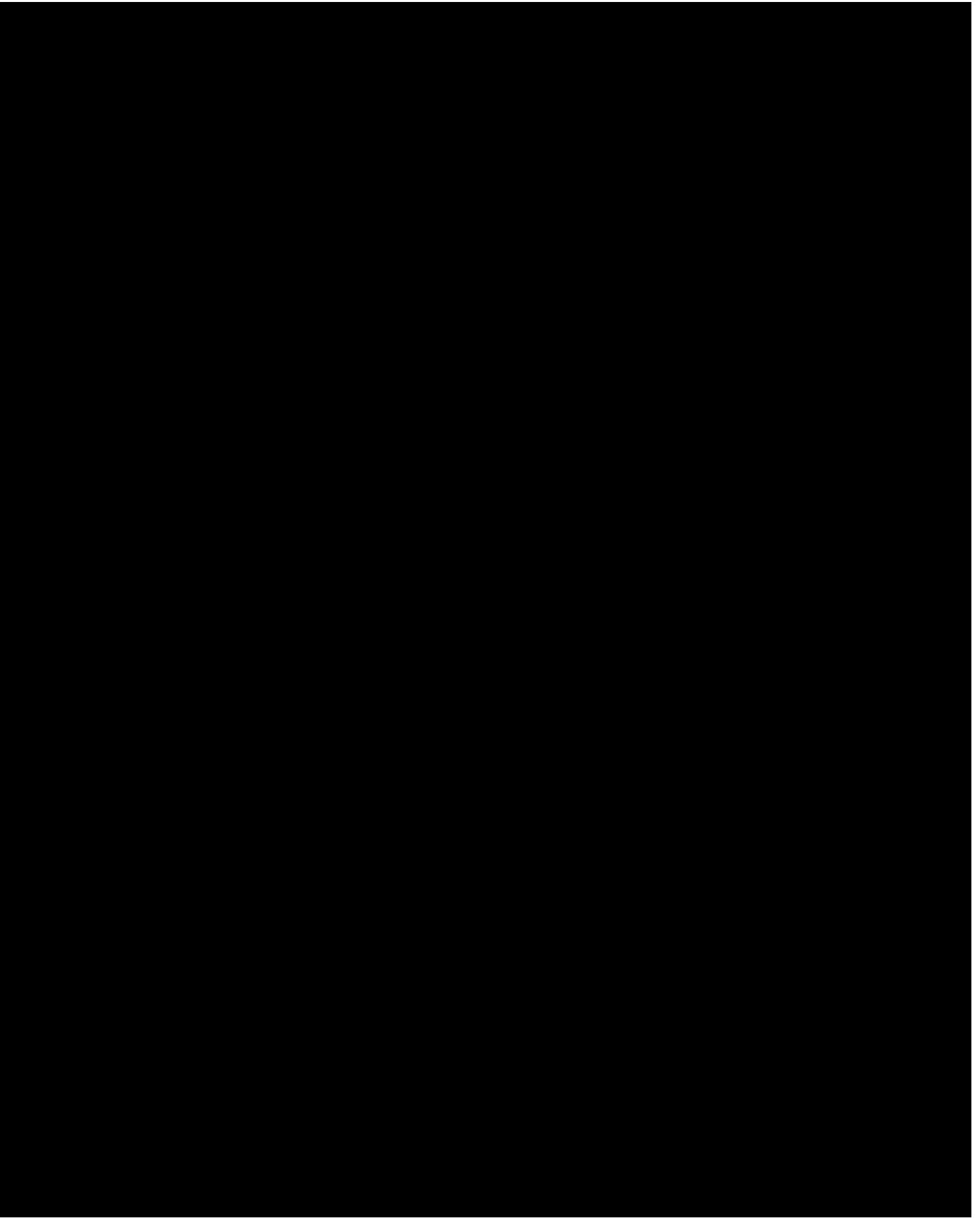
3 Cost summary

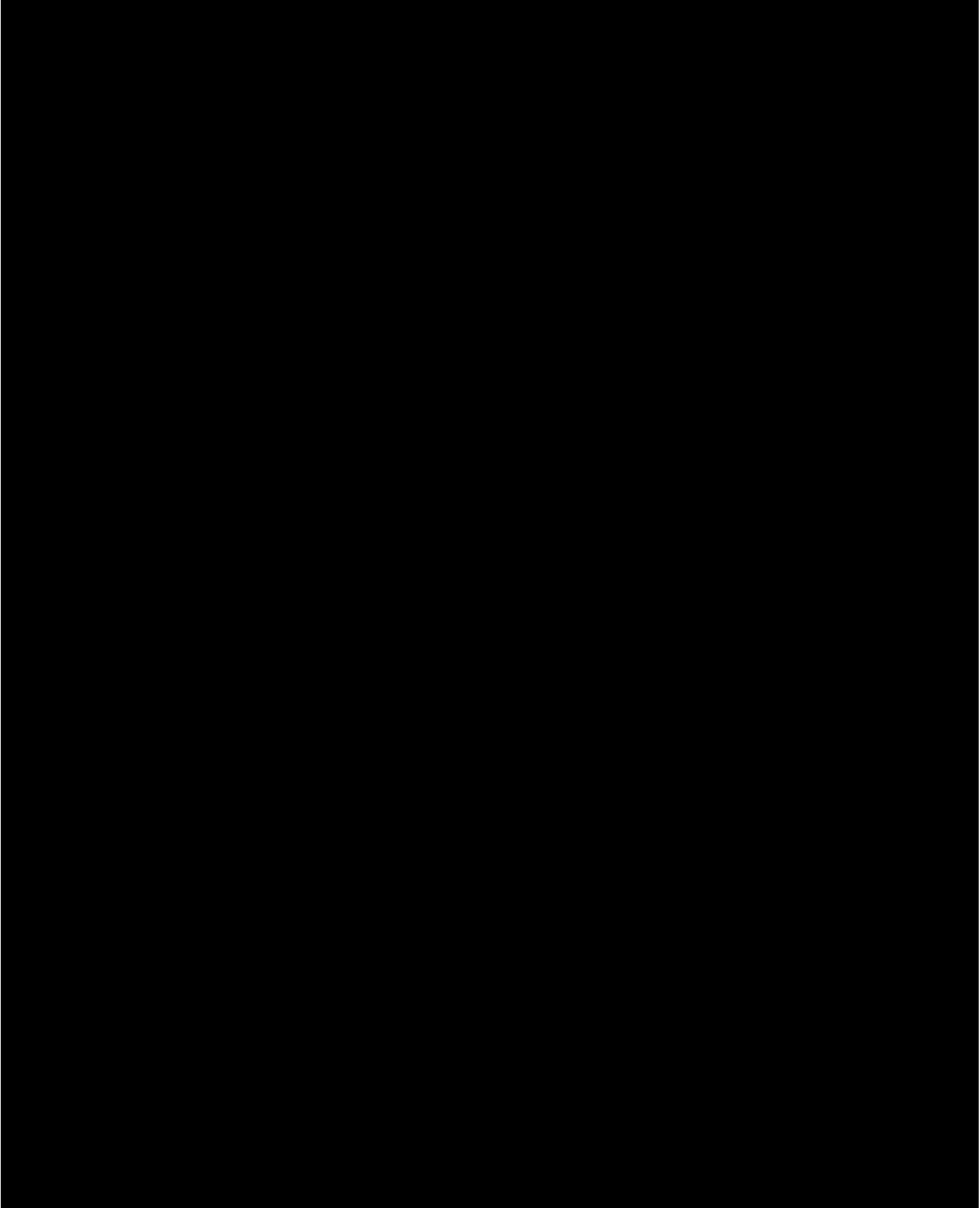


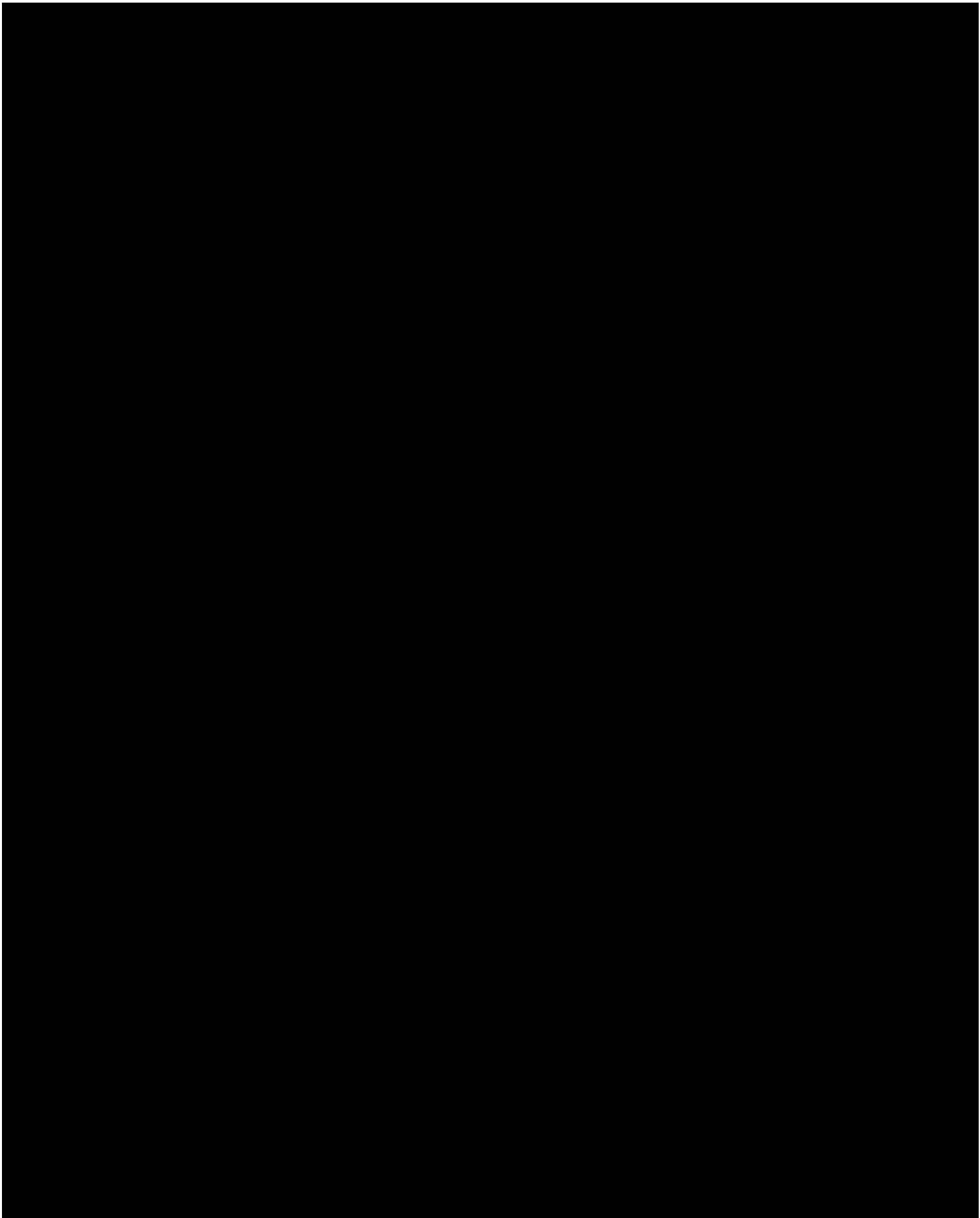
1 Appendix A Cost estimate summary forms (DBE)











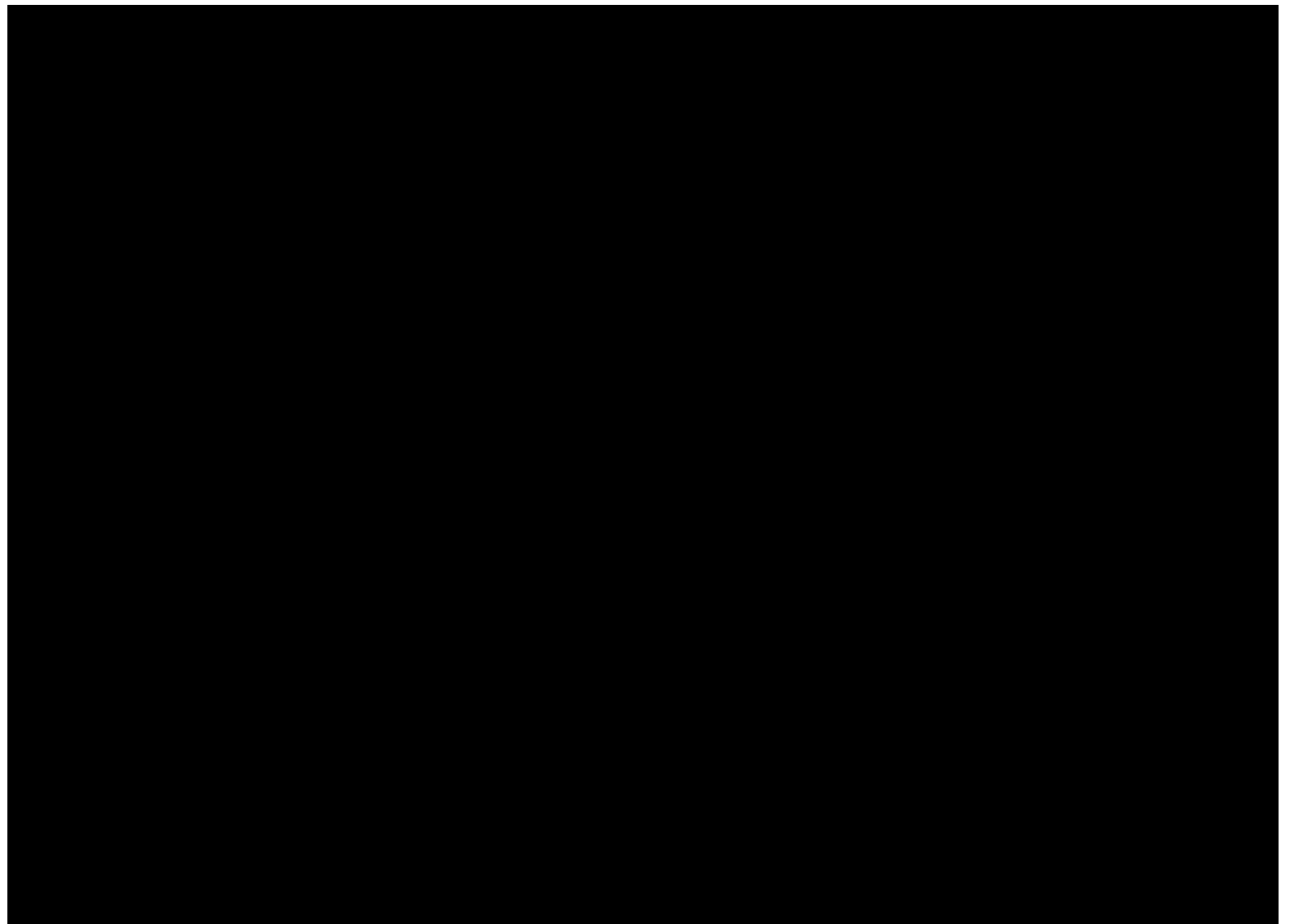
2 Appendix B Property cost estimate memorandums

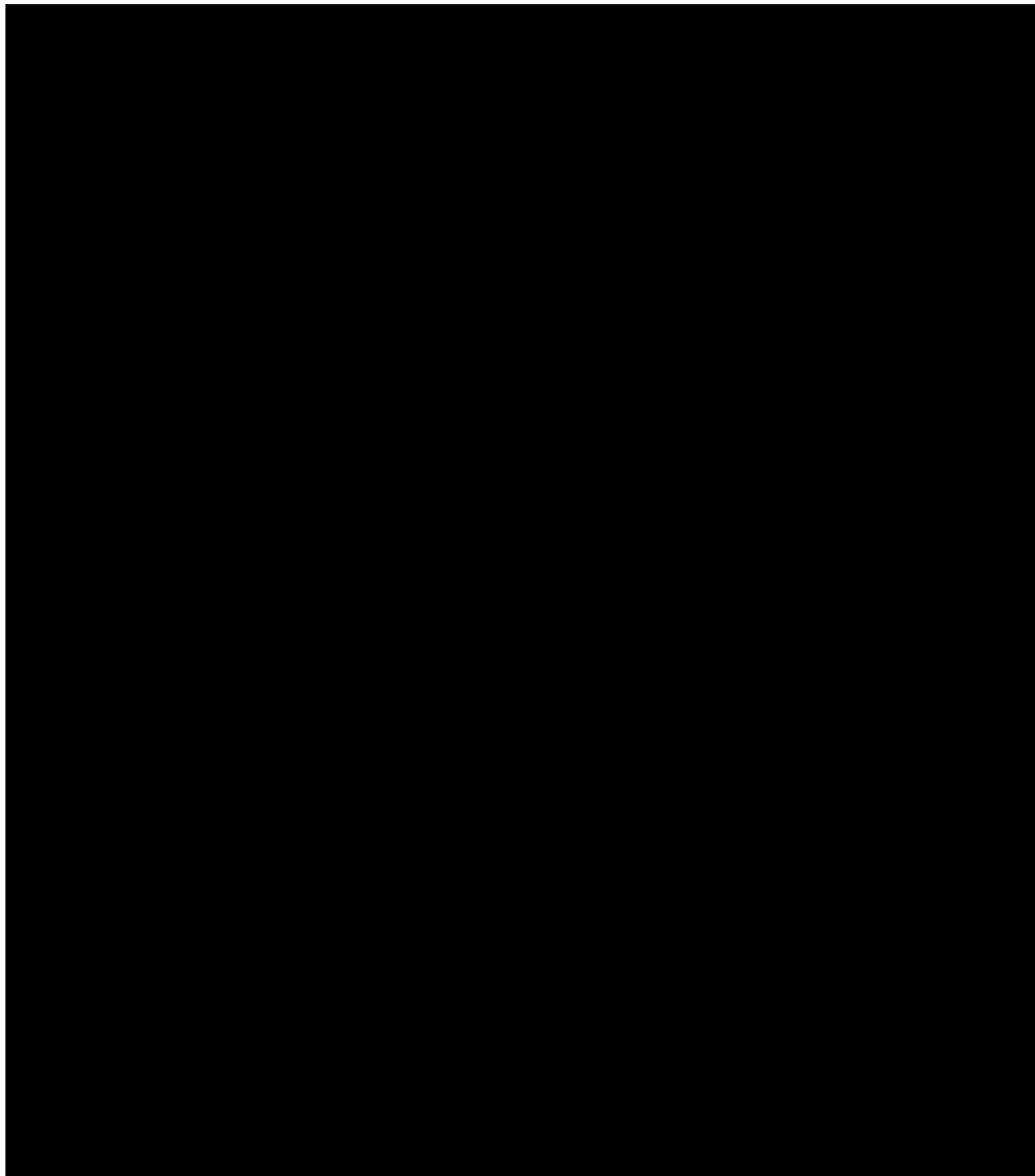
The first part of the paper discusses the importance of the research and the objectives of the study. It then presents a literature review of the existing research on the topic. The next section describes the methodology used in the study, including the data sources and the statistical techniques employed. The results of the study are then presented, followed by a discussion of the findings and their implications. The paper concludes with a summary of the main points and suggestions for further research.

The study was conducted using a quantitative research design. Data was collected from a sample of 100 participants. The data was then analyzed using statistical software. The results of the analysis are presented in the following table:

Variable	Mean	Standard Deviation
Variable 1	1.2	0.5
Variable 2	2.5	0.8
Variable 3	3.1	1.2
Variable 4	4.5	1.5
Variable 5	5.2	1.8

The results of the study indicate that there is a significant relationship between the variables. The findings suggest that the research has important implications for the field. Further research is needed to explore these findings in more detail.



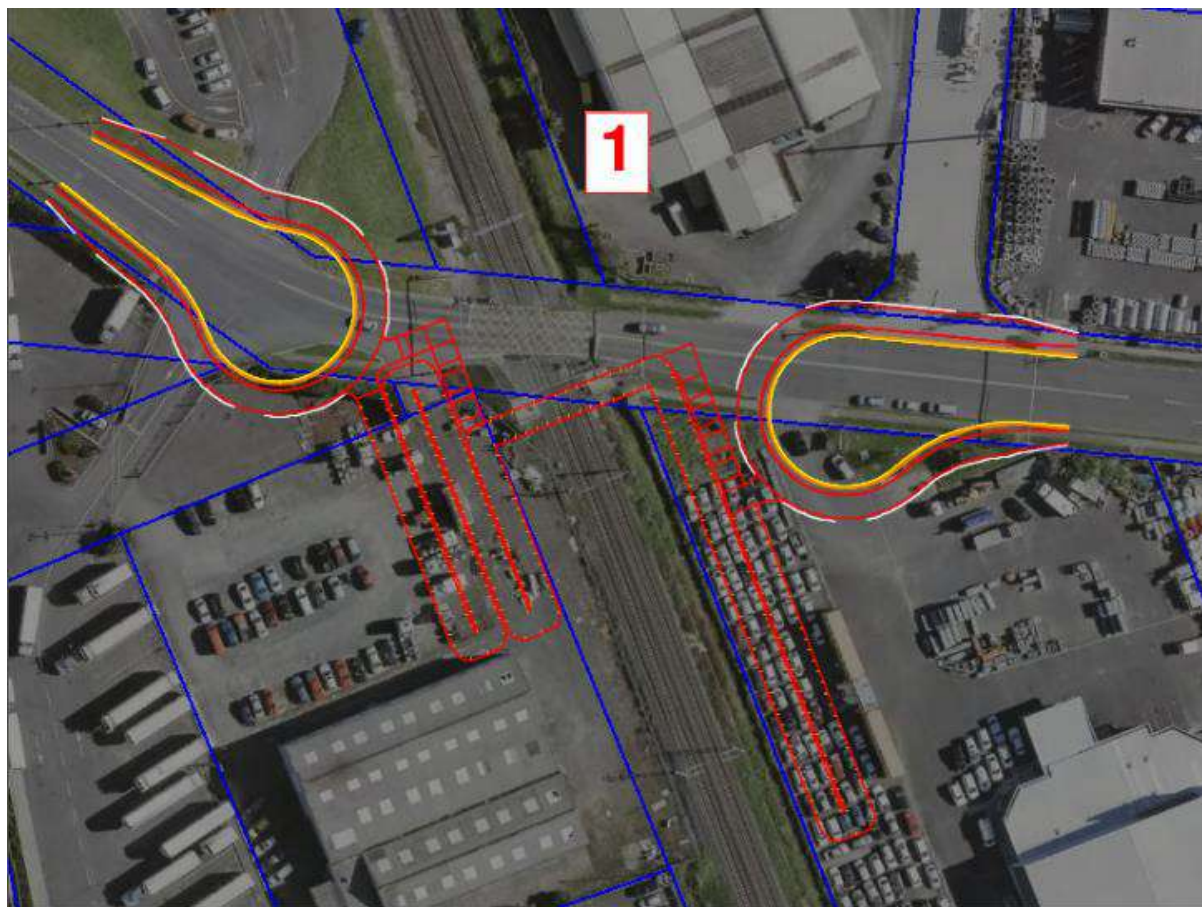


3 Appendix C Generic physical works assumption schedule

4 Appendix D Project costing segments

Spartan Road

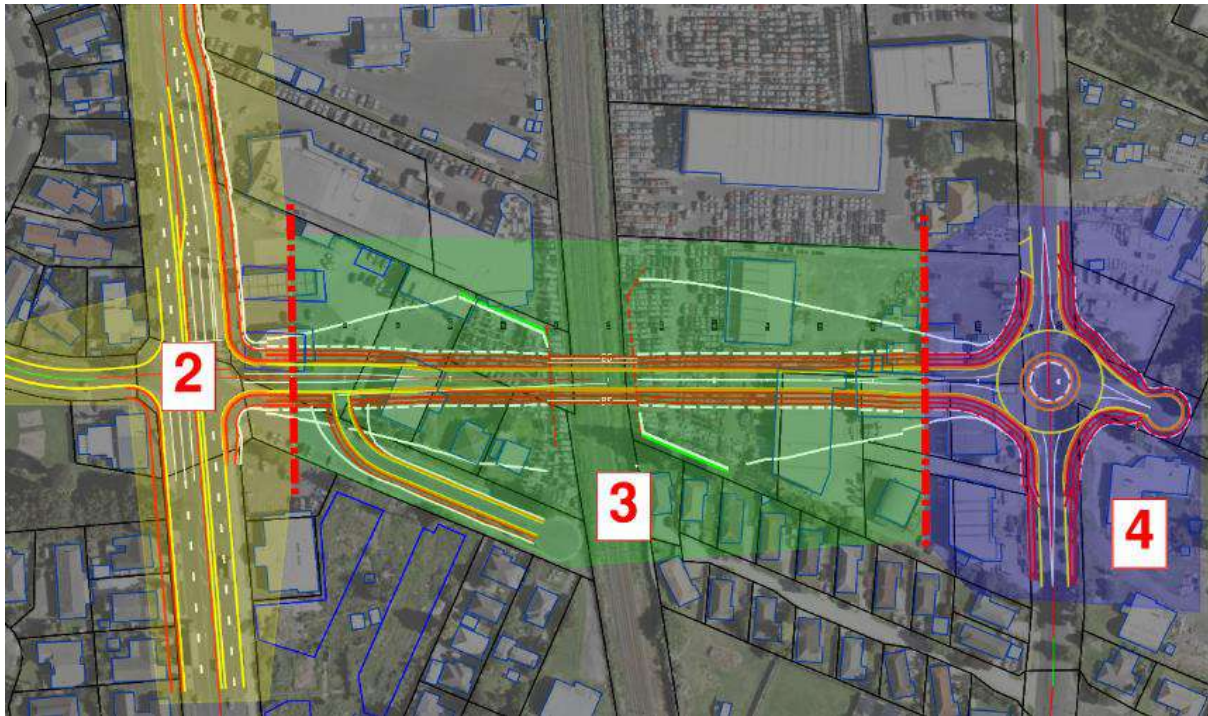
Extent of scope for physical works cost estimation:



Segment	Description	CH Start	CH End
Segment 1	The scope of works include: • Cul-de-sac • Active modes bridge • Ramps and stairs	N/A	N/A

Manuia Road

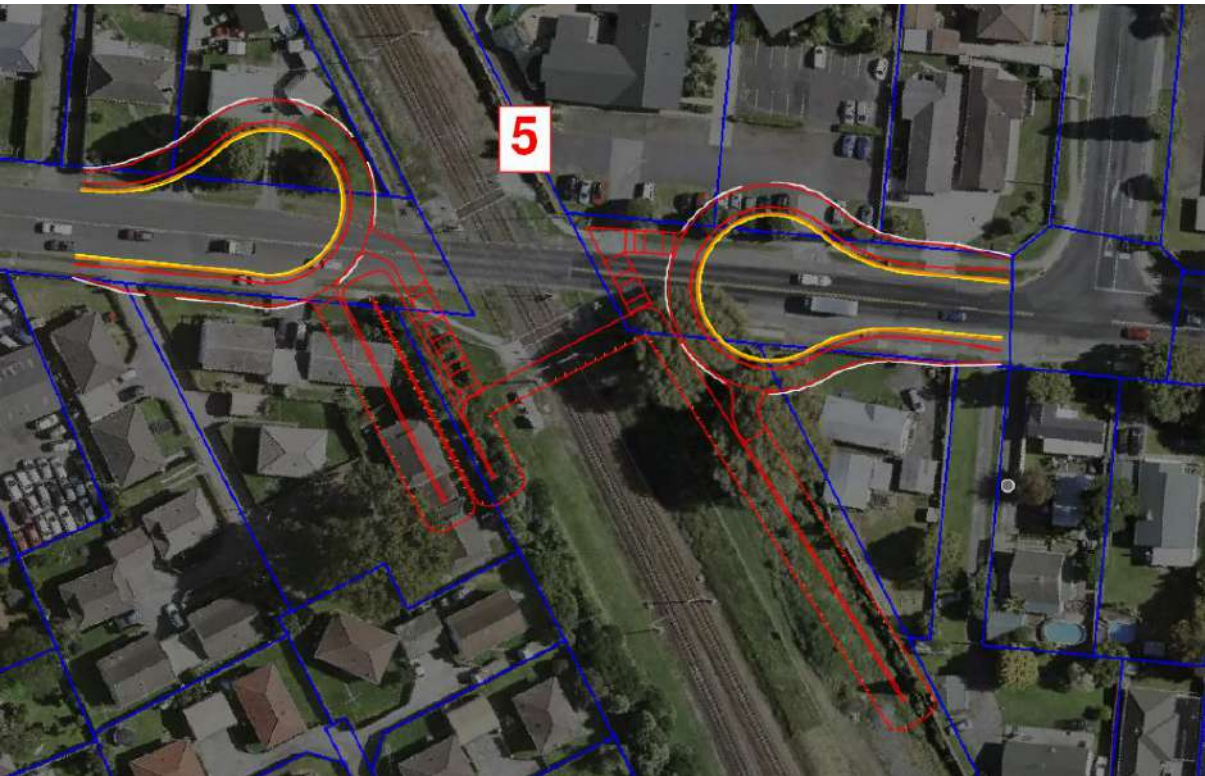
Extent of scope for physical works cost estimation:



Segment	Description	CH Start	CH End
Segment 2	Great South Road/ Manuia Road/ Challen CI signalised intersection	0	40
Segment 3	Manuia Road mid-block mainline corridor, including the accessway at existing Manuia Road and bridge	40	280
Segment 4	Oakleigh Ave/ Hitchcock Road roundabout	280	331

Manuroa Road

Extent of scope for physical works cost estimation:



Segment	Description	CH Start	CH End
Segment 5	The scope of works include: - Cul-de-sac - Active modes bridge - Ramps and stairs	N/A	N/A

Taka Street

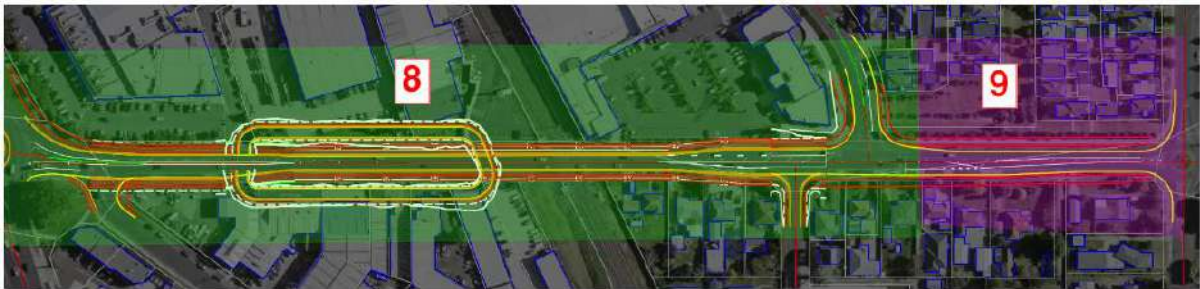
Extent of scope for physical works cost estimation:



Segment	Description	CH Start	CH End
Segment 6	Mid-block mainline corridor, accessways, cul-de-sac and bridge	0	360
Segment 7	Mid-block mainline corridor	360	530

Walters Road

Extent of scope for physical works cost estimation:



Segment	Description	CH Start	CH End
Segment 8	Mid-block mainline corridor, accessways, Arion Road intersection, Braeburn PI intersection, Tironui Road intersection and bridge	0	440
Segment 9	Mid-block mainline corridor	440	585

Takaanini Level Crossings Project

Appendix K – Economics Assessment

October 2023

Version 1.0

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Responsibility	Name
Author	
Reviewer	
Approver	
Peer reviewer	

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N/A	23/09/2022	Draft report sent to peer reviewer
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Appendices

Appendix 1 – Sector-Sector Traffic Benefits

Appendix 2 – SATURN PLOTS

Acronym/Term	Description
AFC	Auckland Forecasting Centre
AT	Auckland Transport
ATAP	Auckland Transport Alignment Project
AUP	Auckland Unitary Plan
BCR	Benefit to Cost Ratio
CRL	City Rail Link
CRV	Traffic Congestion
DBC	Detailed Business Case
DM	Do Minimum
DN	Do Nothing
FTN	Frequent Transit Network
FULSS	Future Urban Land Supply Strategy
HBE	Home-based Education
HBO	Home-based Other
HBW	Home-based Work
IBC	Indicative Business Case
LX	Level Crossing
MBCM	Monetised Benefits and Costs Manual
MSM	Macro Strategic Model
NIMT	North Island Main Trunk
NPV	Net Present Value
NZ	New Zealand
PT	Public Transport
PV	Present Value
SAMM	Strategic Active Modes Model
SD	Standard Deviation
TDM	Travel Demand Management
V/C	Vehicle to Capacity
VEPM	Vehicle Emission Prediction Model

Acronym/Term	Description
VKT	Vehicle Kilometres Travelled
VOC	Vehicle Operating Costs
VoT	Value of Time
WEB	Wider Economic Benefit

1 Introduction

1.1 Purpose

This report details the economic appraisal for the Takaanini Level Crossings Detailed Business Case (TLC DBC) recommended network at the Supporting Growth Alliance (Te Tupu Ngātahi) Programme. The TLC DBC proposes rail crossings removal and/or replacements to support the expected future growth in Takaanini. The evaluation is primarily based on the standard evaluation method for transport infrastructure, which is typically dominated by travel time savings, although this has been extended to reflect the particular conditions of the appraisal.

The TLC DBC considers the removal and/or replacement of four existing level crossings, and a new grade separated crossing. **Figure 1-1** exhibits the TLC DBC recommended option showing the level crossings that are proposed to be closed or replaced with grade-separated bridges for all modes as well as new proposed connections. The TLC DBC recommendations for the recommended network are:

- **Spartan Road** and **Manuroa Road** - level crossings closures (cul-de-sacs) with new active mode bridges
- **Taka Street** and **Walters Road** - grade separation over the rail line
- **Manuia Road** – new grade-separated rail crossing between Great South Road and Oakleigh Avenue

An economic appraisal has been undertaken on these rail crossing changes. This appraisal is undertaken in accordance with Waka Kotahi NZ Transport Agency's Monetised Benefits and Costs Manual (MBCM). All costs are reported in NZD unless otherwise stated. Non-monetised benefit measures are documented in **Appendix G** (Transport Outcomes Report) of the DBC but were calculated in intermediate steps in the process of monetising benefits for the present economic analysis.

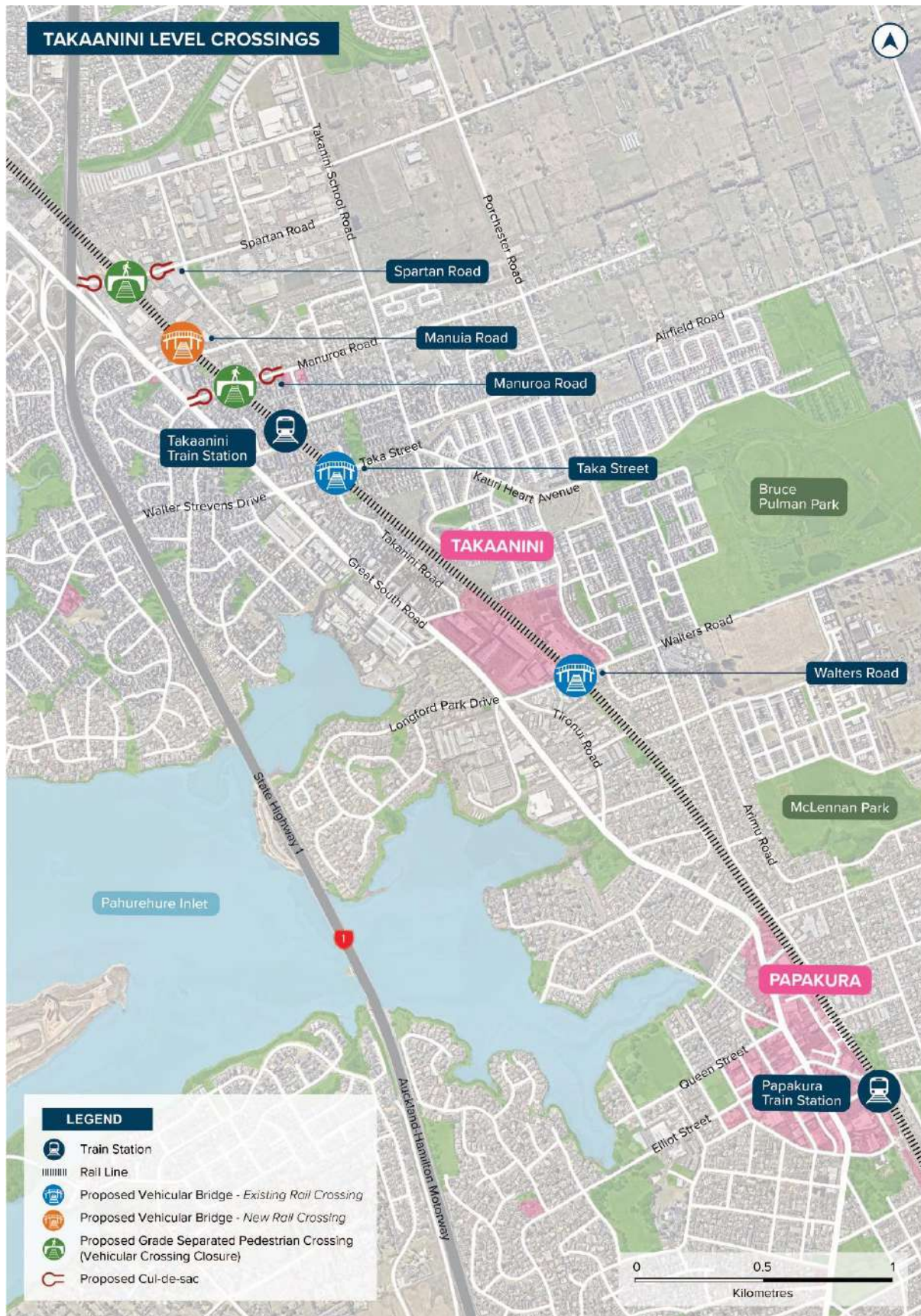


Figure 1-1: TLC recommended option

1.2 Approach and Key Issues

The TLC DBC is for the purposes of route protection, rather than imminent implementation. The appraisal has therefore been targeted at this decision (to progress to route protection), rather than at a more detailed assessment that could be expected for an implementation decision. The appraisal has also been undertaken in the context of the following key issues:

- Estimates of the type, scale, sequencing and rate of growth have been made for the DBC. However, the resulting growth is highly uncertain and subject to other regulatory processes such as Structure Plans, Plan Changes, sub-division consents and economic demand.
- The Te Tupu Ngātahi programme, via its owners and partners, will make decisions on the implementation of specific projects based on separate prioritisation and decision processes over the next 30+ years.
- The Te Tupu Ngātahi business cases have focussed on the transport elements and footprints to support the long-term, full build-out of the area. The actual land use development is likely to occur progressively in stages, which allows more detailed sequencing and staging decisions (e.g. some corridors could be improved with initial upgrades that are expanded in later years). This is particularly important given the, as yet, unknown long-term effects of the COVID-19 pandemic.
- The Te Tupu Ngātahi programme identified a network of improvements to support the growth with the desired outcomes for this area. The present DBC is being prepared in parallel with the Te Tupu Ngātahi South Frequent Transit Network DBC (South FTN DBC). It is currently assumed that the FTN elements will be implemented progressively between 2038 and 2048, but this is subject to funding being confirmed.
- The Te Tupu Ngātahi network is planned to comprise a part of a wider network, including projects such as the City Rail Link (CRL), four-tracking of the rail corridor between Wiri and Pukekohe, Drury Local DBC and Mill Road DBC. Whilst those projects are independent of the Te Tupu Ngātahi programme elements, the appraisal of the Te Tupu Ngātahi programme elements is dependent on the assumptions made about the timing of those other elements. It is currently assumed that these other elements will be implemented progressively between 2028 and 2048, but this is still subject to funding being confirmed.

Based on the purpose, scope and identified issues, the appraisal has adopted some key principles:

- A level of detail suitable to the route protection decision, rather than imminent implementation
- A focus on the appraisal of the full build-out project rather than analysis of fine-grained staging options
- Simplified modelling approach with limited analysis of project inter-dependencies, rather than extensive analysis of the various possible combination of project sequencing in the wider network
- Analysis of the project under a range of potential scenarios of project timing, discount rates etc, rather than a focus on a single BCR (i.e., sensitivity tests)
- The Takaanini Level Crossing DBC recommended network scenario has been assessed against a 'Reference' do minimum scenario (that includes an assumed sequencing of adjacent projects), rather than a 'true' do minimum that includes only committed projects. This is to avoid the potential for double counting of common benefits that would be assigned to whichever project is assumed to be implemented first.
- The overall combination of Te Tupu Ngātahi programme elements, termed as 'recommended network' in this report, has been considered against an overall 'Reference' do minimum package for the modelled years (2028, 2038, 2048, 2048+). For this economic appraisal it is

assumed that all the level crossing changes will occur at the same time rather than subsequently staged over years.

‘Reference’ Option and ‘Reference’ Do Minimum Assumptions

Three potential definitions of the do minimum have been considered:

1. The train frequency and track capacity upgrades proceed (as separate to the Takaanini level crossings project), with consequential impacts on the east-west accessibility from increased barrier-down time and progressively worsening delays and safety risks at the rail crossings (i.e., the existing at-grade level crossings will remain open but will have severe impacts). This will subsequently be called the “Do Nothing” scenario.
2. The train frequency and track capacity upgrades proceed (as separate to the Takaanini level crossings project), but the progressively worsening delays and safety risks from the barriers become so significant that the crossings must be closed (i.e., the crossings are closed, and the corridors become cul-de-sacs). This will subsequently be called the “Do Minimum Closure” scenario.
3. The train frequency and track capacity upgrades cannot be fully realised due to the severity of impacts it has on the crossings (i.e., the existing at-grade level crossings will remain but will have less impacts due to the need to constrain the rail upgrades). (Do Minimum 3)

With respect to the Do Nothing and Do Minimum Closure scenarios, the bulk of the benefits will be to east-west traffic and active mode movements. However, with respect to do minimum 3, the upgrading of the crossings will have less east-west movement benefits but would generate rail passenger benefits as it would enable the train frequency and track capacity upgrades required to support the major developments further south at Drury to be fully realised. Do minimum 3 is considered a valid scenario but involves benefits for elements (e.g. rail upgrades) outside the scope of the TLC DBC, so it has not been used for the present economic appraisal. Both the Do Nothing and Do Minimum Closure scenarios were used in the present economic appraisal to give an indication of economic returns. The Do Nothing scenario will necessarily have an element of do minimum 3 and so as presented represents an optimistic do minimum case; the benefits calculated with respect to the Do Nothing scenario are therefore likely to be conservative. A “Staged Do Minimum” scenario was also created by assuming the Do Nothing scenario for the earlier years, then gradually transitioning to the Do Minimum Closure scenario for the later years.

The phasing of the project components of the Te Tupu Ngātahi Business Cases are uncertain, since the DBC purpose is for route protection, rather than imminent implementation. Hence for the modelling purpose it is considered that the 2048+ model will have the long-term, full build-out project components implementation, while interim years will include a subset of network.

The projects included for the Reference Option and do minimum are as follows:

- Four-tracking between Papakura to Pukekohe in 2048 and 2048+; whereas two-tracking in 2028 and 2038 as outlined in the Rail DBC
- Three new stations at Maketuu, Ngaakooroa and Paeraataa (Drury Central, Drury West and Paerata) in 2028, 2038, 2048 and 2048+ as per the Rail DBC
- The upgrade for Bremner Road, Jesmond Road, Waihoehoe Road and SH22 for the years 2028, 2038, 2048 and 2048+ as defined in the Drury Local Business Case (noting that development in Drury has already begun).
- The north-south Opaheke arterial is considered only in 2048+ and taken out from earlier years
- Pukekohe Expressway and the full-length Mill Road upgrade is assumed in 2048 and 2048+

All the above projects are considered both in the Reference Option and do minimum scenarios for the TLC DBC, and the differences between them are the project components as discussed in **Section 1.3.2**.

1.3 Modelling Tools and Assumptions

1.3.1 Modelling Tools

The transport user costs and benefits have been estimated based on a suite of transport models owned by the Auckland Forecasting Centre (AFC). The models include:

- **The regional, multi-modal, macro strategic model (MSM).** This creates estimates of car, truck, and public transport (PT) movements at a regional level based on land use, network, and policy inputs. This model is the primary tool to estimate future regional PT usage and provides the basis for the more detailed forecasts for the road network described below. Generally, these models are run using regional assumptions as per recent Auckland Transport Alignment Project (ATAP) planning, but with scenario-specific inputs in the Te Tupu Ngātahi growth areas. Models for years 2028, 2038, 2048 and 2048+ have been run and their outputs were used for obtaining traffic matrices for SATURN models, PT benefits, crash savings, and wider economic benefits (WEBs).
- **A local traffic model (SATURN).** This uses the traffic demands from MSM on a more detailed representation of the road network. For the economic analysis, the outputs from SATURN are extracted from the same scenarios i.e., Option Scenario and Do Minimum Closure Scenario for the modelled years 2028, 2038, and 2048+. For the economic assessment using SATURN outputs, the 2048 benefits are estimated by interpolating the 2038 and 2048+ benefits.
- **A strategic active modes model (SAMM).** This tool gives strategic-level estimates of walking and cycling demands that respond to land use, the quality of the walking and cycling network, and the relative change in costs for competing car and PT modes. It derives land use and network data directly from MSM whilst using a more refined zone system. MSM zones are disaggregated to a smaller zone system for use in SAMM, i.e., MSM covers the Auckland region via some 600 zones, while SAMM covers the same area via some 1,100 zones. The refined zone system was deemed necessary to obtain more precise trip costs, particularly for shorter and intra-zonal trips. The model has a strong interface with MSM to provide key inputs but can be operated independently to assess specific changes to the active modes network.

MSM is used to derive PT user benefits and provides traffic demand estimates for the SATURN model. The SATURN model is used to estimate benefits to general traffic, while SAMM was used to estimate benefits to walking and cycling, as shown in **Figure 1-2**. Each mode (PT, general traffic, walking and cycling) are appraised separately, albeit with the changes in mode share reflected in the demands for each mode. Sector to sector analysis has been carried out for understanding the benefits pattern of vehicular traffic (light and heavy vehicles) and are presented in **Appendix 1**.

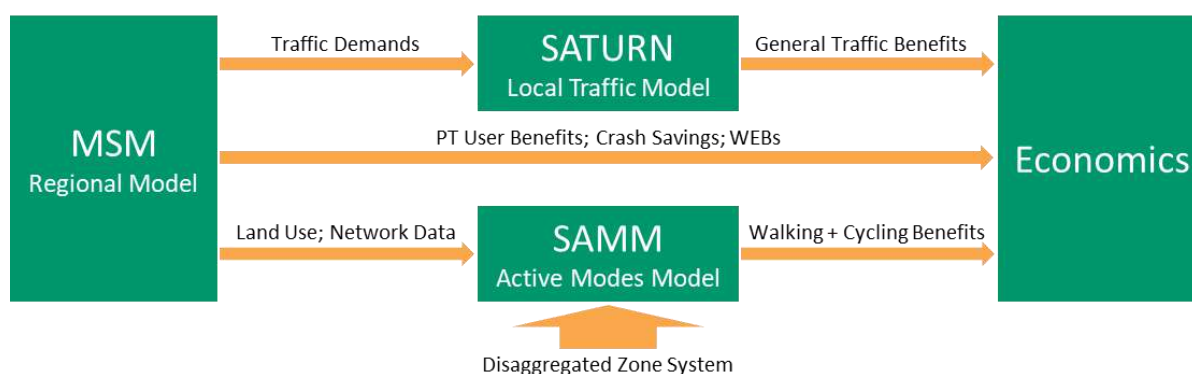


Figure 1-2: Suite of Transport Models

Although the regional model was suitably validated against observed 2016 conditions, analysis against 2013 census data indicated that not all 2016 commuter trip distribution patterns were well replicated. However, because the land use in the growth areas will significantly transform travel patterns in this area, those 2013 patterns will be of limited relevance to those future conditions. This means that while the changes in the predicted travel patterns and benefits which form the key element of this economic appraisal appear plausible, the total travel movements will continue to have some uncertainty. Additionally, longer term changes in travel behaviour due to COVID-19 could eventuate such as higher frequency of working from home. As these remain highly uncertain, no changes have been made to the model inputs or parameters to reflect COVID-19 changes in travel pattern. Considering this however, sensitivity tests have been undertaken (see **Section 4.2**), including with 25% less benefits, which to a large extent would cover this issue.

1.3.2 Modelling Key Principles and Assumptions

Land Use Information

The modelling has been based on the regional growth assumptions reflected in land use 'Scenario i11.6' forecasts released by AFC in mid-2020.

The Scenario i11.6 forecasts are based on Statistics NZ medium population growth estimates for Auckland. In those forecasts the staging of greenfield growth is based on the direction indicated in Auckland Council's Future Urban Land Supply Strategy (FULSS). The standard Scenario i11.6 forecasts extend to the year 2048, however, an additional scenario was developed for Te Tupu Ngātahi referred to as 2048+. This is based on the standard 2048 forecasts but reflects full build-out in the greenfield growth areas which would occur beyond 2048. The timing for full development build-out is uncertain, however for the purposes of this appraisal the 2048+ model results were allocated to the year 2053, estimated from the typical rate of growth predicted for the area.

Currently, the area adjacent to the SH1, Takaanini state highway interchange and the NIMT is zoned as light and heavy industrial as indicated in **Figure 1-3**. There is slow uptake in development of the eastern section of the industrial area. This land use and number of jobs have been discussed with Auckland Council, Waka Kotahi and AT. Auckland Council wishes to maintain the industrial land use and AT acknowledges the slow land use uptake, which has been reflected in the modelling as discussed below.

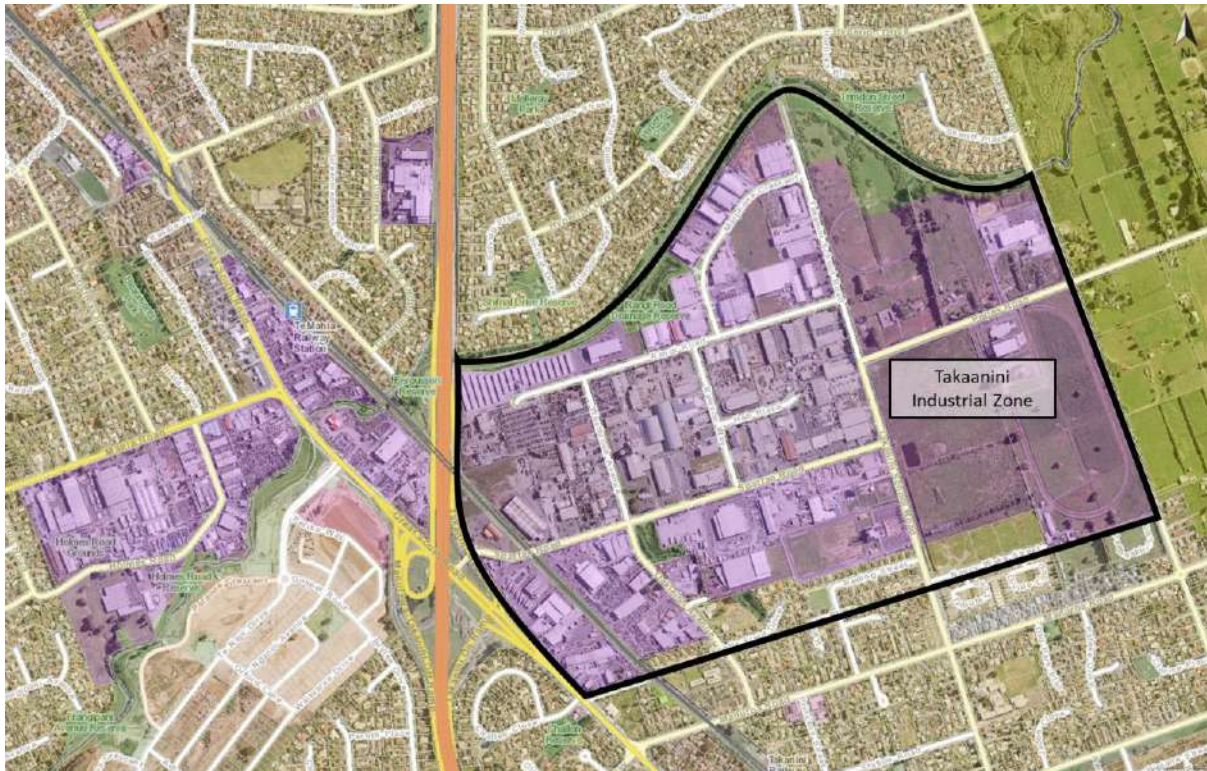


Figure 1-3: Takaanini Industrial Area (AUP:OiP)

The Takaanini industrial area (**Figure 1-3**) land use forecast shows this area as having 1,665 jobs in 2018 (scenario i11.6 land use forecast). The i11.6 land use forecasts predict there will be 9,620 jobs in this industrial zone in 2048+. This predicted employment density is high compared to other established employment areas such as Wiri and Manukau employment zones.

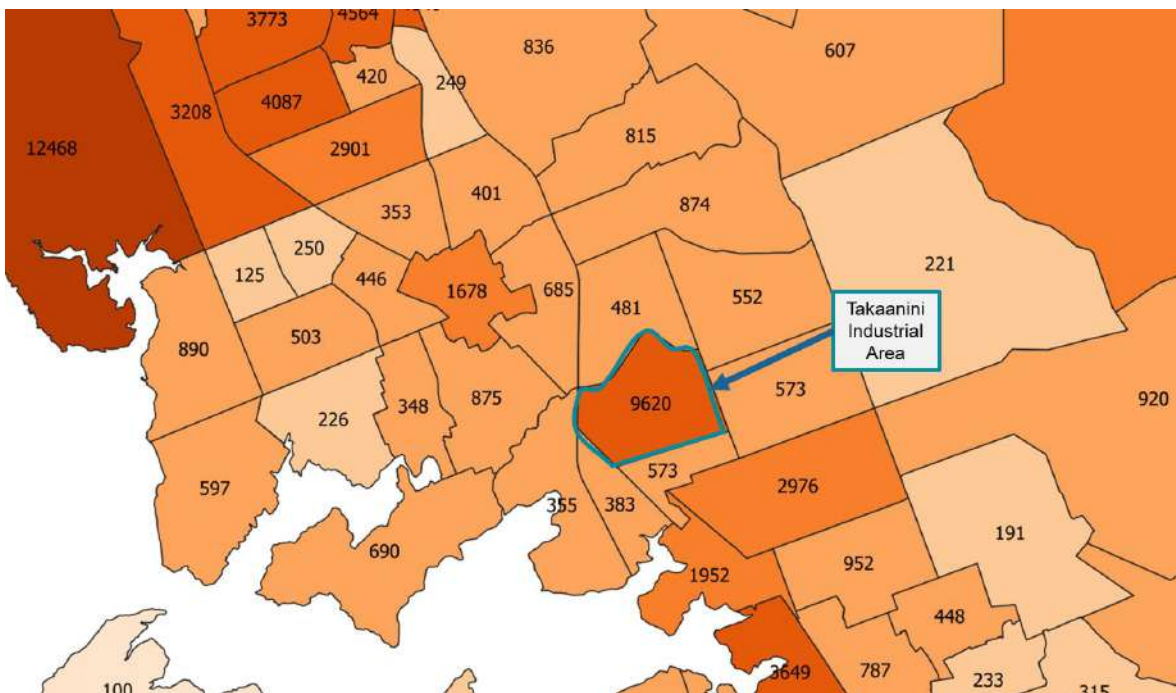


Figure 1-4: Number of jobs in 2048+ (i11.6 land use forecast)

Sensitivity testing was carried out to understand the impacts on the wider network if the forecasted employment growth did not eventuate. On the basis of the assessment, it was assumed that 75% of the forecasted employment growth eventuating is considered an 'aspirational' growth scenario, while 50% of the forecasted growth is considered 'likely'. The 'aspirational' growth scenario was progressed for modelling purposes. Hence an internal adjustment was carried out in SATURN by factoring the vehicle trip matrices, considering only 75% of the trips (in/out) from the industrial zone for all the modelled years. For the PT elements, no adjustments were made in the model as their effects are considered relatively small.

Recommended network and Do Minimum Model Development Process

Due to the interdependencies with other projects in this area, Do Nothing, Do Minimum Closure and Recommended Network scenarios were created for each modelled year, based on a Reference scenario. The Reference scenario included an assumed sequencing of the full IBC network. For example, the 2028 Reference model only included a subset of the DBC networks, while the 2048+ Reference model included the full DBC network

If the project being appraised (e.g. the TLC DBC), was included in the Reference model for the forecast year, then this was used as the Option scenario. A matching Do Nothing and a matching Do Minimum were then created for that year that excluded the project being assessed.

TLC DBC Components Assumptions

The project comprises of five rail crossings (Spartan Road, Manuia Road, Manuroa Road, Taka Street and Walters Road) in the Takaanini area, which are assessed together in this economic analysis as a single stage business case analysis.

The reference option scenario also known as Takaanini recommended network (as in **Figure 1-1**) was adopted as the recommended network, whilst the "Do Minimum Closure" scenario was created by modelling the closure of all level crossings for all modes in the project area. Likewise, the Do Nothing scenario was created by modelling the existing atgrade- level crossings in the project area. The methodology for assessing the delays for the Do Nothing scenario are described in **Section 1.7**. A Staged Do Minimum scenario was then created by assuming the Do Nothing scenario for the earlier years, then gradually transitioning to the Do Minimum Closure scenario for the later years.

The differences between the Recommended network and the Do Minimum or Do Nothing scenarios lies only for the project components as summarised in **Table 1-1**.

The rationale for assuming the closure of the existing level crossings in the Do Minimum Closure and the latter years of the Staged Do Minimum rather than maintaining the at-grade level crossings is detailed in the 'Level Crossings Investment Case' in the DBC report, but a summary is set out below:

- Future growth, increased train services, and four-tracking of the rail corridor will exacerbate the current safety risks.
- Increase in train frequency and barrier-down time will result in adverse east-west connectivity and decreasing levels of service for all users including active modes.
- The existing level crossings limits the potential north-south rail capacity restricting access to economic and social opportunities and rail freight efficiency.

Table 1-1: TLC Scenario Summary

Rail Crossing	Recommended network	Do Nothing	Do Minimum Closure	Staged Do Minimum
Spartan Road	Closed to vehicular traffic (cul-de-sac). New active mode bridge.	As per existing – at-grade level crossing open to all modes.	Closed to all modes (cul-de-sac).	As per the Do Nothing scenario until 2038, then gradually transitioning to the Do Minimum Closure scenario, and then continuing with the full Do Minimum Closure scenario from 2048 onwards. The transition period assumes a staggered closure of level crossings and has been assessed by allocating proportionally less benefits with respect to the Do Nothing case and more benefits with respect to the Do Minimum Closure case between years 2038 and 2048.
Manuia Road	New grade-separated crossing (for all modes) between Great South Road and Oakleigh Avenue.	N/A	N/A	
Manuroa Road	Closed to vehicular traffic (cul-de-sac). New active mode bridge.	As per existing – at-grade level crossing open to all modes.	Closed to all modes (cul-de-sac).	
Taka Street	Grade-separated bridge replacement (for all modes).	As per existing – at-grade level crossing open to all modes.	Closed to all modes (cul-de-sac).	
Walters Road	Grade-separated bridge replacement (for all modes).	As per existing – at-grade level crossing open to all modes.	Closed to all modes (cul-de-sac).	

There are uncertainties around the project implementation year. Hence, some broad assumptions are made on the construction start date based on the expected implementation period. The construction periods were assumed based on advice from the Te Tupu Ngātahi TLC DBC design team, as detailed in **Appendix J** of the DBC. The grade-separated bridges are to be constructed in stages:

- Construction of the bridges at Manuia Road and Walters Road to commence in 2025 with a duration of 3 years,
- The Taka Street bridge construction is expected to commence in 2028 for a duration of 3 years, and
- Construction of the active mode bridges at Manuroa Road and Spartan Road are expected to commence in 2031 for a duration of 1 year.

However, for the simplicity of the assessment a single time zero and construction period is assumed. The ‘time zero’ of 2024 has been calculated backwards based on the construction start period. The ‘time zero’ and the project construction period for TLC DBC projects are given in **Table 1-2**. Due to the construction of two major vehicular crossings (Manuia Road and Walters Road) expected to be completed by 2028, it is assumed that partial benefits will be obtained when these crossings are operational. Hence, the construction period is 7 years and covers the phased construction of the bridges, with these being progressively opened during this period.

Table 1-2: Time Zero, Construction Start Date and Period Assumption

Project Components	Time Zero	Construction Start Year from Time Zero	Construction period (in years)
TLC	2024	2	7

1.3.3 Modelling of the Public Transport Benefits

The PT benefits are directly derived from MSM scenarios for all the modelled years. The MSM PT volume was used to calculate benefits using a simplified approach as discussed in **Section 2.6**.

Although no specific PT intervention is considered as part of the TLC DBC, the removal of the existing at-grade level crossings and their replacement with grade-separated bridges supports the key transport action of ‘improving the reach, frequency and quality of public transport’. The Recommended network also supports walking and cycling (as discussed in **Section 1.3.4**) through the provision of active mode bridges at the vehicular closures (Spartan Road and Manuroa Road) and dedicated facilities where grade-separation is proposed.

The provision of grade-separated bridges over the rail line in Takaanini is expected to contribute limited PT benefits as there are no significant differences between the Recommended network and Do Minimum Closure PT operation, other than improved accessibility between the east-west region served by the local bus. However, it is expected to have increased PT reliability along the FTN route due to reduced traffic pressures on key east-west PT routes such as Alfriston Road which is proposed to have a key function in the Takaanini FTN network.

For the Do Nothing case, the PT benefits are expected to be relatively small as both the Recommended network and Do Nothing scenarios have east-west connectivity and hence the project is not carrying out any specific PT improvement nor is there a requirement to reroute buses. However, the Recommended network is expected to have PT travel time savings compared to the Do Nothing as it will not have the delay and congestion that is present in the Do Nothing due to the rail crossing signals. As a consequence, since the impacts were expected to be small the Do Nothing was not modelled in MSM as it was considered that the resulting PT user, reliability and health benefits would be less than what is expected for the Recommended network with respect to the Do Minimum Closure scenario (which were also expected to be small). Hence, the PT user, reliability and health benefits of the Recommended network with respect to the Do Nothing have not been quantified but the impacts are qualitatively described in **Section 2.6** to **Section 2.8**. Moreover, the Recommended network is also expected to have resilience benefits for rail traffic compared to the Do Nothing, given that incidents at the at-grade level crossings will cause disruptions to rail services which otherwise are not present with grade-separated bridges; these rail resilience benefits have been included in the assessment and are described in **Section 2.9**.

1.3.4 Modelling of Walking and Cycling Benefits

SAMM was run only for the full build-out 2048+ scenario, with benefits allocated to earlier years based on assumed growth profiles. SAMM was run with the full TLC DBC active mode network (Recommended network) and for scenarios without the proposed active mode facilities (Do Minimum Closure and Do Nothing).

Because of the proposed full closure of the crossings in the Do Minimum Closure scenario, the provision of the active mode bridges over the rail line in Takaanini is expected to contribute to walking and cycling benefits as follows:

1. Providing connectivity to existing walking and cycling facilities (such as the Southern Path) and to future walking and cycling facilities along the recommended future FTN route on Great South Road
2. Providing facilities to accommodate for the anticipated uptake of active modes and increased walking and cycling demand
3. Decreasing cycling and walking distances travelled by cyclists and pedestrians due to direct east-west connections across the rail line compared to possible diversion routes if the crossings were closed

Point 3 above is irrelevant to the Do Nothing case as the existing at-grade level crossings already provide direct east-west connectivity. However, given the high frequency rail services in the future, delays due to the extensive barrier-down time may influence cyclists and pedestrians to use alternative routes. This additional delay is discussed in **Section 1.7**.

1.3.5 Modelling of Traffic Benefits

The traffic benefits are calculated from the SATURN South model which covers the region between Manukau and Drury, as shown in **Figure 1-5**. The rail crossing changes as part of the TLC DBC are relatively local, hence decongestion occurring outside of the study area was not captured in the economic appraisal.

Because of the proposed full closure of the crossings in the Do Minimum Closure scenario, the provision of grade-separated bridges over the rail line in Takaanini is expected to contribute to traffic benefits as follows:

1. Providing east-west connectivity between Great South Road and Porchester Road via Manuia Road, Taka Street and Walters Road,
2. Increasing access for future employees in the Takaanini industrial area and residents in the residential areas and future urban zones, and
3. Decreasing driving distance due to direct east-west connections across the rail line compared to possible diversion routes if the crossings were closed.

Point 3 above is irrelevant to the Do Nothing case as the existing at-grade level crossings already provide direct east-west connectivity. However, given the high frequency of rail services in the future, delays due to the extensive barrier-down time may influence drivers to use alternative routes.

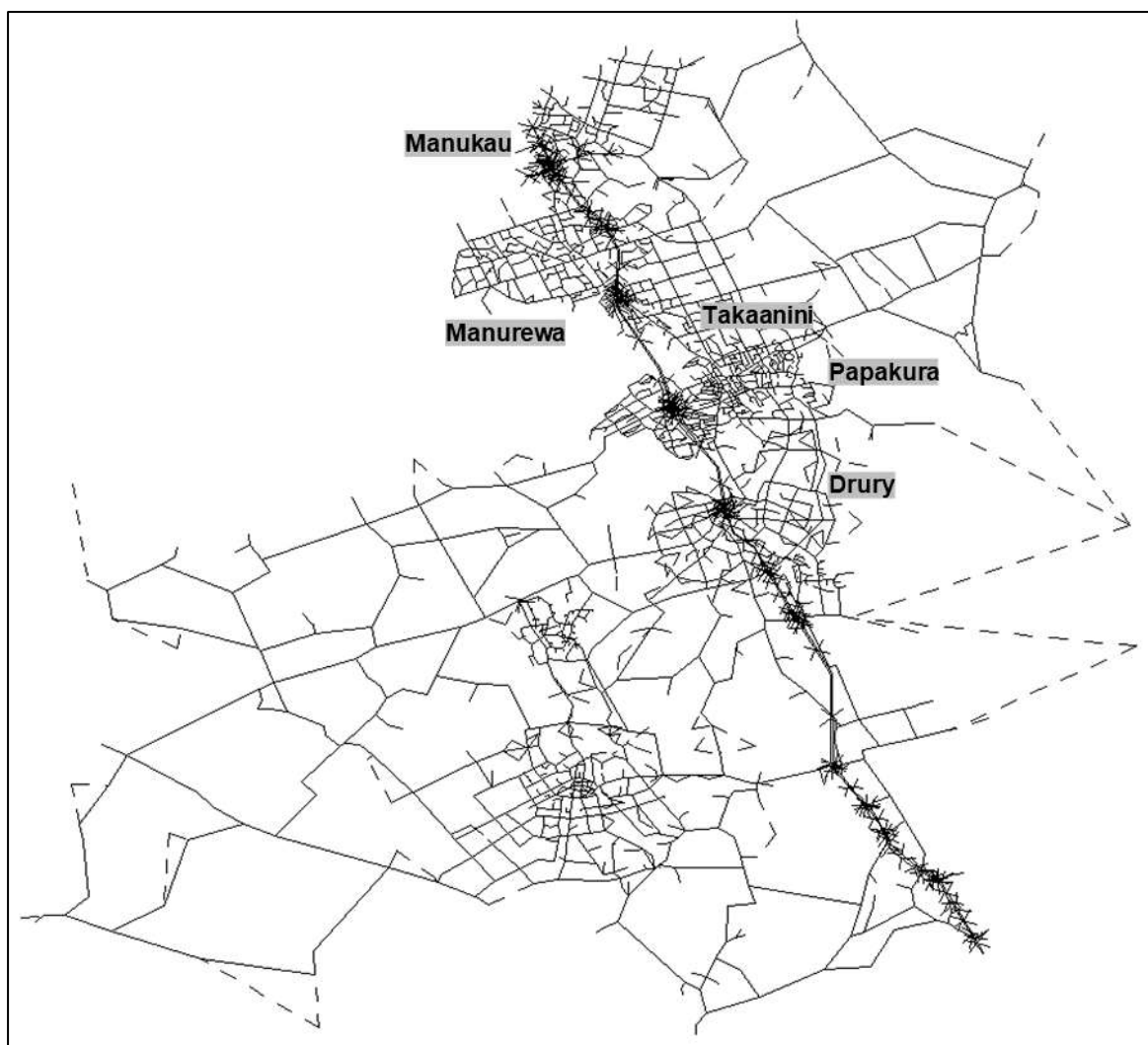


Figure 1-5: SATURN TLC DBC Network

1.3.6 Modelled Scenarios

For the purpose of the economic assessment, scenarios were modelled in MSM and SATURN. Do Minimum Closure and Recommended network scenarios were created for each modelled year (2028, 2038, 2048 and 2048+). For each modelled year, the Do Minimum Closure scenario involves the closure of all level crossings in the Takaanini area, whilst the Recommended network scenario includes the proposed changes presented in **Figure 1-1**. Similarly, for years 2028, 2038, and 2048+, the Do Nothing scenario was modelled in SATURN to maintain the existing at-grade level crossings in the Takaanini area. **Table 1-3** summarises the modelled scenarios and their relevant modelling suites used for the economic assessment. SATURN scenarios are modelled for all years except 2048; as per **Section 1.3.1**, the 2048 SATURN benefits are assessed by interpolation.

These same scenarios were modelled in SAMM for year 2048+. The scenarios were developed by using the land use and network from the relevant MSM scenario, then applying relevant cycle facility updates and zone connector refinements.

Table 1-3: Modelled Scenarios

Scenario	Scenario Description	Modelling Suite(s) Used
Recommended network	Spartan Road and Manuroa Road: level crossings closed with new active mode bridge Taka Street and Walters Road: level crossings closed with grade-separated bridge replacement Manuia Road: new grade-separated connection	MSM (2028, 2038, 2048, 2048+) SATURN (2028, 2038, 2048+) SAMM (2048+)
Do Nothing	Spartan Road, Manuroa Road, Taka Street and Walters Road as existing at-grade level crossings No new connection at Manuia Road	SATURN (2028, 2038, 2048+) SAMM (2048+)
Do Minimum Closure	Spartan Road, Manuroa Road, Taka Street and Walters Road as cul-de-sac, with no active mode bridge No new connection at Manuia Road	MSM (2028, 2038, 2048, 2048+) SATURN (2028, 2038, 2048+) SAMM (2048+)

Note: The Do Nothing was not modelled in MSM as it was considered that the resulting PT user, reliability and health benefits will be less than what is expected for the Recommended network with respect to the Do Minimum Closure scenario. However, PT resilience benefits were assessed in **Section 2.9**, given that incidents occurring at the at-grade crossings (Do Nothing) will cause disruptions to rail services which otherwise are not present with grade-separated bridges (Recommended network).

1.4 Evaluation Framework

The economic evaluation is consistent with the Waka Kotahi NZ Transport Agency's MBCM, 2021.

1.4.1 Economic Evaluation Approach

The overall economic evaluation is based on the following assumptions:

- Basic values of time, vehicle operating costs, etc. are derived from the values set out in the MBCM, updated to current values with a base date of 1 July 2021 using update factors in **Table 1-4**
- Assessment of base and congested (CRV) travel time benefits from the SATURN models due to the reasons detailed in **Section 1.3.5**
- Assessment of base running vehicle operating costs (VOC) from the SATURN models
- Time zero, construction start date and duration specified as in **Table 1-2**
- Analysis period is 40 years, but sensitivity tested at 60 years
- Discount rate of 4% applied to all annual benefits and costs, but sensitivity tested for 3% and 6%
- Traffic reliability benefits assumed as 8% of the base travel time benefit, as a standard approach for the Do Minimum Closure. For the Do Nothing, due to unreliability and delay involved in the barrier-down time the traffic reliability percentage is estimated as 25% as demonstrated in **Section 2.2**, but a lower percentage of 20% was adopted.
- PT reliability benefits was assumed to be 70% of PT user benefits in the commuter peaks and 70% in other periods due to unreliability on other diversion routes

- Carbon dioxide (CO₂) benefits are calculated from the vehicle emission prediction model (VEPM) version 6.3, with (upper bound) rates as per the MCBM and specified in **Table 2-8**.
- Travel time user cost is based on urban arterial road type as per Table 16, MCBM. The Sector-Sector traffic benefits calculation as in **Appendix 1** shows that there is negligible benefits due to the trips between External North and External South Zones illustrating that the rural strategic type trips are unaffected.
- Walking and cycling benefits were estimated based on trip demand and travel cost matrices from SAMM, using the same method as used for PT benefits in MSM, and using the same approach as the Rail and Drury DBCs.
- As a sensitivity test, WEBs calculated, in accordance with the MCBM, then applied to the project using an adopted percentage uplift to the conventional benefits. The analysis is done for three principal types of WEBs (agglomeration impact, imperfect competition impact, and labour supply impact).
- Since the crossings are constructed in phases, the benefits start date have been phased out accordingly. It is assumed that upon implementation of the Manuia Road and Walters Road grade-separated bridges 70% of the total benefits can be realised by 2028 since two out of three vehicular crossings are operational. It is assumed that 95% of the benefits can be realised on implementation of the third vehicular crossing in 2031 and full benefits realised in year 2032 on construction of Spartan and Manuroa active mode bridges.
- Beyond the 2048+ modelled year (assumed to be allocated to year 2053) benefit growth is dampened out over 10 years and there after assumed to remain constant with no further benefits growth. **Figure 1-6** shows the benefits profile for a 40-year analysis period (for the Do Minimum Closure case) to demonstrate how benefits are treated over time. The earlier year benefits are staggered since as discussed above it is assumed that partial benefits can be realised upon the completion of construction of the Manuia Road and Walters Road grade-separated bridges.

Table 1-4: Update Factors for Benefits

Item	Base date	Update factor to 2021
Travel time costs	July 2002	1.59
Vehicle operation costs	July 2015	1.15
Crash cost savings	July 2015	1.10
Passenger transport user benefits	July 2008	1.28
Walking and cycling benefits	July 2018	1.06

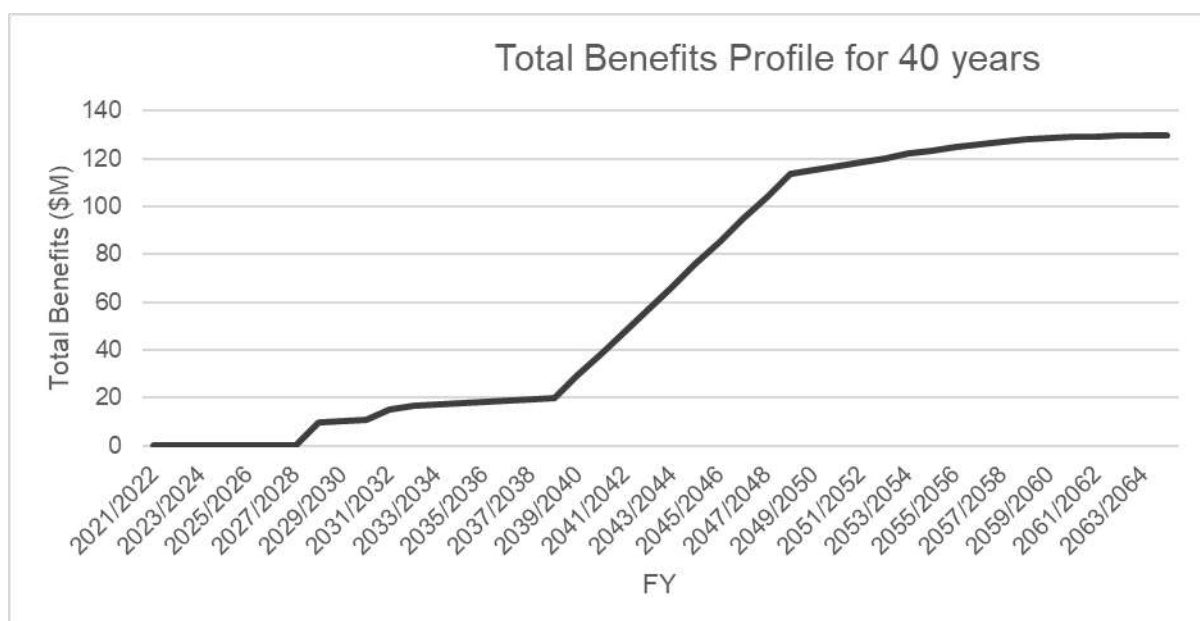


Figure 1-6: 40-Year Benefits Profile (Recommended network vs. Do Minimum Closure)

1.5 Expansion of Benefits from Transport Models

Annualisation factors for private transport are shown in the following tables. The below factors are based on analysis of current traffic patterns.

Table 1-5: Traffic Annualisation Factors (1-hour SATURN Models)

Period	Modelled period used	Equivalent hours per day	Days per year
Weekday AM	AM	2	245
Weekday PM	PM	2	245
Weekday Interpeak	IP	7.2	245
Weekday evening / night	IP	3.9	245
Weekend / holiday	IP	13	120

A different set of factors was used for PT indicators, as its usage profile is different from private cars.

Table 1-6: PT Annualisation Factors (2-hour Models)

Modelled Period	Annual factor
AM	245
IP	1524
PM	245

SAMM provides daily estimates of travel, therefore an expansion factor of 365 was assumed.

1.6 Analysis Period

The economic analysis was carried out for a 40-year analysis period as a base estimate, but sensitivity tested for 60 years.

1.7 Do Nothing Delay Calculations

This section describes how the delay from the existing at-grade level crossing signals were modelled in the Do Nothing scenario.

1.7.1 Pedestrian Delay

Pedestrian delay was assessed using Pretty's method¹, based on uniform arrival rates and equal pedestrian phases:

$$d_1 = \frac{P}{2C} (C - w)^2$$

where:

d_1 = total delay to pedestrians crossing one street;

P = pedestrian volume crossing one street;

C = cycle length; and

w = walk time.

The assessment focussed on delay per pedestrian and hence set P to 1 in the calculations. The cycle length (i.e. the headway between trains, assuming 24 trains per peak hour as indicated by the CRL rail plan provided by AT) was estimated to be 2.5 minutes and the barrier-down time per cycle was assumed to be 1.6 minutes, giving an estimated walk time of 0.9 minutes. This yielded an estimated 30 seconds of delay per pedestrian at the existing at-grade level crossings in the Do Nothing scenario. This was included in the SAMM for the Do Nothing scenario by adding a delay of 1 minute to each of the at-grade rail crossings and applying a perception factor to the estimated delay.

1.7.2 General Traffic Delay

Delay to general traffic was assessed using the bottleneck model and subsequently approximately replicated in SATURN by adjusting the capacity at the at-grade level crossings.

The CRL rail plan (provided by AT), indicated 24 trains per peak hour and 12 trains per off-peak hour were operating on the southern rail line, between Puhinui and Pukekohe, in 2031. A range of barrier-down times of 1.5 and 1.6 minutes were assumed for each time a train passes in the network. This indicated that the barriers at the Takaanini level crossings may be down for 61% to 64% of the peak hour, and 30% of the interpeak. Given these barrier-down times, the maximum capacity is between 500 and 580 vehicles per peak hour at the crossings, and 1,000 vehicles per interpeak hour. These capacities were modelled in the 2048+ Do Nothing SATURN model which gives the flow and delay at the rail crossings as tabulated in **Table 1-7**. These capacities and delays are highly dependent on the number of trains running and the barrier-down time. There lies a lot of uncertainty in these capacities and delays as the rail plan is being regularly updated. Hence, it is acknowledged that

¹ Pretty's method (<https://www.fhwa.dot.gov/publications/research/safety/pedbike/98107/section4.cfm>)

the level crossing capacities in the model may not be precise, but the uncertainties in the indicative BCR are covered in the sensitivity tests undertaken on the traffic benefits (see **Section 4.2.2**).

Table 1-7: Delay and Flow at the Rail Crossings – Year 2048+

Rail Crossing	Direction	Vehicle Flow (veh/hr)			Average Delay per Vehicle (minutes)		
		AM	IP	PM	AM	IP	PM
Spartan Road	Eastbound	256	522	257	1.55	1.59	3.14
Manuroa Road		309	534	286	0.90	0.84	1.63
Taka Street		250	119	230	0.45	0.04	0.51
Walters Road		163	196	304	0.18	0.09	0.62
Spartan Road	Westbound	127	218	116	3.78	0.69	4.14
Manuroa Road		408	378	484	1.67	0.44	1.78
Taka Street		406	283	298	1.08	0.19	0.64
Walters Road		403	376	488	0.34	0.11	0.59

2 Benefits Analysis and Discussion

The benefits analysed for the TLC DBC economic assessment are discussed below, and the outcome is enumerated in **Section 4**.

2.1 Traffic Travel Time and Congestion Savings

The travel time costs have been calculated based on the matrix-based SATURN outputs. The travel time components include:

- Base travel time; and
- Congested travel time (defined as 'CRV' in the MBCM).

The base travel time applies to the total travel times, whereas the CRV has been applied to the mean delay time from the transport model outputs. In theory, CRV should be applied to where the CRV value has been applied to sections of road deemed congested, such as:

- Urban roads in the model which use the methodology for urban roads, whereby CRV only applies to links with a volume to capacity (V/C) ratio greater than 70%; and
- All bottleneck delay, such as intersections.

However, due to the nature of the matrix-based outputs, the CRV has been applied to all the mean delay time calculated by the transport models, due to the inability to distinguish individual V/C on each section of road for each origin-destination pair. This is deemed to be acceptable given minimal delays at V/C ratios lower than 70%.

2.2 Traffic Reliability Benefits

Travel time reliability can generally be improved by upgrading the road network, improving connectivity and improving PT services. For the Do minimum Closure scenario, traffic reliability was assumed to be 8% of the travel time benefits, as per the standard approach with other South Te Tupu Ngātahi business cases. However, it is acknowledged that with increased frequency of barrier closures and increasing traffic flows on the crossings, the variability of making east-west movements over the rail corridor will significantly increase, as such, adopting this common assumption would likely underestimate the full reliability benefits.

The traffic reliability for the Recommended network over the Do Nothing is expected to be higher than the standard reliability percentage due to the additional reliability offered by the grade-separated crossings. The at-grade level crossings are highly unreliable due to unpredictable barrier-down time and delays and queueing related to the rail crossing signals. Hence, trip time reliability for the Do Nothing is estimated by the methodology provided in the MBCM (Process for evaluating reliability benefits – page 139). The standard deviation (SD) for delay has been estimated using a bottleneck model and applied to the formula:

$$\text{Reliability} = \text{SD} \times 0.9 \times \text{correction factor}$$

A correction factor of 0.3 is used (Table 73, MBCM) given that the crossings represent only a small part of typical journeys. The bottleneck model was used to estimate average and standard deviation of crossing delays at varying levels of traffic flow. Trip time reliability was then calculated from these standard deviations and divided by the average delay to identify reliability benefits as a proportion of

travel time benefits. The reliability percentages are higher for lower traffic flows but decreases with increased traffic flows due to congestion, until a point where the network is congested and further variation in delay is not possible. The traffic reliability at the rail crossings is predicted to be 25% for the general range of traffic flows expected at the crossings between 500 and 600 vehicles per hour in the peak periods. However, a lower reliability percentage of 20% has been adopted as network-wide traffic reliability (rather than the commonly used 8%).

Table 2-1 shows the range of flow and reliability.

Table 2-1: Traffic Reliability % estimated from bottleneck model

Flow, vph	Delay, min	STD, min	Reliability	Reliability/Time (Reliability %)
100	0.7	0.693765	0.187317	27%
200	0.6	0.63305	0.170924	27%
300	0.7	0.630424	0.170214	26%
400	0.9	0.859868	0.232164	26%
500	1.0	0.894577	0.241536	23%
600	1.5	1.011883	0.273208	19%
650	2.6	1.465179	0.395598	15%
700	5.3	3.475545	0.938397	18%
750	9.0	6.008303	1.622242	18%
800	10.6	7.266978	1.962084	18%

2.3 Vehicle Operating Costs

VOC for private travel were estimated based on applying running costs (from the MBCM) to the SATURN model outputs. PT operating costs were included as a system cost item (rather than user cost).

2.4 Active Modes Benefits

The active modes benefits were calculated from SAMM based on the change in demands and generalised costs (the same method used for PT benefits from MSM). The road sections where cycling facilities are upgraded and designated as buffered or protected cycle lane in the Recommended network scenario are shown in the cycle facility map in **Figure 2-2** below and are measured against the Do Minimum Closure scenario where the existing level crossings are closed and the new cycle facilities are excluded (i.e. except those present in the base year) as in **Figure 2-1**. The Do Nothing scenario was also modelled, which has the same active mode network as the Do Minimum Closure scenario but with the at-grade level crossings and rail crossing signals still in place.

The key difference in cycling facilities between the Recommended network and the Do Minimum Closure scenario is that the Recommended network includes active mode facilities across the rail line at Spartan Road, Manuia Road, Manuroa Road, Taka Street, and Walters Road.

The key difference between the Recommended network and the Do Nothing scenario is that the Recommended network includes an east-west connection across the rail line at Manuia Road. The existing at-grade level crossings in the Do Nothing also cause additional delay (as described in **Section 1.3.4**) due to the rail crossing signals, which are not present for the grade-separated crossings in the Recommended network.

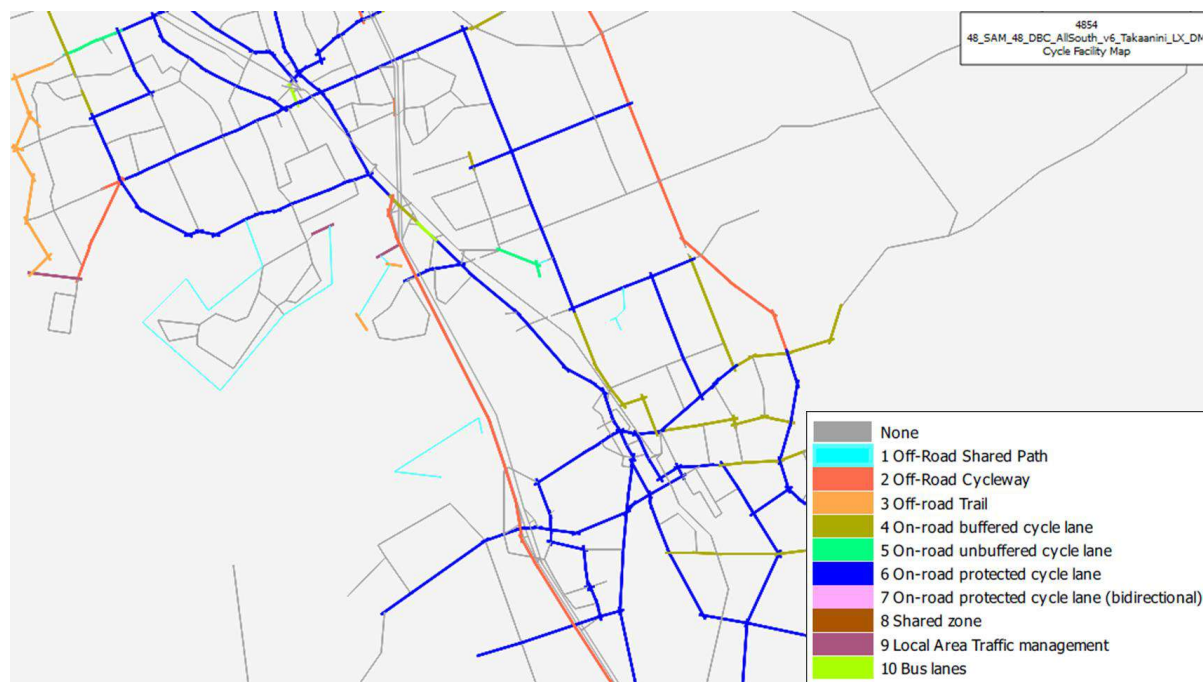


Figure 2-1: Cycle Facilities for Do Minimum Closure Scenario in 2048+

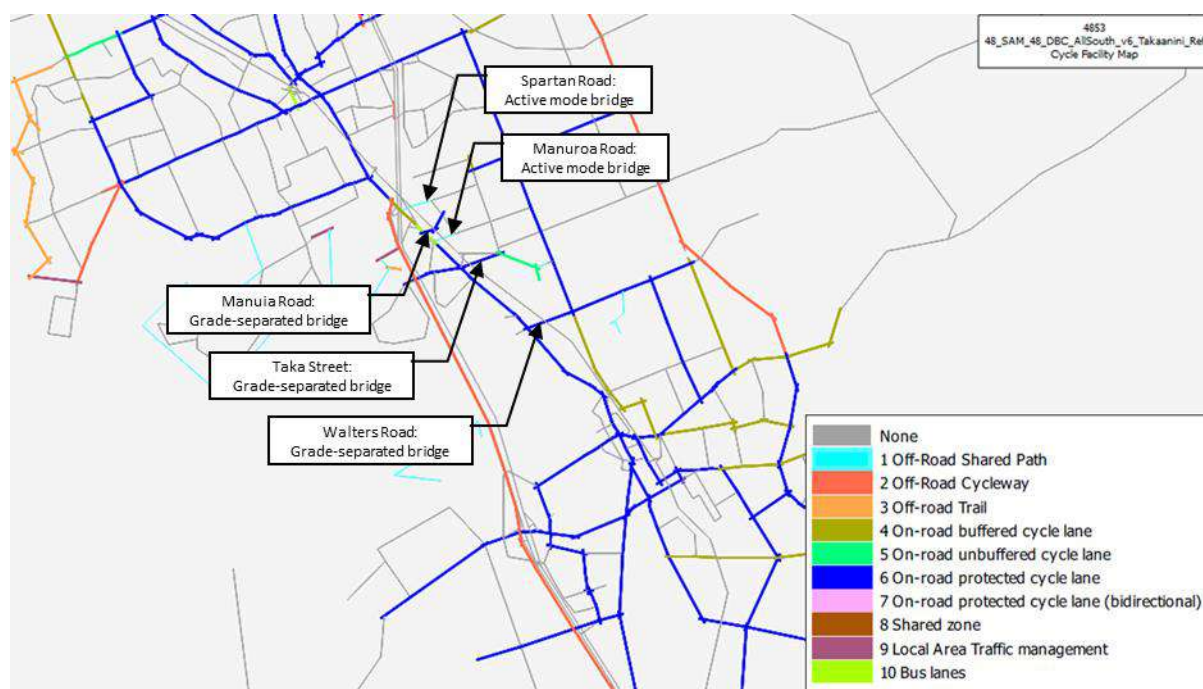


Figure 2-2: Cycle Facilities for Recommended network Scenario in 2048+

There are various components to the active modes benefits as shown below:

2.4.1 Travel Time Benefits

The user travel cost benefits were assessed using the demand and perceived costs matrices in SAMM. They are split into two purposes: home-based work (HBW) and other (including home-based education (HBE), home-based other (HBO), and non-home-based). The value of time (VoT) used for the HBW purpose is \$7.80 per hour and for non-work travel purpose is \$6.90 per hour, which are then multiplied with the update factor of 1.59 (year 2021).

The provision of active mode bridges at Spartan Road and Manuroa Road and their exclusivity to active modes leads to travel time savings for the cyclists and pedestrians. It is expected to obtain reasonable travel time savings for the active mode users in Takaanini due to the provision of grade separated active mode bridge to cross the rail line and facilitating better connectivity. The active modes travel time benefits are shown in **Table 2-2**. Differences in the quality of routes are reflected in the attributes incorporated in SAMM which are similar to those included in the MBCM.

Table 2-2: Active Modes Travel Time Benefit – Year 2048+

Mode	Base	Option	Benefits (generalised minutes)		VoT (\$/hr)		Update Factor	Annual Factor	Annual TT Benefit (\$M)		
			HBW	Other	HBW	Other			HBW	Other	TOTAL
Cycle	DM Closure	Preferred	1,511	2,376	\$7.80	\$6.90	1.59	365	0.11	0.16	0.27
Walk	DM Closure	Preferred	5,217	41,460	\$7.80	\$4.49	1.59	365	0.39	1.80	2.19
Cycle	DN	Preferred	467	710	\$7.80	\$6.90	1.59	365	0.04	0.05	0.08
Walk	DN	Preferred	123	-246	\$7.80	\$4.49	1.59	365	0.01	-0.01	0.00

Note: The value of time for the Walk Other trips has been reduced by 35% of the MBCM recommended to account for the TDM effect in MSM (conversion of a proportion of mechanised short trips (shorter than 3 km) to active mode trips in MSM turned off for HBO trips. This has been agreed during the Drury local peer review process as the reviewer considered Walk Other purpose benefits to be potentially overstated relative to HBW purpose. Additionally, for evaluation purposes the walk trips beyond 6 km and cycle trips beyond 30 km were removed to avoid particularly long trips.

Compared to the Do Nothing, the walking distances across the rail line via Spartan Road or Manuroa Road are longer in the Recommended network due to the additional walking distance added by the ramps for the proposed active mode bridges. Because of this increased walking distance in the Recommended network and the delay from barrier-down time in the Do Nothing, the walking travel time benefits are negligible with respect to the Do Nothing.

2.4.2 Health, Safety and Decongestion Benefits

Road traffic reduction and health benefits were estimated from the change in the amount of walk- and cycle-km as obtained from SAMM. The walk- and cycle-km were calculated in SAMM by multiplying the walk and cycle trips with the walk and cycle distance travelled, respectively. The change in predicted walk- and cycle-km is multiplied with the cyclist (\$2.20 per cyclist per km) and pedestrian (\$4.40 per pedestrian per km) composite benefit factors, as obtained from the MBCM. These are updated to year 2021 by applying the update factor of 1.06.

The decongestion benefits obtained due to cycling are calculated by multiplying the change in cycle-km by the road traffic reduction factor and the number of car users who experience mode shift. It is calculated as the ratio of car diversion rate for cycle (65%) and car occupancy (1.2 persons). The

road traffic reduction factor of \$1.54 per vehicle per km was obtained from the MBCM, but because SAMM only provides daily demand this was reduced by 50% to make allowance for lower decongestion outside the peak periods. The safety benefits for cyclists are obtained by multiplying the cycle-km with the safety factor of \$0.05 as obtained from MBCM SP11, year 2021². The TLC active modes health, safety and decongestion benefits are shown in **Table 2-3**.

Table 2-3: Active Modes Health, Safety and Decongestion Benefit – Year 2048+

Mode	Base	Option	Km Increase	Health factor	Safety Factor	Update Factor	Benefits (\$M)		
							Health	Safety	Decongestion
Cycle	DM Closure	Preferred	1,229	2.2	0.05	1.06	1.05	0.03	0.24
Walk	DM Closure	Preferred	1,445	4.4	-	1.06	2.46	-	-
Cycle	DN	Preferred	525	2.2	0.05	1.06	0.45	0.01	0.10
Walk	DN	Preferred	-640	4.4	-	1.06	-1.09	-	-

Compared to the Do Nothing, the increased walking distance at Spartan Road and Manuroa Road (due to the ramps to the active mode bridges) in the Recommended network is unattractive to pedestrians, resulting in a reduction in pedestrians using the bridges. Hence, the walking health, safety and decongestion benefits are negative for the Recommended network with respect to the Do Nothing.

The active modes benefits were assessed from SAMM for year 2048+, with benefits of earlier years being assessed as a proportion of the 2048+ benefits, based on the population data of zones (using land use scenario i11.6) affected by the active modes network. The assumed proportions for the interim years are as follows:

- 2028 = 60%
- 2038 = 65%
- 2048 = 70%
- 2048+ = 100%

2.5 Crash Cost Savings

Crash reduction benefits were estimated using average crash costs per vehicle kilometres travelled (VKT) for different road categories, as used in the IBC. This captures both changes in the total VKT (e.g. from mode shift) and from shifting traffic between different road categories. The crash rates used were calculated based on the total recorded crashes in the Auckland region between 2013 and 2017 and the VKT by road type and speed from the 2016 MSM regional model which are outlined below in **Table 2-4**.

² The safety factor has no reference in recent MBCM but is present in the SP11 calculation worksheet. It has reference in Economics Evaluation Manual (EEM) 2018 with value dated year 2008. Hence it was updated with update factor 1.28 as per Table 1-4.

Table 2-4: Crash Costs by Road Type and Speed

Road Type	Speed	Veh-km (millions/year)	Crash Cost (\$M/year)	Cents/Veh-km
Motorway	All speeds	4,687.6	126.2	2.69
Arterial	<80	4,659.8	525.7	11.28
	>=80	68.97	10.0	14.56
Local	All speeds	1,698.8	139.6	8.22
Rural	<80	486	21.5	4.43
	>=80	1,390	242.7	17.46
All categories		12,991.3	1065.9	8.20

For the Recommended network compared to the Do Minimum Closure, the network-wide crash cost savings are obtained by multiplying the veh-km savings from the MSM models with the crash rate and then updated to year 2021 by applying the update factor of 1.10. It is expected to have substantial crash cost saving due to the shorter and direct access between Great South Road and Porchester Road facilitated by grade-separated level crossings. The veh-km savings is translated to crash cost savings as shown in **Table 2-5** below.

For the Recommended network compared to the Do Nothing, given that the existing at-grade level crossings already provide direct east-west connections, the network-wide crash cost savings are expected to be lower than when compared to the Do Minimum Closure case and hence were obtained by taking a proportion of the latter's crash cost savings.

However, given the safety risks expected to arise from the high frequency rail services in the future, there will likely be additional crash cost savings specifically for the railway crossings i.e. from the removal of the existing at-grade level crossings and their replacement with grade-separated bridges removing any possible interactions between road users and rail vehicles. Hence for the Recommended network compared to the Do Nothing, in addition to the network-wide crash cost savings, railway crossing-related savings were estimated using a crash rate analysis for urban railway crossings as per the MBCM and Crash Estimation Compendium.

To calculate the railway crossing-related savings with respect to the Do Nothing, the typical crash rate was calculated using the coefficients for half-arm barriers from the Crash Estimation Compendium, traffic volumes taken from SATURN, and assumed daily train volumes. It was assumed that there will be 18 trains per peak hour in 2028 and 24 trains per peak hour in 2038, 2048 and 2048+, with 8 trains per (operational) off-peak hour across all four modelled years. The calculated cost rates were converted to crash cost savings by multiplying with an assumed cost of \$580,000 per reported injury, as per Table A36 in the MBCM. This cost per injury is intended for use for "all other sites" in a "100km/h near rural" speed environment, however it was deemed appropriate for the present analysis as there was no specific value for an urban railway crossing site and, although the road corridors of interest have a 50km/h speed limit, the trains will be travelling at much higher speeds. These cost savings were then updated to year 2021 by applying the update factor of 1.10.

Table 2-5: Crash Cost Savings for the Modelled Years

Year	Crash Cost Savings (\$M)	
	Recommended Network – Do Minimum Closure	Recommended Network – Do Nothing
2028	2.01	0.63
2038	2.42	0.75
2048	3.91	1.18
2048+	4.62	1.39

2.6 Public Transport Users Benefits

There is no change in the PT services between the Recommended network and Do Minimum Closure scenarios apart from the rerouting of bus services travelling across Taka Street to Walter Strevens Drive. It is assumed that with the Taka Street closure in the Do Minimum these bus services will travel to Manurewa via Porchester Road and Alfriston Road. The benefits arising due to an increase in PT patronage on the western side of Taka Street is expected to be relatively small.

With respect to the Do Minimum Closure case, the PT benefits of the Recommended network are estimated by multiplying the value of time (as obtained from the MBCM) of each trip purpose to the passenger hours obtained from MSM. The value of time used for HBW purpose is \$7.80 per hour, for work travel purpose is \$23.85 per hour, and for other non-work travel purpose is \$6.90 per hour; these were then updated to year 2021 by applying the update factor of 1.59.

However, both the Recommended network and Do Nothing scenarios have east-west connectivity hence the project is not carrying out any PT improvement nor is there a requirement to reroute buses. In both scenarios, the bus services are expected to operate the same. It is also expected that there is no effect on rail patronage as access to train stations does not change between the Option (grade-separated bridges) and the Do Nothing (at-grade level crossings). In contrast, some PT user benefits are expected for the Recommended network with respect to the Do Nothing as there will be travel time savings from having no delay and congestion that is otherwise present in the Do Nothing due to the rail crossing signals. However, these is considered to be small and hence the potential PT benefits have not been included.

2.7 Public Transport Reliability Benefits

For the Recommended network compared to the Do Minimum Closure case, the grade-separated bridges over the rail line are expected to improve overall network PT reliability by avoiding route diversions of traffic along the FTN routes of Porchester and Alfriston corridors. These FTN corridors are expected to perform with greater reliability as the delay and congestion decreases along these corridors. The PT reliability of 70% of PT user benefits is assumed for all peaks, maintaining consistency with other Te Tupu Ngātahi South business cases for peak periods. The inter-peak reliability is assumed to be same as commuter peaks as without the bridges, unreliability effects are expected for all day. Since the PT travel times benefits are minimal, sensitivity tests on the PT reliability percentage are not considered necessary.

As with the PT user benefits described in **Section 2.6**, it is recognised that there will be some PT reliability benefits for the Recommended network with respect to the Do Nothing due to faster and more reliable bus services with the removal of delay and congestion from the rail crossing signals, but since the Do Nothing was not modelled in MSM these were assumed to be zero.

2.8 Public Transport Health Benefits

For the Recommended network compared to the Do Minimum Closure case, a certain amount of health benefits was also obtained from the PT walk trips (trips that walk to the stops or stations to access PT services) predicted from MSM. The provision of active mode facilities across the rail line provides increased PT accessibility by providing east-west direct connection across the rail line compared to possible diversion routes if the crossings were closed. However, the direct access across the rail line provided by the active mode facilities and the shorter bus routes leads to shorter walk distances accessing buses, which results in negative health benefits (against the Do Minimum Closure case) as shown in **Table 2-6** below.

Table 2-6: PT Stop/Station Walk Trips Health Benefits from MSM – Year 2048+ (against Do Minimum Closure case)

Health Factor	Update Factor	Daily km Increase	Annual Health Benefits (\$M)
4.4	1.06	-754	-1.28

As with the PT benefits described in **Section 2.6** and **Section 2.8**, it is recognised that the presumably faster and more reliable bus services in the Recommended Option will give rise to some increases in patronage, with respect to the Do Nothing. However, the Do Nothing was not modelled in MSM and hence the PT health benefits for the Recommended network are also assumed to be zero with respect to the Do Nothing case.

2.9 Public Transport Resilience

The project is expected to obtain resilience benefits to the rail service, due to safer and reliable grade-separated crossings. For major incidents (e.g. trespassers on the tracks, broken barrier arms, malfunctioning gates), disruptions to the rail services are expected, forcing them to close until the incidents have been addressed. It is assumed that there could be 5 incidents or crashes a year (involving vehicles and/or pedestrians) in the Do Nothing scenario, and 0.5 incidents a year (involving pedestrians) in the Do Minimum Closure scenario that would cause disruption to the rail services. This assumption is based on the Takaanini crossing fault data received from Kiwi Rail. As per the data, there are 233 maintenance incidents, 2 pedestrian and 67 vehicular incidents that led to the closure of level crossings, occurred in a 10-year period (2013 to 2022). MSM scenarios were modelled with the rail service closures and the benefits were calculated for the aforementioned number of incidents. **Table 2-7** shows the PT resilience benefits.

Table 2-7: PT Resilience Benefits from MSM – Year 2048+

Item	Annual PT Resilience Benefits (\$M)
Recommended Network – Do Nothing	4.63

Item	Annual PT Resilience Benefits (\$M)
Recommended Network – Do Minimum Closure	0.46

2.10 Carbon Dioxide Emissions

The CO₂-equivalent emissions are calculated from SATURN models using the VEPM 6.3 emission rates. The difference between the Recommended network and Do Minimum Closure or Do Nothing models gives the emission impact due to the project.

Compared to the Do Minimum Closure case, the grade-separated bridges in the Recommended network increase east-west permeability in the Takaanini network by providing shorter and direct route. It is expected to obtain CO₂ savings from this project due to shorter routing and reduced congestion in the network.

Compared to the Do Nothing case, the grade-separated bridges in the Recommended network removes the delay from the rail crossing signals for the existing at-grade level crossings. It is expected to obtain CO₂ savings from this project due to reduced congestion in the network.

The TLC DBC projects reduces the yearly level of emissions as seen in **Table 2-8**. The economic benefit of the emissions is calculated by multiplying the social cost per CO₂ tonne emitted as per the higher values in the range provided in the MBCM.

Table 2-8: Annual Emission Benefits for the Modelled Years – TLC DBC

Year	Social Cost of CO ₂ (\$/tonne)	Annual CO ₂ -equivalent Emission Savings (tonnes)		Annual Emission Cost Savings (\$M)	
		Recommended Network – Do Nothing	Recommended Network – Do Minimum Closure	Recommended Network – Do Nothing	Recommended Network – Do Minimum Closure
2028	143	1,587	10,204	0.23	1.46
2038	178	2,281	10,713	0.41	1.91
2048	222	2,183	8,298	0.48	1.84
2048+ ³	246	2,134	7,090	0.52	1.74

Other emissions like volatile organic compounds, NO_x and particulates were assessed and it was found that the emission savings were comparatively insignificant.

2.11 Wider Economic Benefits

Given the scale of the proposed improvements and its impact in the future urban mobility in the area, it was deemed likely that there would be significant WEBs. The WEBs were initially assessed using

³ The social cost of CO₂ used for 2048+ is the upper bound value for year 2053, extrapolated from the values provided in the MBCM.

the MBCM procedures from the 2048+ Do Minimum Closure MSM model. After consideration of the results, a method was adopted that involved a fixed uplift in the conventional transport benefits.

The analysis is done for three principal types of WEBs:

- Agglomeration impact;
- Imperfect competition impact; and
- Labour supply impact and more productive jobs impact.

The total WEBs evaluated for the TLC DBC are shown in **Table 2-9**.

Table 2-9: WEBs by Type Determined from MSM Models 2048+

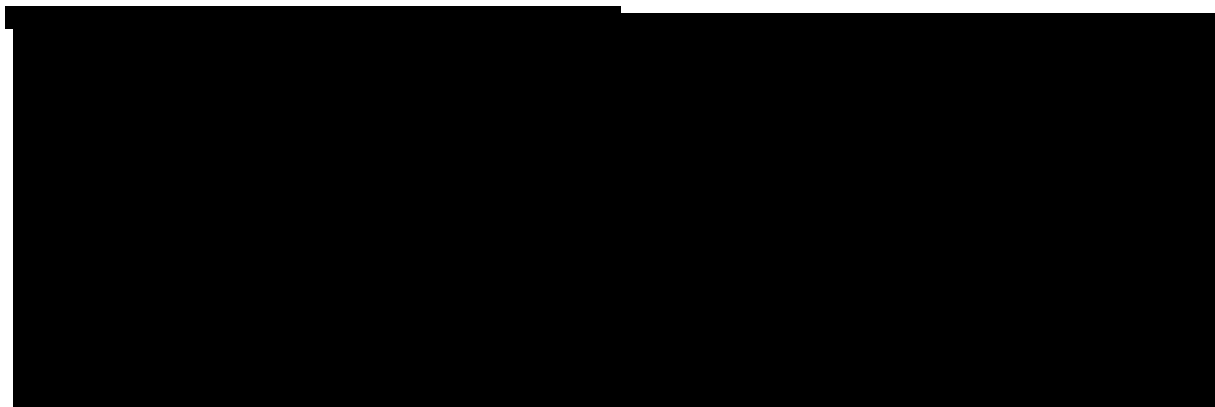
Item	Benefits (\$M)
Agglomeration Impact	11
Imperfect Competition impact	7.85
Labour Market Impact	0.087
Total WEBs	18.93
WEBs Percentage	16%

As shown above, the WEBs for the comparison with the Do Minimum Closure case was estimated as 16%. However, based upon feedback from the peer review process the nature of the TLC DBC proposals has a limited case for including WEBs in the analysis as the MBCM states that only the most significant infrastructure improvements are likely to generate WEBs. As agreed with the peer reviewer, a sensitivity test was undertaken (for the Do Nothing, Do Minimum Closure, and Staged Do Minimum cases) to include WEBs by adopting 5% uplift over the conventional benefits (for each year). 5% for WEBs would include only imperfect competition benefits and exclude agglomeration and labour supply benefits and hence was considered an appropriate assumption for the present economic appraisal.

3 Project Costs

3.1 Capital Cost

The economic analysis used the expected costs (P50) as a base estimate, but sensitivity tested with P95 costs. **Table 3-1** summarises the cost estimates for the TLC DBC. It was assumed that for the Do Minimum Closure scenario, a separate contractor will undertake the works for closing the rail crossings hence the costs for converting the affected corridors to cul-de-sacs were excluded from the present economic appraisal. Therefore, the capital costs for the Recommended network are assumed the same with respect to both Do Minimum Closure and Do Nothing scenarios.

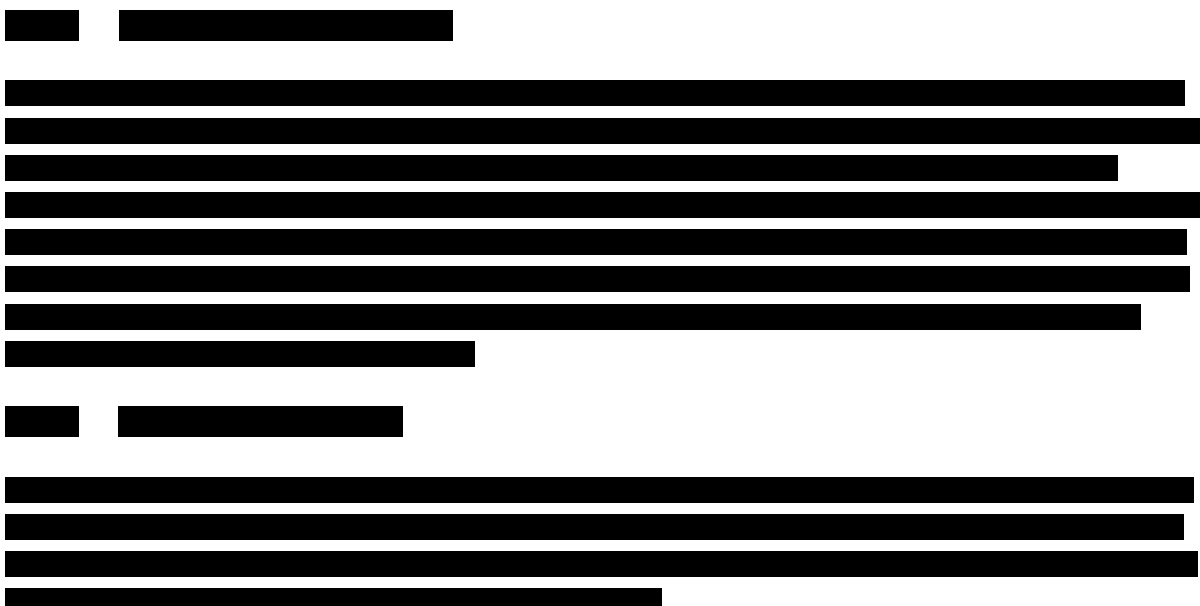


The contingency assumptions for the capital costs are detailed in **Appendix J** of the DBC but a summary is provided here:

- Capital costs include a 25% contingency (P50) and a funding risk contingency (P95) of 20%.
- Property costs include a 15% contingency (P50) and a funding risk contingency (P95) of 20%.

3.2 Operation and Maintenance Costs

Operating and maintenance costs were assessed below and summarised in **Table 3-2**.



[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

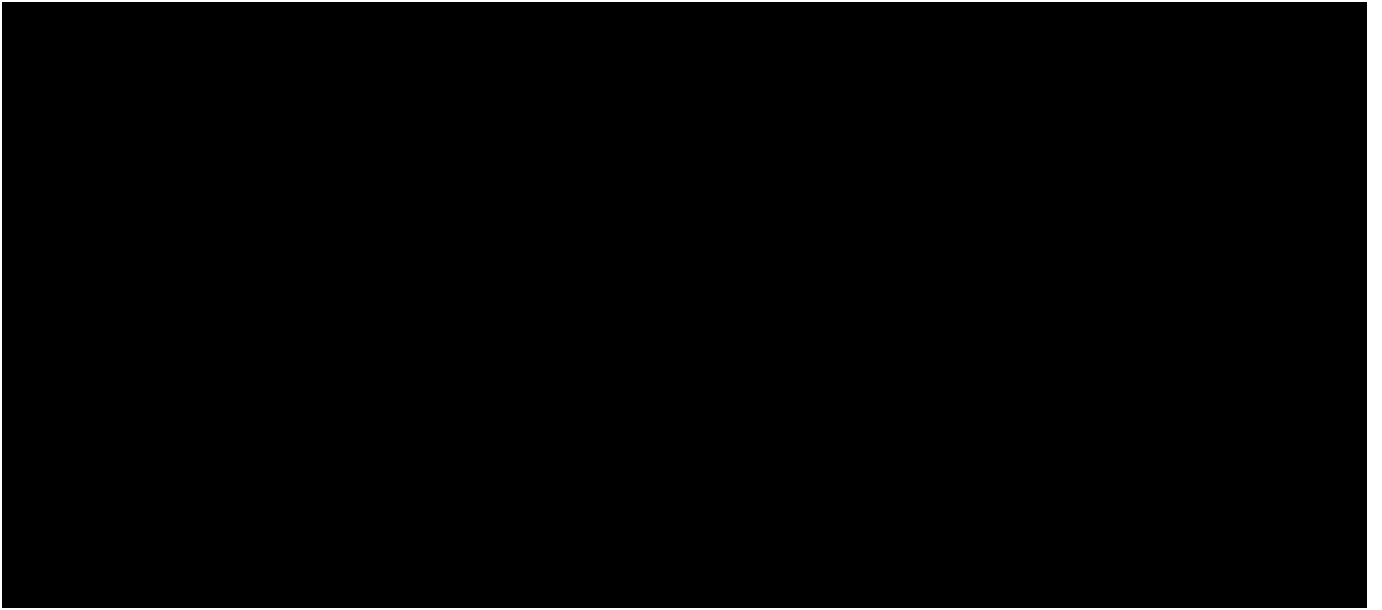
3.3 Public Transport Operating Costs

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]



4 Benefits-Cost Ratio (BCR)

4.1 National BCR Outputs

Based on the methodology described above, the net present values of benefits were evaluated and summarised in **Table 4-1**. The core results for the TLC DBC package components were generated from a set of 'core' assumptions.

Table 4-1: Summary of Core Benefits and BCRs for TLC DBC

Item	NPV (\$M)		
	Recommended network – Do Nothing	Recommended network – Staged Do Minimum	Recommended network – Do Minimum Closure
Traffic - Travel Time Benefits	210	579	1,061
Traffic - Congestion Benefits	27	84	170
Traffic - Trip Reliability	42	57	85
Traffic - Vehicle Operating Costs	71	153	242
Active Modes	-5	37	76
Crash savings	16	36	51
PT - Travel Time Benefits	0	1	4
PT - Reliability	0	1	3
PT - Health benefits	0	-9	-17
PT - Resilience	57	30	6
CO ₂	7	15	28
PV total net benefits excluding WEBS	423	984	1,709
PV of total net costs	383	387	389
National BCR Excluding WEBS	1.1	2.5	4.4
WEBS Benefits (5%)	21	49	85
PV Benefits Including WEBS	445	1,034	1,794
National BCR Including WEBS⁴	1.2	2.7	4.6

⁴ The BCR including WEBS was calculated as a sensitivity test.

4.1.1 Key Observations

- The results are sensitive to the definition of the do minimum, as demonstrated by the different BCRs with respect to the Do Nothing, Do Minimum Closure, and Staged Do Minimum scenarios.
- With the high frequency rail service operating in future supporting the development further south at Drury, the barriers are expected to be down for the majority time of the day if existing patterns of operations as set out in the Do Nothing remain. Hence this project is crucial for maintaining the safe and reliable network operation essential to the development of the Takaanini area and areas further south.
- The traffic benefits comprise a major portion of the benefits which appears reasonable as the seamless east-west connectivity of the traffic is expected to reduce significant delays and congestion in the Takaanini area.
- There is also a plausible amount of active mode benefits with respect to the Do Minimum Closure and Staged Do Minimum due to provision of better connectivity for active modes.
- The project does not improve the access to the rail stations and there is no change in the bus networks with respect to the Do Nothing scenario. The removal of the delays from the crossings would improve PT travel times for users and also the reliability of the services. These have only been partially assessed quantitatively and so the benefits presented would be conservative.
- It is expected that the existing at-grade rail crossings will be converted to cul-de-sacs in order to operate high frequency trains in later years. Hence the project comparison with the Staged Do Minimum scenario is the most likely representative of the project which yields a BCR of 2.5 without WEBs.

4.2 Sensitivity Tests

The key purpose of the sensitivity tests is to understand the relative impact of key assumptions on the BCR. The sensitivity tests were carried out as per the MBCM.

The sensitivity tests are split into analysis framework and parameter sensitivity tests. The analysis framework includes discount rate and analysis period, whilst parameter sensitivity includes WEBs, cost, and active mode and traffic benefits variability.

4.2.1 Analysis Framework Sensitivity Tests

The analysis framework includes the discount rate and analysis period:

Discount Rate and Analysis Period

The discount rate recommended in the current MBCM is 4% with sensitivity tests for 3% and 6%. A range of discount rates was tested, being 3%, 4%, 6%. The analysis period used for testing is 40 years and 60 years. The longer analysis period is relevant for long-lived strategic infrastructure projects such as the bridges in the TLC DBC.

Table 4-2 shows the BCR range for the above analysis parameters (excluding WEBs).

Table 4-2: BCR Range – Different Discount Rate and Analysis Period

Discount rate	Analysis period	BCR		
		Recommended network – Do Nothing	Recommended network – Staged Do Minimum	Recommended network – Do Minimum Closure
3%	40 years	1.3	3.2	5.2
4%		1.1	2.5	4.4
6%		0.78	1.7	3.3
3%	60 years	1.9	4.6	6.5
4%		1.4	3.5	5.3
6%		0.92	2.1	3.6

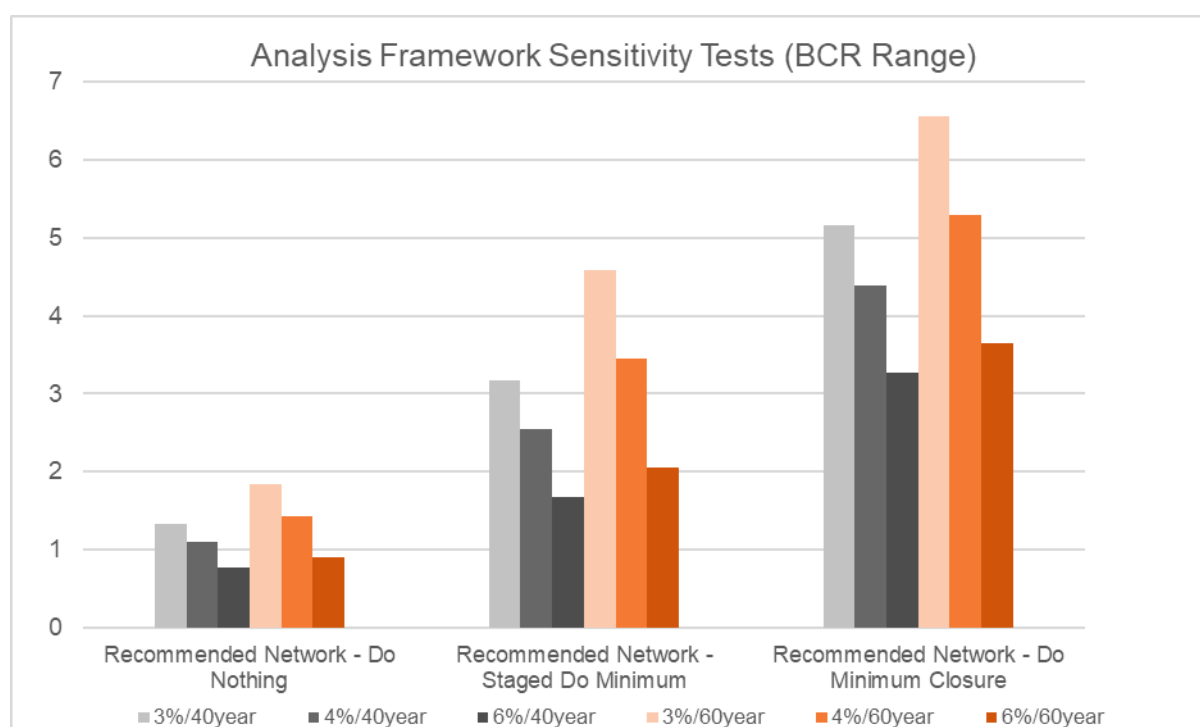


Figure 4-1: Analysis Framework - BCR range for the TLC DBC Project

The above analysis shows that:

- The range for the most probable scenario, Recommended network against the Staged Do Minimum, lies between that of the Do Nothing and Do Minimum Closure scenarios, at a range of 1.7 to 4.6.
- Using the recommendation in the MBCM (4%/40years), the BCR ratio is 2.5 for the Recommended network against the Staged Do Minimum.
- Since the bridges are long-lived infrastructure, a sensitivity test for a 60-year analysis period was carried out which further uplifts the BCR to 3.5 for the Recommended network against the Staged Do Minimum.

4.2.2 Parameter Sensitivity Tests

These sensitivity tests are performed by altering one parameter at a time while maintaining the rest of the core assumptions, including the 4% discount rate and 40-year analysis period. The following parameter sensitivity tests were carried out:

- Including WEBs: +5%
- Active modes benefits variability: $\pm 25\%$
- Traffic benefits variability: $\pm 25\%$
- Costs variability: P95 costs

WEBs Sensitivity Test

As discussed in **Section 2.11**, a sensitivity test was performed by including WEBs benefits as 5% uplift over the conventional benefits. The results are shown in **Table 4-3**.

Table 4-3: BCR Variation including WEBs

WEBs %	BCR		
	Recommended network – Do Nothing	Recommended network – Staged Do Minimum	Recommended network – Do Minimum Closure
0% (core)	1.1	2.5	4.4
5%	1.2	2.7	4.6

Active Mode Benefits Sensitivity Test

During the Drury Local peer review, extensive modelling methodology checks were carried out to better understand the walk benefits predicted by the model, especially for the “Other” trip purpose. These were found to align with expected daily travel by each mode and purpose. However, the greenfield nature of the location and the extensive future population growth make it more difficult to independently check the scale of benefits. It was therefore agreed to test with $\pm 25\%$ active mode benefits. The same tests have been carried out for the TLC DBC economics. The variation in active mode benefits cause no significant variance to the overall BCRs.

Table 4-4: BCR Variation with Active Mode Benefits Change

Active Mode Benefit %	BCR		
	Recommended network – Do Nothing	Recommended network – Staged Do Minimum	Recommended network – Do Minimum Closure
-25%	1.1	2.5	4.3
0% (core)	1.1	2.5	4.4
25%	1.1	2.6	4.4

Moreover, the active mode benefits with respect to the Do Minimum Closure case were also sensitivity tested by removing the Spartan Road and Manuroa Road active mode bridges from the Recommended network in SAMM. The results showed no change in BCR.

Traffic Benefits Sensitivity Test

The traffic benefits variability is tested for robustness since the traffic benefits exhibited highly sensitive with the projects and they comprise of bulk of the total benefits. The travel time, congestion, vehicle operating cost and trip reliability was tested for $\pm 25\%$. The results in **Table 4-5** show that the BCR is relatively sensitive to changes in traffic benefits, which is expected given that they form the bulk of the benefits in the present appraisal.

Table 4-5: BCR Variation with Traffic Benefits Change

Traffic Benefit %	BCR		
	Recommended network – Do Nothing	Recommended network – Staged Do Minimum	Recommended network – Do Minimum Closure
-25%	0.88	2.0	3.4
0% (core)	1.1	2.5	4.4
25%	1.3	3.1	5.4

Cost Sensitivity Test

The cost variability was tested for robustness by applying the P95 cost estimates. The results are shown in **Table 4-6**.

Table 4-6: BCR Variation with Capital Cost Change

Cost Scenario	BCR		
	Recommended network – Do Nothing	Recommended network – Staged Do Minimum	Recommended network – Do Minimum Closure
P50	1.1	2.5	4.4
P95	0.92	2.1	3.7

4.2.3 Land Use Sensitivity

There is particular uncertainty around the extent and timing of the land-use development over the years. To examine the possible effects of alternative land use forecasts, two tests have been carried out to test the effects of delayed growth or accelerated growth termed as land use decelerated growth and land use accelerated growth respectively. The tests have been undertaken by ascribing the benefits estimated for the base case to different years that reflect faster or slower rates of land use development. For each of these it is assumed that year 2028 will remain the same as for the base case scenario and the long-term effects will also remain the same but the timing of growth between these points will differ. In case of the land use deceleration scenario the long-term effects will be

achieved at a delayed date than base case and for land use acceleration it will be achieved earlier as exhibited in **Figure 4-2**. The specific assumptions for land use sensitivity tests are:

- Land use decelerated growth – it is assumed that 2028 benefits will remain same as base case with no growth until 2038, 2038 benefits occur in 2048 and 2048 benefits occur in 2048+.
- Land use accelerated growth – for year 2028 the benefits remain same as base case. Year 2038 have about 80% benefits of year 2048. Year 2048+ growth occurs in 2048 and, as a result, year 2048+ experiences 10% additional benefits as the effect of land use acceleration.

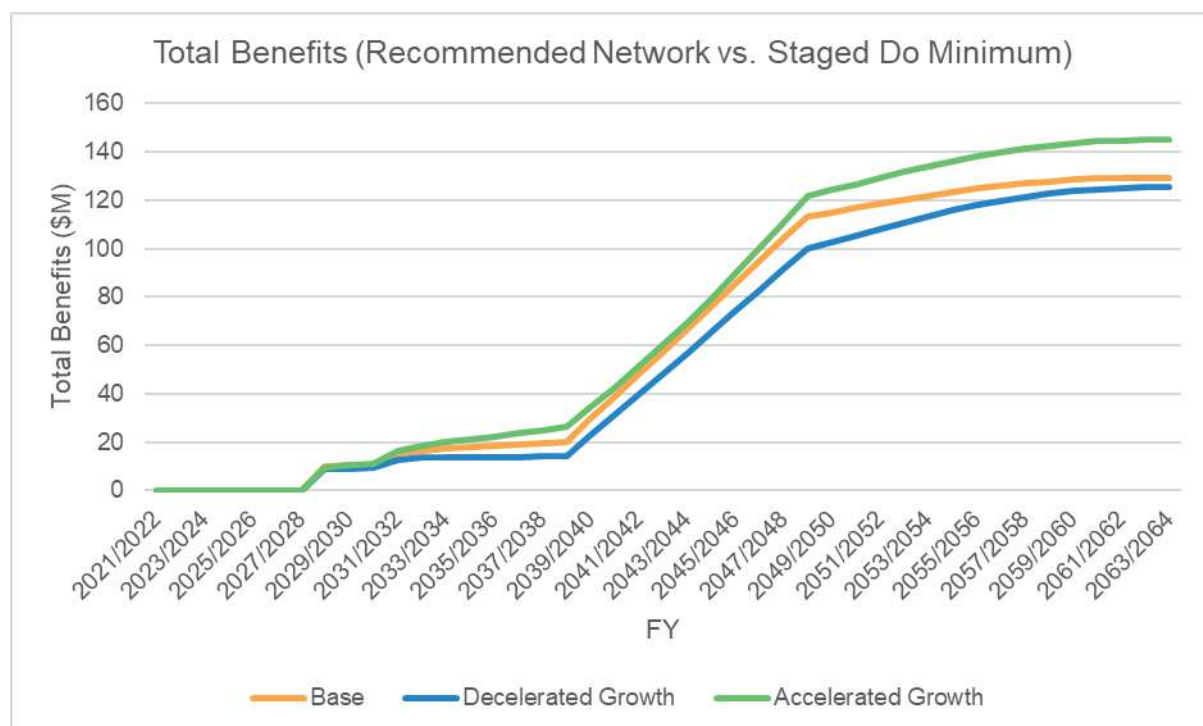


Figure 4-2: Land Use Deceleration or Acceleration Effects on Total Benefits (\$M)

Table 4-7 below shows BCRs with different land use growth scenarios.

Table 4-7: Land Use Sensitivity tests

Land Use Scenario	BCR		
	Recommended network – Do Nothing	Recommended network – Staged Do Minimum	Recommended network – Do Minimum Closure
Base	1.1	2.5	4.4
Decelerated Growth	0.87	2.3	4.1
Accelerated Growth	1.3	2.8	4.5

The project is reasonably sensitive to growth and therefore project implementation to match the growth is important. Route protection at an early stage will be required to help ensure that changes in the timing of development either accelerated or delayed can be easily accommodated. The

‘decelerated growth’ sensitivity test could be taken as a conservative scenario where the north-south Opaheke arterial and the growth in the Takaanini future urban zone do not eventuate or are delayed, considering that these are expected to occur in 2048+.

4.2.3.1 COVID-19 Scenario

The land use growth might slow down due to COVID-19 or any other unknown reasons in long term and hence the project start date might need to be delayed to meet the changed transport needs. It was assumed that if such a situation arises, it will not have a significant impact on the economic returns from the project as the costs and benefits timestreams will be shifted with the project start. However, to some extent, the COVID-19 scenario is covered by the reduced traffic benefits sensitivity test in **Table 4-5**.

4.2.3.2 Staging of Staged Do Minimum

Under the Staged Do Minimum scenario, there is uncertainty in the staging of level crossing closures, i.e. starting at 2038 and gradually transitioning from the Do Nothing scenario to the Do Minimum Closure scenario over 15 or 20 years as opposed to the assumed 10 years. Sensitivity tests were not undertaken to assess such different staging scenarios in the Staged Do Minimum. However, it can be inferred that the BCR with respect to the Staged Do Minimum will remain between that of the Do Nothing and Do Minimum Closure scenarios, i.e. not expected to fall below 1.

5 Summary

The core results for the economic evaluation of the TLC DBC are set out in **Table 5-1**.

Table 5-1: BCR Summary

Item	PV total benefits (\$M PV)	PV total net costs (\$M PV)	BCR excluding WEBs	WEBs (\$M PV)	BCR including WEBs
Recommended network – Do Nothing	424	383	1.1	21	1.2
Recommended network – Staged Do Minimum	985	387	2.5	49	2.7
Recommended network – Do Minimum Closure	1,709	389	4.4	85	4.6

Key conclusions were noted as follows:

- The BCR with respect to the Do Nothing is 1.1 without WEBs and slightly increases to 1.2 if WEBs are included.
- The BCR with respect to the Do Minimum Closure is 4.4 without WEBs and increases to 4.6 if WEBs are included.

- The BCR with respect to the Staged Do Minimum is 2.5 without WEBs and increases to 2.7 if WEBs are included. The Staged Do Minimum case is assumed as the likely scenario as the high frequency rail services in the future is expected to push for a need for crossing closures.
- Sensitivity testing of many of the assumptions or parameters used in the analysis indicated that there are few circumstances where the BCR falls below 1. The BCRs are relatively insensitive to changes in these assumptions and parameters, and the results can therefore be considered robust. The results of these sensitivity tests are summarised in **Table 5-2**.
- Larger variations in BCR would result from changes to the analysis framework (evaluation periods and discount rates away from the standard values) used in the assessment.
- In relation to the sensitivity analysis (see **Section 4.2**), the BCR ranged from 0.78 to 1.9 with respect to the Do Nothing, 1.7 to 4.6 with respect to the Staged Do Minimum, and 3.3 to 6.5 with respect to the Do Minimum Closure, with the analysis framework tests affecting the lower and upper bounds of these ranges.
- With respect to either the Do Minimum Closure or the Staged Do Minimum, all sensitivity tests give a BCR greater than 1. The BCR with respect to the Do Nothing falls below 1 for five sensitivity tests: the 6% discount rate with a 40- and 60-year analysis period, 25% less traffic benefits, P95 costs, and the decelerated growth scenario.
- The benefits with respect to the Do Nothing may be understated because of the effects of unreliability and increased travel times, especially for PT users, with increased barrier-down time.

Table 5-2: BCR Range Summary

Type of Sensitivity Test	Recommended network – Do Nothing	Recommended network – Staged Do Minimum	Recommended network – Do Minimum Closure
Analysis Framework	0.78 – 1.9	1.7 – 4.6	3.3 – 6.5
Parameter Sensitivity	0.87 – 1.3	2.0 – 3.1	3.4 – 5.4

1 Appendix 1 – Sector-Sector Traffic Benefits

The sector system considered for the benefit analysis is shown below; it comprises of all the regions in Auckland as in MSM. **Figure 5-1** shows the internal sectors from MSM.

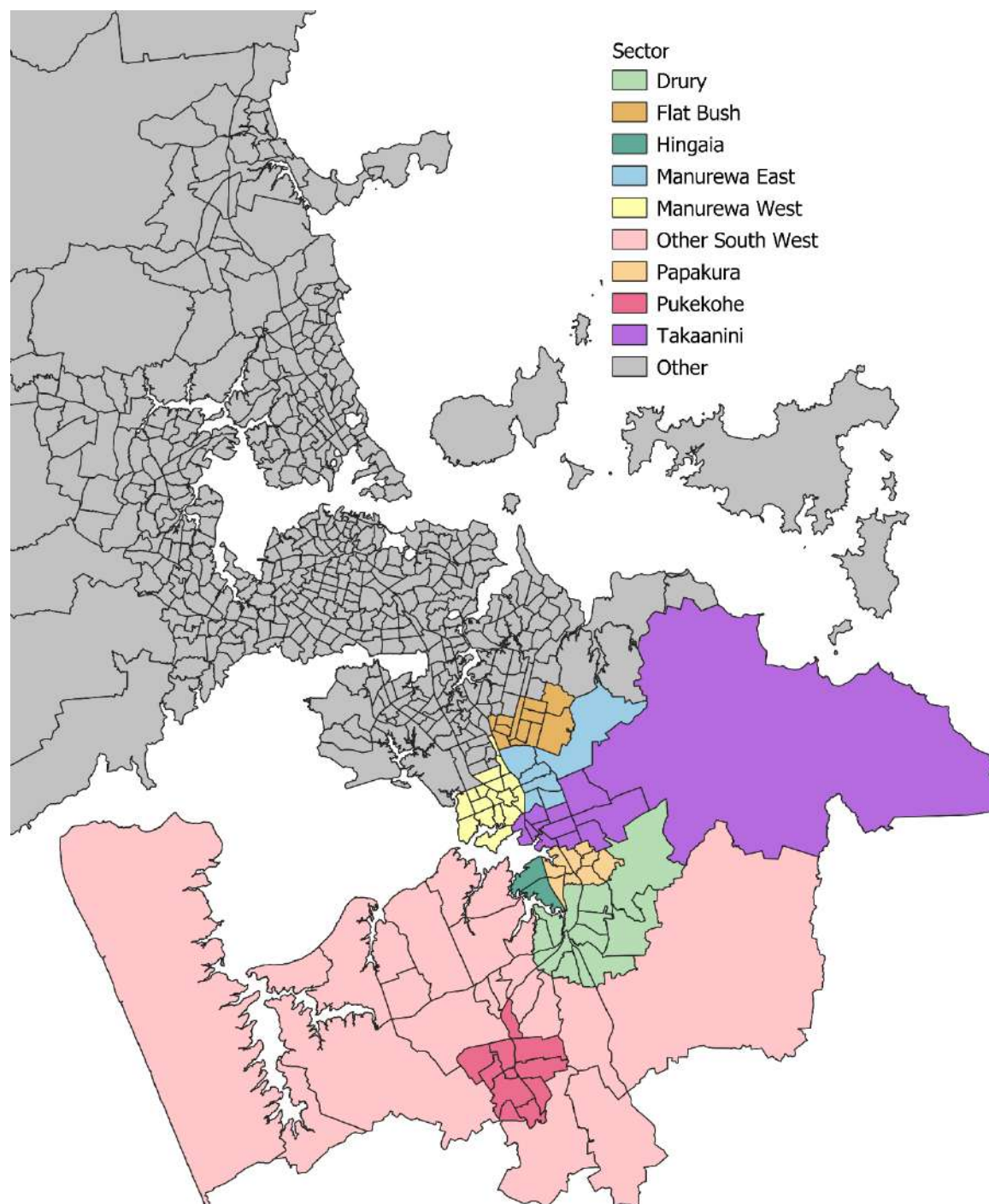


Figure 5-1: Economics Sector Map (Internal Sectors Only)

The SATURN traffic model comprises of region from Manukau to the Pukekohe. The cordon volume from MSM is transferred into SATURN and all the zones north of Manukau covering from Warkworth to Isthmus are treated as external North Zone. The below figure shows the SATURN network with the

blue triangles indicating the traffic model boundary. The sector to sector analysis of traffic benefits derived from SATURN is shown in **Table 5-3** below.



Figure 5-2: Saturn Network

Table 5-3: Sector-Sector Traffic benefit (veh-hr) Analysis – Year 2048+ AM Peak (against Do Minimum Closure case)

Sector	External Zones North	Manurewa West	Flat Bush	Manurewa East	Takaanini	Papakura	Hingaia	Drury	Other South West	Pukekohe	External South	Total
External Zones North	21	-18	5	6	91	-3	-3	-14	-8	-5	-18	54
Manurewa West	0	-7	1	6	32	-1	-2	-5	-2	-1	-2	21
Flat Bush	54	3	6	2	4	1	0	0	0	0	0	69
Manurewa East	142	35	9	5	31	8	1	3	2	1	2	238
Takaanini	127	29	7	11	86	18	3	3	7	5	2	299
Papakura	27	13	1	5	33	9	2	-5	1	0	0	83
Hingaia	-25	-5	0	0	6	1	0	-5	0	0	0	-28
Drury	-99	-10	-4	-4	-19	-36	-11	-35	-3	0	0	-221
Other South West	-118	-15	-2	-2	-5	-13	-4	-12	-10	-3	0	-184
Pukekohe	-78	-9	-1	-1	-7	-8	-2	-4	-1	0	1	-110
External South	-183	-7	0	-5	-5	-3	-4	-1	0	0	0	-209
Total	-131	9	21	24	248	-28	-21	-76	-15	-3	-15	12

There are negligible benefits between external zone trips. Hence 100% of the benefits is accounted to come from urban arterial road type.

2 Appendix 2 – SATURN PLOTS

Below is the delay difference plots between the Recommended network and the Do Minimum Closure scenario in the AM peak 2048+, which shows travel time savings along Alfriston Road and along some portions of the Great South Road. All these delays observed in the model are considered to be plausible.

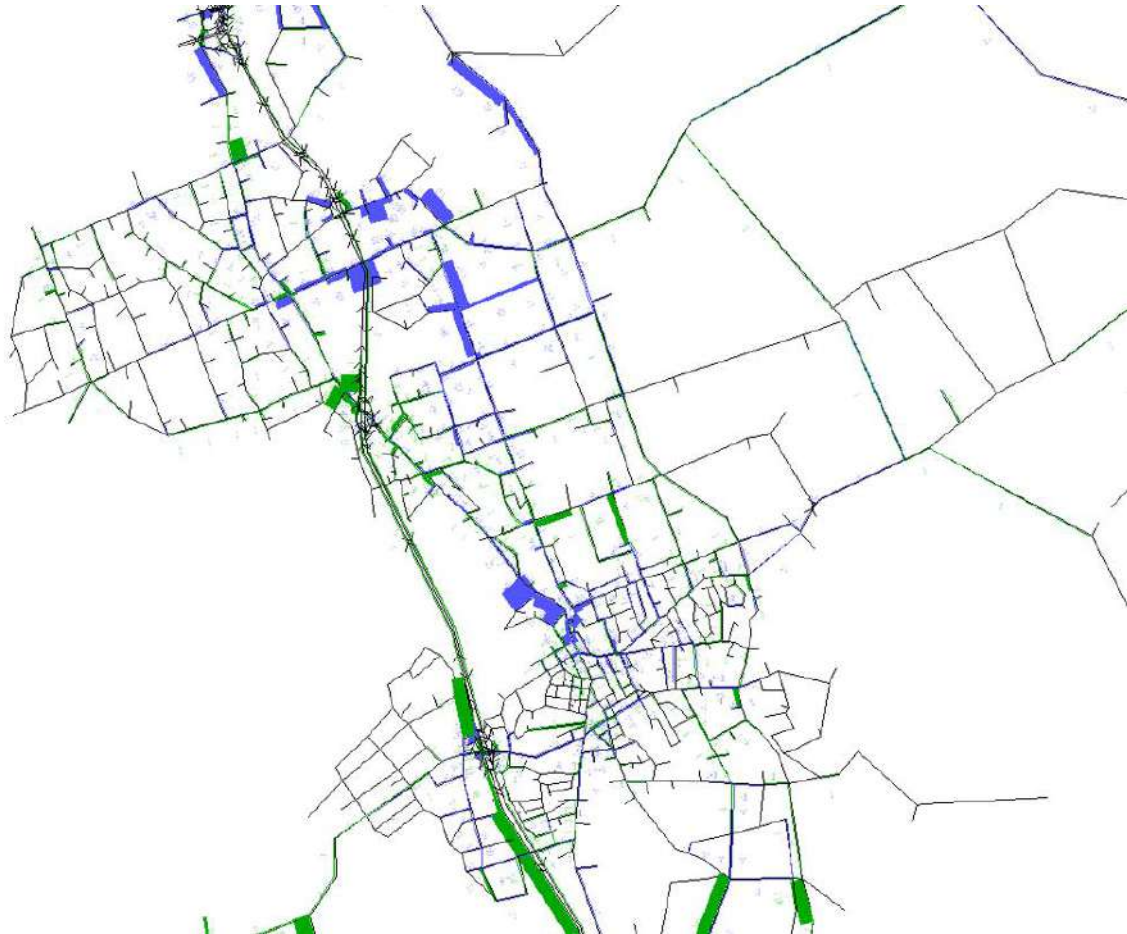


Figure 5-3: Delay Difference between Takaanini Recommended network and the Do Minimum Closure scenarios – 2048+ AM peak

Takaanini Level Crossings Project

Appendix L - Route Protection Strategy

October 2023

Version 1.0

Document Status

Responsibility	Name
Author	██████████, Planner ██████████ Legal
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Appendices

Appendix A – Draft Strategy Selection Checklist

Acronym/Term	Description
AT	Auckland Transport
AUP:OP	Auckland Unitary Plan – Operative in Part
DBC	Detailed Business Case
CRL	City Rail Link
IBC	Indicative Business Case
ISTN	Indicative Strategic Transport Network
LGA 02	Local Government Act 2002
LGA 74	Local Government Act 1974
MCA	Multi-criteria analysis
NIMT	North Island Main Trunk rail line
NoR	Notice of Requirement
PBC	Programme Business Case
PC78	Plan Change 78 to the AUP:OP being the intensification planning instrument under the Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021
PWA	Public Works Act 1981
RMA	Resource Management Act 1991
RMA-EHS	Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021
SGA	Te Tupu Ngātahi Supporting Growth
TLC	Takaanini level crossings project
Waka Kotahi	Waka Kotahi NZ Transport Agency

1 Introduction and Purpose

1.1 Purpose of this report

The purpose of this report is to set out the recommended planning mechanisms to secure route protection for the Takaanini Level Crossings Project (**TLC**). This report is intended to be used as a guide for owner-organisations.

1.2 Background

The TLC is one of two interventions proposed for the Takaanini area as part of the Te Tupu Ngātahi Supporting Growth Programme (**Programme**). The Programme is a collaboration between Auckland Transport and Waka Kotahi NZ Transport Agency to investigate, plan and identify the preferred transport network to support Auckland's future growth areas over the next 30 years. Alongside the Takaanini Frequent Transit Network Project (**FTN**), the TLC is intended to support and respond to forecast growth pressures in Takaanini.

There are currently nine public road level crossings along the existing southern rail network between Britomart and Pukekohe Stations, four of which are currently within the Takaanini area at Spartan Road, Manuroa Road, Taka Street and Walters Road.

As part of the anticipated future growth in passenger and freight rail services, KiwiRail is planning to upgrade the North Island Main Trunk rail line (**NIMT**) consisting of increasing the number of rail tracks on the NIMT line from two tracks to up to four tracks (**Four Tracking**). In the Takaanini context, the net result of Four Tracking is an increasing number of train movements through Takaanini per hour.

The increased rail frequency will lead to greater barrier arm down-time and therefore severance and congestion in the area, which will impact on the functionality and safe operation of these existing road level crossings in Takaanini. Safe and reliable east-west connections over the NIMT will be required to address these issues.

The Project Team also understands that opening of the City Rail Link (**CRL**) may lead to increased train frequency and consequential barrier arm down-time, severance, congestion and safety issues which may prompt earlier implementation timeframes for the TLC. At the time of preparing the DBC and this route protection strategy, the extent of this impact had yet to be confirmed by AT. The Project Team were instructed to proceed with the assessment on the basis of the timing initially assumed as part of the Programme, which was tied to implementation of the Four Tracking project as part of the Southern Rail package.

At the time of preparing this route protection strategy, Plan Change 78 to the AUP:OP (**PC78**) had been notified. Plan Change 78 is an intensification planning instrument prepared under the Resource Management (Enabling Housing Supply and Other Matters) Amendment Act 2021 (**RMA-EHS**). PC78 has immediate legal effect under section 86BA of the RMA. The details of the intensification it proposes are discussed further below.

The preferred options for rail crossings at Takaanini comprise the following components outlined in Table 1 below:

Table 1: Takaanini Level Crossings Project

Corridor	Components
Spartan Road (Closure of existing level crossing)	• Road stopping to the east and west of the NIMT at Spartan Road • Installation of cul-de-sac turning heads including berms and shared use paths to the east and west of the NIMT • Creation of grade separated active modes connection over the NIMT and associated ramps and stairs
Manuroa Road (Closure of existing level crossing)	• Road stopping to the east and west of the NIMT at Manuroa Road • Installation of cul-de-sac turning heads including berms and shared use paths to the east and west of the NIMT • Creation of grade separated active modes connection over the NIMT and associated ramps and stairs
Manuia Road (New grade separated crossing)	• Creation of grade separated road over rail bridge from the intersection with Great South Road to the intersection with Oakleigh Avenue • Realignment of Manuia Road and creation of alternative access to residual properties • Intersection upgrade at Manuia Road/Great South Road/Challen Close • Intersection upgrade/installation of roundabout at Oakleigh Avenue
Taka Street (Closure of existing level crossings and creating new grade separated crossing)	• Grade separated road over rail crossing / bridge • Taka Street west/Great South Road/Walter Strevens Drive intersection upgrade • Takanini Road north cul-de-sac / road closure works • Corridor widening / active mode upgrades
Walters Road (Closure of existing level crossings and creating new grade separated crossing)	• Grade separated road over rail crossing / bridge • Walters Road east / Porchester Road intersection upgrade • Walters Road east / Arion Road intersection active mode upgrades • Walters Road west / Great South Road intersection active mode upgrades • Corridor widening / active mode upgrades

2 Preferred Option

2.1 Overview

As indicated in Table 1 above, the preferred option for the TLC comprise the following key outcomes:

- Closure of the existing level crossings at Spartan Road and Manuroa Road;
- New grade separated active mode crossings at Spartan Road and Manuroa Road;
- New grade separated crossings at Taka Street, Walters Road and Manuia Road; and
- No new grade separation at Rangī Road.

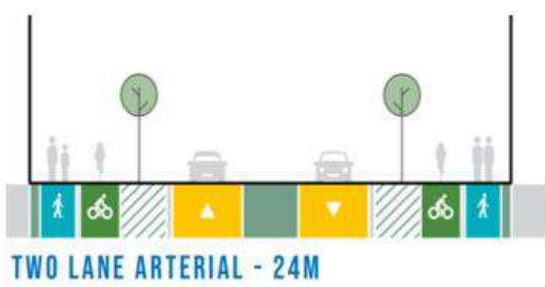
Some subsequent engineering interventions and upgrades along and/or in the immediate vicinity of the respective corridors will also be required to support this preferred option. This includes:

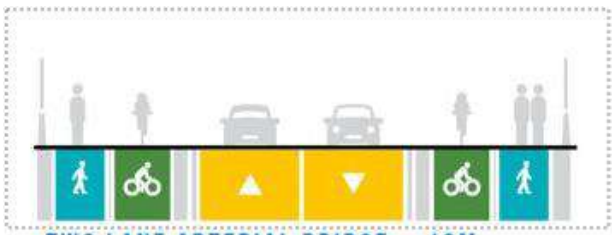
- Intersection upgrades;
- Corridor realignment or widening;
- Alternative access arrangements;
- Road closure;
- Active mode improvements;
- Construction staging and laydown areas; and
- New active mode connections at Manuroa Road, Spartan Road and Takanini Road (where road closures are proposed).

The works anticipated to achieve these outcomes cannot fit within the existing road reserve, as such land acquisition would be required. As a new grade separated crossing/connection is not proposed at Rangī Road, no physical works or land acquisition is anticipated or required along or around Rangī Road.

The typical cross sections in the preferred option are shown in Table 2 below.

Table 2: Typical cross sections in the preferred option

Engineering component / Intervention	Cross Section / Image
Mainline road corridor	 TWO LANE ARTERIAL - 24M

Engineering component / Intervention	Cross Section / Image
Bridge (road over rail)	 TWO LANE ARTERIAL BRIDGE - 18M
Active modes bridge	 ACTIVE MODE BRIDGE - 4.6M

2.2 Planning context

The preferred option as described in Section 2.1 is bound by an existing urban environment (i.e. brownfields). It is comprised primarily of business and residential zoned land with a mixture of industrial, commercial/retail and residential uses. The current zoning and relevant overlays are illustrated in Figure 1 below.

The future surrounding environment will continue to be urban and the likelihood of wide-spread land use change is low, but density is anticipated to increase within the residential zoned areas. Development of at least six storeys is anticipated in areas within a walkable catchment of rapid transit stops such as Takaanini Station and Te Mahia Station. This is prescribed by the National Policy Statement on Urban Development 2020 (**NPS-UD**) and mapped through Plan Change 78 as shown on Figure 2 below. In addition, the implementation of Medium Density Residential Standards (**MDRS**) in accordance with the RMA-EHS enables up to three dwellings as a permitted activity (subject to development standards) in all residential zones.

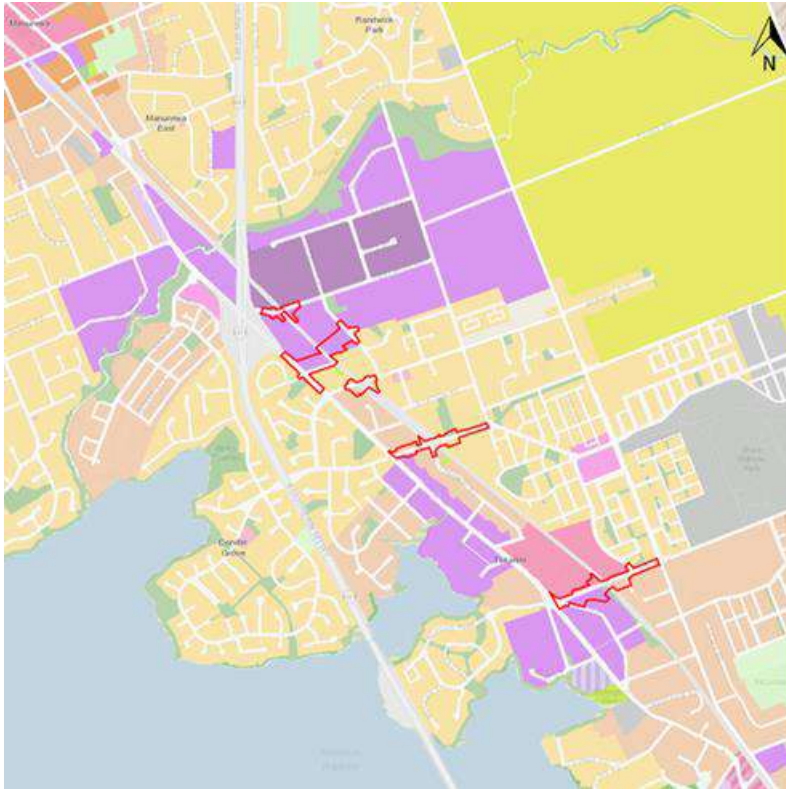


Figure 1: Existing AUP:OP zoning environment for the TLC and indicative NoR boundaries.

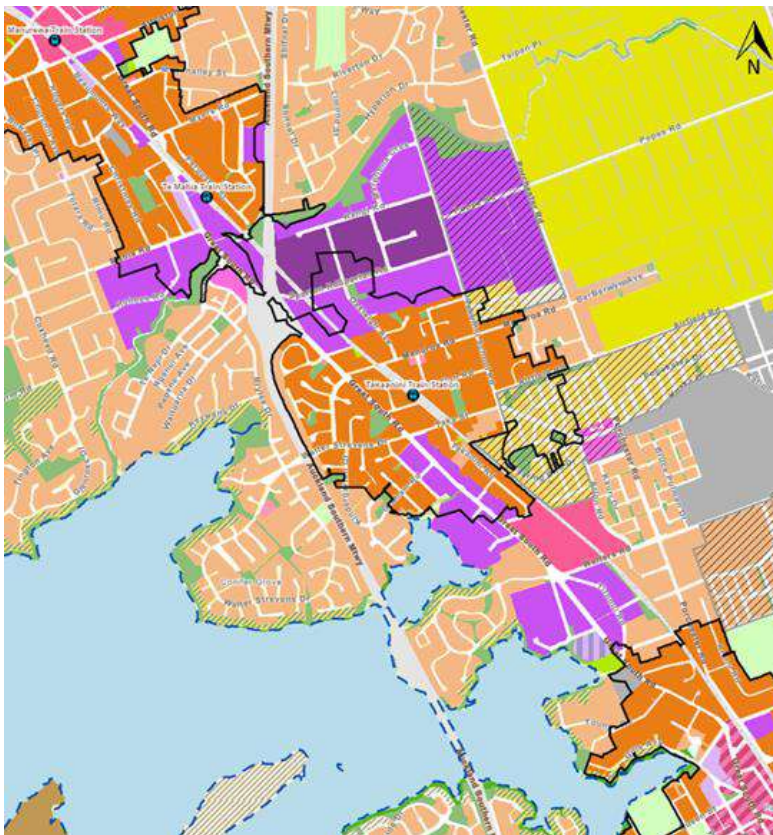


Figure 2: Auckland Council proposed response to the zoning environment for the NPS-UD and MDRS (PC78).

2.3 Statutory context

The TLC components in Table 1 above require approvals under the RMA (for route protection).

The possible route protection mechanisms include the following:

1. **Designations** – as there are no existing roading designations in these locations these would be ‘new’ designations secured through notices of requirement. The existing first-in-time NIMT designation would retain precedence over these new designations.¹ Noting that section 178 of the RMA provides interim protection for proposed alignments and construction areas for the designated purpose until the designation is confirmed and included in the AUP:OIP.
2. **Resource consents** - either for the land use instead of a designation, or for regional consents for construction readiness. Consents would provide authorisation for the works but do not resolve the underlying property approvals.
3. **Structure Plan / Plan Change** – including policy and standard frameworks to provide for/not preclude projects, and application of applicable zoning to project areas (for example rezoning closed roads to the Strategic Transport Corridor zone with the rest of the rail corridor and rezoning areas required for grade separated crossings as road), or use of ‘indicative roads’ in Plan Change Precincts.
4. **Landowner / developer agreements (Infrastructure Funding Agreements)** - can operate as a form of route protection where landowners agree to a specified design and implementation of a project. These can be individually or collectively negotiated but subsequent consents would still be required.

The comparative strengths, weaknesses of these possible options have been assessed and summarised below in Table 3.

Table 3: Possible route protection and consenting mechanisms

Route Protection Mechanism	Summary of strengths and weaknesses within local context
New Designation (Route protection)	• This provides longer term protection (generally 10 to 20 years) and maintains design flexibility. Typically, designations provide less detail upfront but as a consequence usually require additional assessment and design be provided prior to any works commencing as a condition of the designation. A secondary process, typically through provision of an Outline Plan of Works (OPW) to the territorial authority, is usually required. • Provides certainty to affected landowners and the ability to request early buy-out from the requiring authority. • Prevents further intensification within the corridors capital renewals that would need to be demolished for the works. • Additional areas required for construction can be rolled-back after works are completed.
Structure Plan / Plan Change provisions	• Aside from the intensification streamlined planning process there are no plan changes anticipated in these corridors. • Plan changes do not authorise land acquisition and so individual negotiations would still be required. • Ownership within each corridor is fragmented and there are no known redevelopment plans to consolidate or structure plan each area.

¹ Rail vehicles also have a right of way over all other users by virtue of s80 of the Railways Act 2005.

Route Protection Mechanism	Summary of strengths and weaknesses within local context
Developer negotiations / Infrastructure Funding Agreements	As above, ownership within the corridors is fragmented and so developer negotiations would be impractical given the number of parties involved.
Legislation/ Statutory document change	Given the individual property rights that would be affected by this proposal, local legislation change would not be suitable.
AUP OIP 'Corridor Overlay'	As above, this process would not resolve the property acquisition aspects of route protection.
Resource Consents	As above, this process would not resolve the property acquisition aspects of route protection.

3 Project description

The preferred option and supporting engineering components/interventions discussed in Table 1 above forms five east-west alignments. The following sections provide an overview of:

- The corridors;
- The proposed engineering interventions/components within each corridor;
- The key risks and opportunities associated with each corridor for determining the preferred option of route protection; and
- The recommended method of route protection.

A summary of the key factors that have determined the recommended consenting strategy is also provided in Appendix A.

The alignments are discussed below in order of location (from north to south) along the NIMT.

Table 3 provides a summary of the route protection mechanisms considered for the different packages.

3.1 Spartan Road

The Spartan Road corridor includes interventions required to achieve the closure of the existing Spartan Road level crossing of the NIMT and to stop east-west vehicle movement. The interventions within the Spartan Road corridor are indicatively shown in Figure 3 below and set out in Table 4.

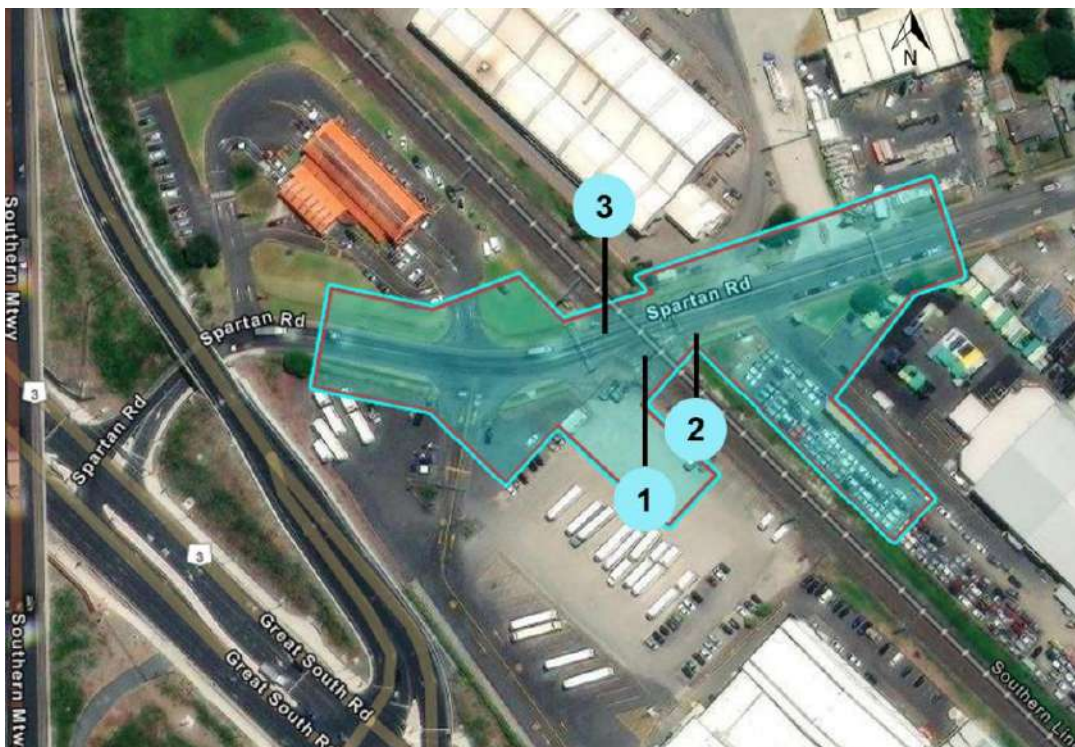


Figure 3: Proposed interventions/components within the Spartan Road corridor

Table 4: Description of components within the Spartan Road corridor

Number reference in Figure 3	Engineering component / Intervention
1	Spartan Road active mode connection / bridge over the NIMT
2	Spartan Road east cul-de-sac turning head / road closure works
3	Spartan Road west cul-de-sac turning head / road closure works

The Spartan Road context is an existing urban environment comprising predominantly existing heavy and light industrial uses (e.g. car yards, Hynds pipe supply yard and VTNZ testing centre). The preferred option recommends closing the existing level crossing for the reasons set out in the Options Assessment report. To achieve this, additional land and works are required beyond the existing road corridor.

Alternative access between the industrial employers and residential areas either side of the NIMT will be provided through a grade separated active modes crossing. There are limited additional land requirements for this structure but provision for areas to assemble and construct the bridge will be required during the construction period.

Route protection is recommended for this corridor due to the liveability outcomes it provides for, the urgent need for protection and the complexity of the TLC.

Spartan Road has strategic importance as a key logistics corridor for the industrial precinct of Takaanini and provides access for local employees to employment. Significant growth pressure in the surrounding residential areas stoked by PC78 present risk of potential further intensification which might inhibit the corridor along with the risk of escalating land values create an urgent need for route protection.

The recommended method of route protection for components within the Spartan Road corridor is notice of requirement (**NoR**) for the following reasons:

- There is insufficient room in the existing road reserve for the proposed works.
- NoR is considered the most efficient method to secure and earmark land to prevent further build out and intensification of the corridor.
- NoRs provide certainty to existing owners and provide for early acquisition either by the requiring authority or at the initiation of the existing owners.
- There are no known active developments and/or plan changes in the area and therefore limited opportunities for developer agreements.
- Seeking resource consents before acquiring the necessary land would risk duplicating the work if the necessary land cannot be secured and the works need to be redesigned.
- NoR is the only route protection method that would obtain the required construction approvals while satisfying the reasonable necessity test for land acquisition at the same time.
- NoR provides interim protection to avoid other users obstructing or further intensifying the corridor until the works commence.

3.2 Manuia Road

The Manuia Road corridor includes interventions required to achieve the grade separation of Manuia Road over the NIMT and provide for east-west vehicle movement between Great South Road and

Oakleigh Avenue. The interventions within the Manuia Road corridor are indicatively shown in Figure 4 below and set out in Table 5.

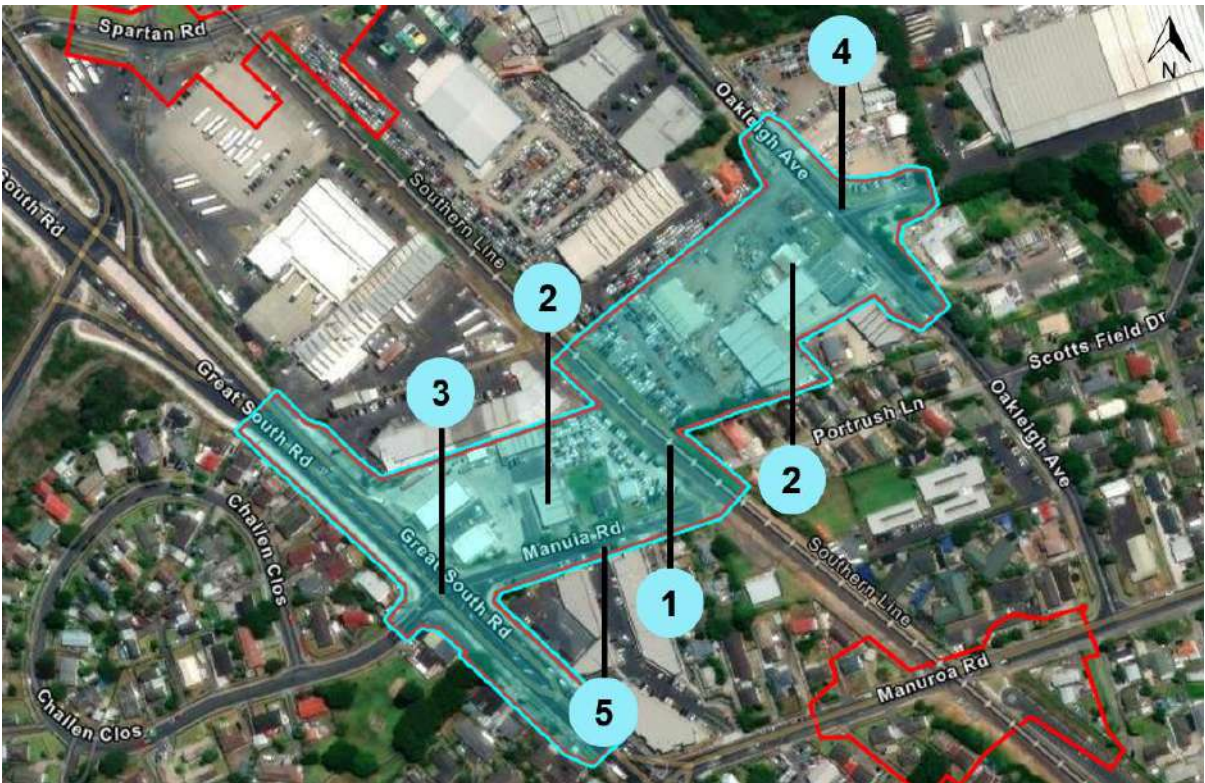


Figure 4: Proposed interventions/components within the Manuia Road corridor

Table 5: Description of components within the Manuia Road corridor

Number reference in Figure 4	Engineering component / Intervention
1	Grade separated crossing / bridge
2	Manuia Road east and west road corridor upgrades
3	Manuia Road west/Great South Road/Challen Close intersection upgrade
4	Manuia Road bridge east / Oakleigh Ave tie-in works
5	Alternative access/service lane to current Manuia Rd properties

The Manuia Road context is an existing urban environment, predominantly with commercial and industrial uses (e.g., service station, car yards, mechanics, warehouses and fabrication services). It is however, on the fringe of established residential, retail and community land uses (e.g., scout hall and family centre). The preferred option recommends the creation of a new grade separated crossing in this area for the reasons set out in the Options Assessment report. To give effect to this, additional land and works are required to provide to construct the bridged crossing, provide alternative access to existing Manuia Road users, and to upgrade and tie-in to intersections on either side.

Route protection is recommended for this corridor due to the urgency and complexity of the TLC. Manuia Road provides a new crossing to facilitate east-west movement for a broad catchment and therefore has strategic significance as well as close alignment with other level crossing closures and the delivery of the southern rail Four Tracking project. The new crossing at this point will impact on

the future shape and urban form of the surrounding residential, commercial and industrial areas, provide for improved safety outcomes and respond to growth pressure in the surrounding residential areas. Route protection is urgent due to the risk of potential further intensification and escalating land values.

The recommended method of route protection for components within the Spartan Road corridor is NoR for the following reasons:

- Additional land is required for the new alignment and supporting structures.
- NoR is considered the most efficient method to secure and earmark land to prevent further build out and intensification of the corridor.
- NoRs provide certainty to existing owners and provide for early acquisition either by the requiring authority or at the initiation of the existing owners.
- There are no known active developments and/or plan changes in area and therefore limited opportunities for developer agreements.
- Given the number of properties intersected by the corridor, resource consenting prior to acquiring the necessary land would be very difficult.
- NoR provides interim protection to avoid other users obstructing or further intensifying the corridor until the works commence.

3.3 Manuroa Road

The Manuroa Road corridor includes interventions required to achieve the closure of the existing Manuroa Road level crossing of the NIMT and to stop east-west vehicle movement. The interventions within the Manuroa Road corridor are indicatively shown in Figure 5 below and set out in Table 6.

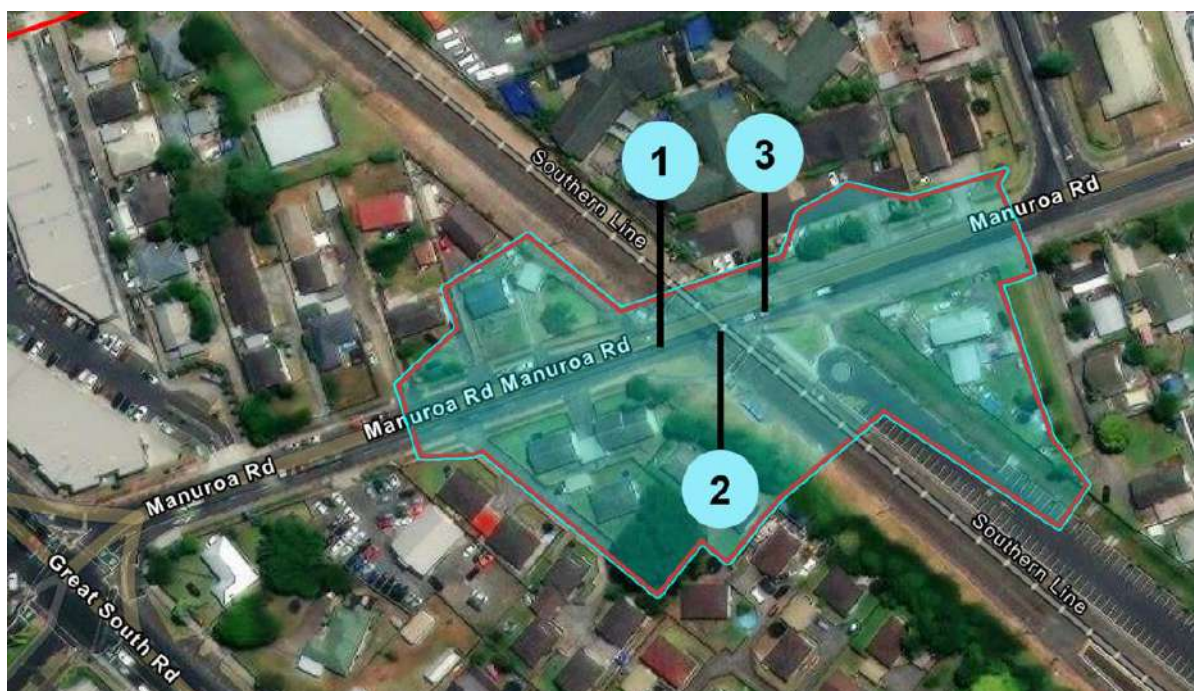


Figure 5: Proposed interventions/components within the Manuroa Road corridor

Table 6: Description of components within the Manuroa Road corridor

Number reference in Figure 5	Engineering component / Intervention
1	Manuroa Road west cul-de-sac / road closure works
2	Active modes grade separated structure
3	Manuroa Road east cul-de-sac / road closure works

Manuroa Road is an existing urban environment comprising predominantly residential uses with some community and commercial land uses (e.g. a church, early childcare centre, shopping centre). Takaanini station is located to the southeast of Manuroa Road. The emerging preferred option recommends closing the existing level crossing for the reasons set out in the Options Assessment report. To give effect to this, additional land and works are required to provide a turning circle either side of the NIMT so that vehicles can safely turnaround and return to either Great South Road (on the western side) or back along Manuroa Road (on the eastern side).

Alternative access from the residential areas on the western side of the NIMT to the Takaanini station will be provided through a grade separated active modes crossing. There are limited additional land requirements for this structure but provision for areas to assemble and construct the bridge will be required during the construction period.

Route protection is recommended for this corridor due to the liveability outcomes it provides for, the urgency of the need for protection and the complexity of the project. Manuroa Road has strategic importance and presents potential synergies with KiwiRail's delivery of the southern rail Four Tracking project, will impact on the future shape and urban form of the surrounding area with the anticipated growth pressure in the surrounding residential area. The corridor is at risk of further potential intensification and escalating land values create an urgent need for route protection.

The recommended method of route protection for components within the Manuroa Road corridor is NoR for the following reasons:

- There is insufficient room in the existing road reserve for the proposed works.
- NoR is considered the most efficient method to secure and earmark land to prevent further build out and intensification of the corridor.
- NoRs provide certainty to existing owners and provide for early acquisition either by the requiring authority or at the initiation of the existing owners.
- There are no known active developments and/or plan changes in area and therefore limited opportunities for developer agreements.
- Seeking resource consents before acquiring the necessary land would risk duplicating the work if the necessary land cannot be secured and the works need to be redesigned.
- NoR is the only route protection method that would obtain the required construction approvals while satisfying the reasonable necessity test for land acquisition at the same time.
- NoR provides interim protection to avoid other users obstructing or further intensifying the corridor until the works commence.

3.4 Taka Street

The Taka Street corridor includes interventions required to achieve the grade separation over the NIMT and provide for east-west vehicle movement along Taka Street. The interventions within the Taka Street corridor are indicatively shown in Figure 6 below and set out in Table 7.

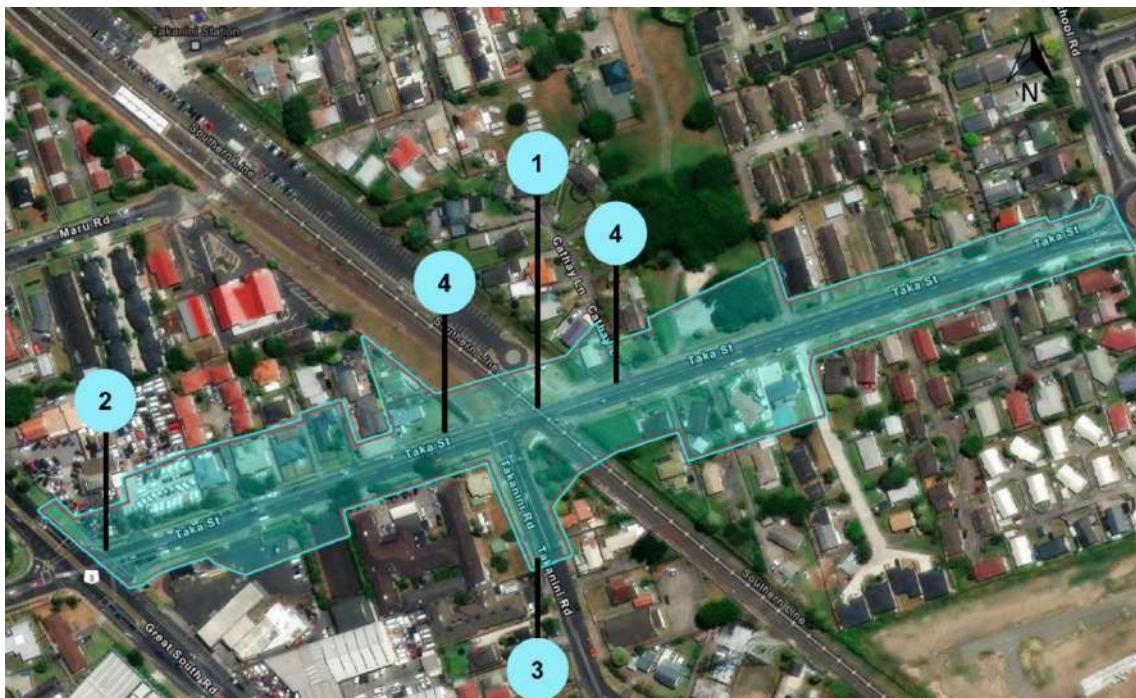


Figure 6: Proposed interventions/components within the Taka Street corridor

Table 7: Description of components within the Taka Street corridor

Number reference in Figure 6	Engineering component / Intervention
1	Grade separated crossing / bridge
2	Taka Street west/Great South Road/Walter Strevens Drive intersection upgrade
3	Takanini Road north cul-de-sac / road closure works
4	Corridor widening / active mode upgrades

The Taka Street context is an existing urban environment dominated by residential uses and limited industrial and commercial uses. Takaanini station is located to the northeast of Taka Street. The emerging preferred option recommends the creation of a new grade separated crossing in this area for the reasons set out in the Options Assessment report. To give effect to this, additional land and works are required to provide to construct the bridged crossing, provide alternative active mode access to Takaanini Road residents, and to upgrade and tie-in to the intersection with Great South Road.

Route protection is recommended for this corridor due to the urgency and complexity of the project. Taka Street provides a new grade separated crossing to facilitate continuing east-west movement for existing and future residents needed in anticipation of, and to align with, the delivery of the southern rail Four Tracking project. The replaced crossing at this point will impact on the future shape and urban form of the surrounding residential, commercial and industrial areas, provide for improved safety outcomes and respond to growth pressure in the surrounding residential areas. Route protection is urgent due to the risk of potential further intensification and escalating land values.

The recommended method of route protection for components within the Taka Street corridor is NoR for the following reasons:

- Additional land is required to widen the corridor and construct the support structures for the grade separated crossing.
- NoR is considered the most efficient method to secure and earmark land to prevent further build out and intensification of the corridor.
- NoRs provide certainty to existing owners and provide for early acquisition either by the requiring authority or at the initiation of the existing owners.
- There are no known active developments and/or plan changes in area and therefore limited opportunities for developer agreements.
- Given the number of properties intersected by the corridor, resource consenting prior to acquiring the necessary land would be very difficult.
- NoR provides interim protection to avoid other users obstructing or further intensifying the corridor until the works commence.

3.5 Walters Road

The Walters Road corridor includes interventions required to achieve grade separation over the NIMT and provide for east-west vehicle movement along Walters Road. The interventions within the Walters Road corridor are indicatively shown in Figure 7 below and set out in Table 8.

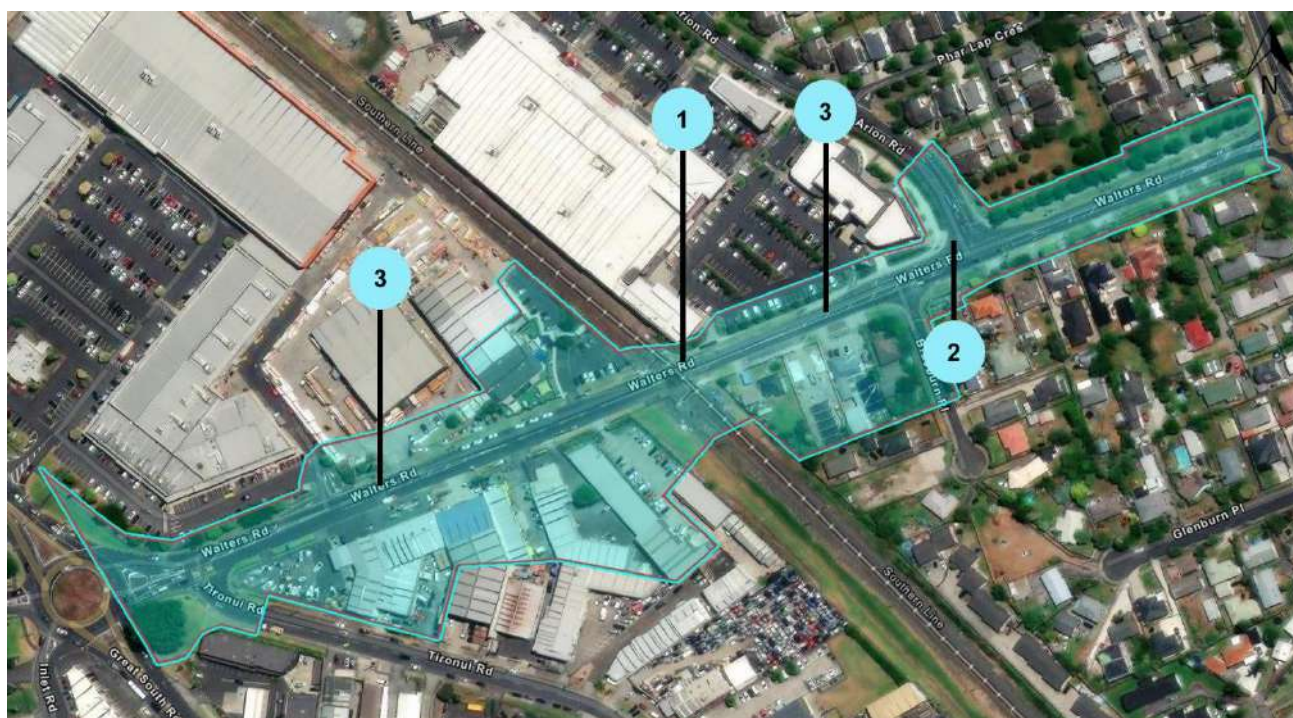


Figure 7: Proposed intervention/components within the Walters Road corridor

Table 8: Description of components within the Walters Road corridor

Number reference in Figure 7	Engineering component / Intervention
1	Grade separated crossing / bridge
2	Walters Road east / Arion Road intersection active mode upgrades
3	Corridor widening / active mode upgrades

The Walters Road context is an existing urban environment dominated by residential uses to the east and industrial and commercial uses to the west. The emerging preferred option recommends retention of a crossing within this alignment for the reasons set out in the Options Assessment report. To give effect to this, additional land and works are required to construct the bridged crossing and to upgrade and tie-in to intersections with Great South/Inlet/Tironui, Arion and Porchester roads.

Route protection is recommended for this corridor due to the urgency and complexity of the project. Walters Road provides a new grade separated crossing to facilitate continuing east-west movement for existing and future residents needed in anticipation of, and to align with, the delivery of the southern rail Four Tracking project. The replaced crossing at this point will impact on the future shape and urban form of the surrounding residential, commercial and industrial areas, provide for improved safety outcomes and respond to growth pressure in the surrounding residential areas. Route protection is urgent due to the risk of potential further intensification and escalating land values.

The recommended method of route protection for components within the Walters Road corridor is NoR for the following reasons:

- Additional land is required to widen the corridor and construct the support structures for the grade separated crossing.

- NoR is considered the most efficient method to secure and earmark land to prevent further build out and intensification of the corridor.
- NoRs provide certainty to existing owners and provide for early acquisition either by the requiring authority or at the initiation of the existing owners.
- There are no known active developments and/or plan changes in area and therefore limited opportunities for developer agreements.
- Given the number of properties intersected by the corridor, resource consenting prior to acquiring the necessary land would be very difficult.
- NoR provides interim protection to avoid other users obstructing or further intensifying the corridor until the works commence.

4 NOR grouping and packaging

As discussed in Section 2.3, NoRs are the recommended route protection mechanism for all components / interventions in the Takaanini level crossings project. This section provides an overview on the recommended grouping and packaging of the NoRs.

The grouping and packaging of new NoRs provides an opportunity to improve efficiencies in the NoR process, including streamlining statutory timeframes and avoiding unnecessary duplication. This however must be balanced with the potential for increased planning risk and added complications of grouping NoR corridors (and their potential issues) together.

The following criteria have been considered in determining the appropriateness of potential NoR groupings and packages:

- **Project context and transport outcomes:** A shared contextual basis (e.g. similar business case foundations, investment objectives, requiring authority, geographic context and project drivers) allowing for efficiencies in base information which will be provided to support the NoR package / bundle.
- **Planning risk:** A similar level planning risk (e.g. notification risk, likelihood of appeal, complexity of planning approval requirements) limits the likelihood that projects are unnecessarily exposed to delays and added planning complexity, noting projects also need to be credible and be able to stand alone if required.
- **Phasing/timing:** Similar programme timing (including design, assessment, project drivers) provides consistency in the urgency of route protection, the provision of information, key deadlines and delivery targets. The interconnectedness of the corridors and combination of closures and grade-separated replacement crossings also mean that the necessity of each project hangs on the completion of the other.
- **Project complexity:** A similar level of project complexity (such as design complexity and project scale) provides consistency in provision of information requirements and limits the likelihood that projects are unnecessarily exposed to added complexity.

Various packaging options have been assessed including two, three, or four NoRs and even the possibility of advancing each corridor on their own (refer to Figure 8 below). Overall, the apportioned packages were considered to be less desirable on the basis that:

- The options have been considered and assessed on a network-wide approach and therefore due to their physical proximity and interdependence on each other;

- When considered separately, the proposed interventions in each corridor might overstate the possible severance effects in each catchment; and
- The commonality of issues and effects of each corridor warrant collective assessment.

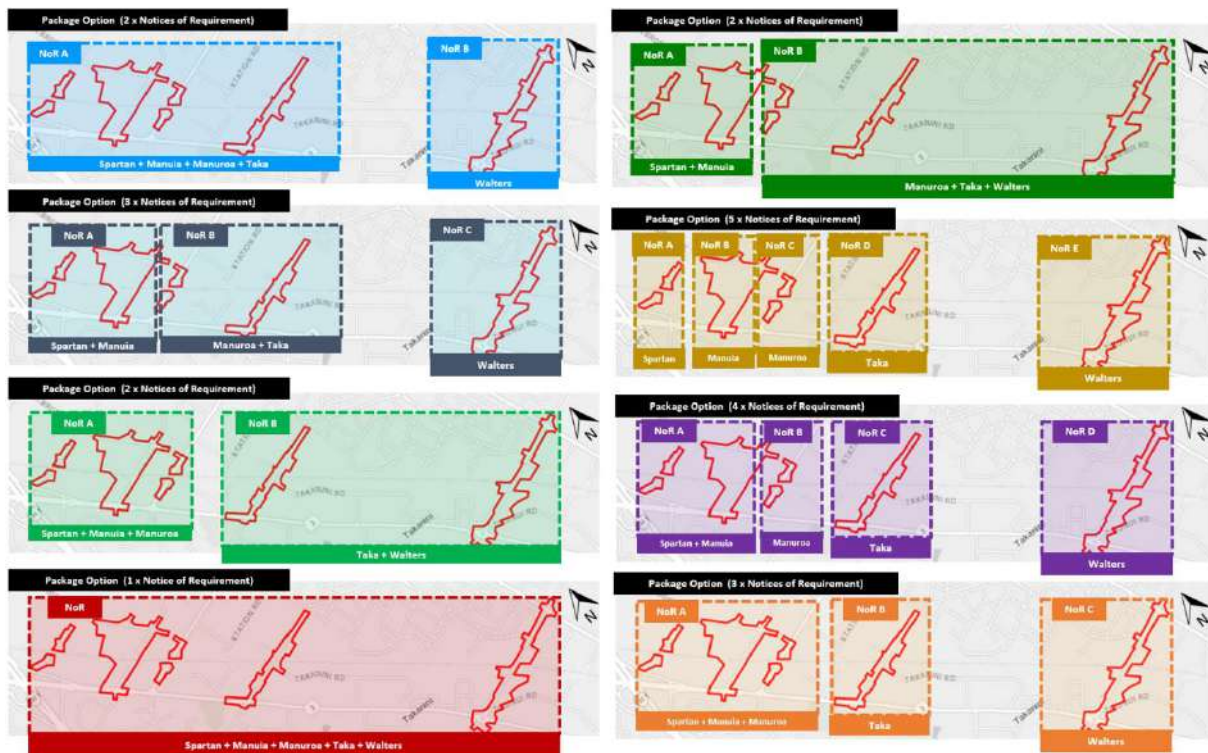


Figure 8: Precis of potential packages

Based on the evaluation of the projects against the relevant criteria, one package covering all five corridors is preferred at this stage. However, we also recommend that this approach be revisited in the event that any new information in relation to the projects is obtained during community and stakeholder feedback. The benefits of this approach are:

- It allows the alignments to be evaluated in an integrated fashion across the network and localised catchments;
- Provides consolidated lapse dates for the relative packages of works which would be satisfied once works commence on the first alignment and therefore mitigate the risk that the project lapses; and
- Provides for efficiencies in hearing preparation and attendance.

The proposed package is set out below.

1 NoR Package - Takaanini Level Crossings Package will cover:

- **Spartan Road**
 - Spartan Road active mode connection / bridge over the NIMT
 - Spartan Road east cul-de-sac turning head / road closure works
 - Spartan Road west cul-de-sac turning head / road closure works
- **Manuia Road**
 - Grade separated crossing / bridge

- Manuia Road east and west upgrades
- Manuia Road west/Great South Road/Challen Close intersection upgrade
- Manuia Road bridge east / Oakleigh Ave tie-in works
- Alternative access/service lane to current Manuia Rd properties
- **Manuroa Road**
 - Active modes grade separated structure
 - Manuroa Road west cul-de-sac / road closure works
 - Manuroa Road east cul-de-sac / road closure works
- **Taka Street**
 - Grade separated crossing / bridge
 - Taka Street west/Great South Road/Walter Strevens Drive intersection upgrade
 - Takanini Road north cul-de-sac / road closure works
 - Corridor widening / active mode upgrades
- **Walters Road**
 - Grade separated crossing / bridge
 - Walters Road east / Porchester Road intersection upgrade
 - Walters Road east / Arion Road intersection active mode upgrades
 - Walters Road west / Great South Road intersection active mode upgrades
 - Corridor widening / active mode upgrades

As noted above, we consider that this approach should be reconsidered upon receipt of feedback from the community and stakeholders.

5 Conclusions

Route protection is warranted and necessary for the proposed level crossing closures, grade separated crossings and supporting works associated with the TLC. Due to the existing urban environment and the intensification enabled through PC78 there is a significant risk that further development will compromise the TLC corridors. The need for route protection is urgent.

Designating is recommended as the most appropriate method to protect the route for the TLC. This is because the truncated timing of PC78 and the fragmented small landholdings surrounding the corridors make alternative planning or third party mechanisms inappropriate.

Appendix A: Summary table of recommendations

1 Appendix A - Draft strategy selection checklist

This table is to be used as a checklist, with brief notes, to summarise key factors that have determined the recommended consenting pathway.

Key to table:		Liveability Outcomes					Urgency							Complexity												
		Strategic importance – anchor projects, area synergies (e.g., southern rail Four Tracking, FTN projects)	Window of opportunity to shape urban form (especially considering remaining land)	Window of opportunity to improve safety outcomes and network connectivity	Window of opportunity to coordinate with other infrastructure providers (e.g., KiwiRail)	Existing (e.g. zoning) environment and scope of any existing designations	General growth pressure in the focus area and risk of imminent build out	Status and timing of Council's structure planning/plan change process (specifically plan changes in response to NPS-UD and MDRS)	Status and timing of proximate or related projects – completing linked projects (i.e., southern rail)	Likelihood of early funding OR availability of confirmed funding (i.e., National Land Transfer Fund))	Escalating land values	Developer timing and staging plans	High degree of interest from local and/or central government (specifically local level due to impact on existing community)	Alignment with strategic documents	Level of certainty regarding width of corridor and likely mode	Need for flexibility in relation to mode and progression of mode over time	Size, scale, and number of components that need to be bundled (road closures, grade separated crossings, corridor and intersection upgrades)	Existence of sensitive receiving environment or locations (ie) existing urban environment, highly constrained and existing / established communities)	Significance of social, environmental or cultural effects (specifically social impact)	Number of affected landowners and complexity of landowners involved.	Extent of alignment with developer aspirations	Level of community engagement (support vs opposition; engaged vs. disengaged)	Physical constructability issues (i.e., peat issues known in project area)	Future consenting risk for implementation phase (i.e., future-proofing in anticipation of CRL implementation requirements)	Lack of certainty re future land use density (FUZ, residential, industrial zones)	Complex timing / staging approach involved (due to intervention interdependency and anticipated implementation constraints)
Neutral	O																									
Positive / High	✓																									
Negative / Low	X																									
Not applicable / Not relevant	blank																									
<u>LC2 – Closure of existing level crossing and stopping Spartan Road</u>		✓	✓	✓	✓	X	✓	✓	✓	✓	O	✓	O	✓	O	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	
<u>LC 3 – Closure of existing level crossing and stopping Manuroa Road</u>		✓	✓	✓	✓	X	✓	✓	✓	✓	O	✓	O	✓	O	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	
<u>LC 4 - Closure of existing level crossing and creation of grade separated crossing at Taka Road</u>		✓	✓	✓	✓	X	✓	✓	✓	✓	O	✓	O	✓	O	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	
<u>LC 5 - Closure of existing level crossing and creation of grade separated crossing at Walters Road</u>		✓	✓	✓	✓	X	✓	✓	✓	✓	O	✓	O	✓	O	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	
<u>LC 6 - Creation of grade separated crossing at Manuia Road</u>		✓	✓	✓	✓	X	✓	✓	✓	O	O	✓	O	✓	O	✓	✓	✓	✓	O	✓	✓	✓	✓	✓	

Takaanini Level Crossings Project

Appendix M - Risk register

October 2023

Version 1.0

Document Status

Responsibility	Name
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1 Introduction

1.1 Risk management process

Risk management has been undertaken throughout the development of this Takaanini level crossings Detailed Business Case (DBC) in accordance with the Te Tupu Ngātahi Supporting Growth Alliance's (SGA's) 'Risk and Opportunity Management Plan' which comprises of the following stages:

- Risk (threat and opportunity) identification – relative to context.
- Risk analysis – likelihood and consequences based upon current control measures.
- Risk evaluation – scoring of the risk to determine it's relative magnitude.
- Risk treatment – to eliminate or reduce the consequences or likelihood of the risk occurring.

The remainder of Section 1 of this Risk Register outlines the process that has been followed in each of these stages. Section 2 then summarises Programme-wide risks and Section 3 summarises Project-specific risks.

1.2 Identification

Threat and opportunity identification has been a continuing process throughout the development of the DBC and has included the following:

- Initial risk workshops to identify threat and opportunities at the start of the DBC.
- Regular identification (and update) at the project team meetings based upon the DBC's development and subsequent feedback from the team and partners/stakeholders.
- Specific risk workshops throughout the development of the design.
- Ad-hoc emails/conversations with team members.

Identified risks were captured within the Takaanini DBC SharePoint risk register, Risk Owner assigned and subsequent analysis undertaken (as detailed below).

1.3 Analysis

The likelihood of occurrence and consequence of the risks have been analysed using the criteria identified in Table 1-1 and Table 1-2 below based upon the current control measures.

Table 1-1 : Likelihood risk or opportunity rating

Likelihood Risk or Opportunity Rating		Likelihood of Risk or Opportunity Occurring	%
5	HIGHLY LIKELY	May occur in next 12 Months	> 85
4	LIKELY	May occur in the next >1 to 2 years	55 – 85
3	POSSIBLE	May occur in next >2 to 6 years	30 – 55
2	UNLIKELY	May occur once in >6 to 10 years	5 – 30
1	RARE	May occur once in 10 years	< 5

Table 1-2 : Semi-quantitative threat criteria

Semi-Quantitative Threat Criteria							
Rating Scale	Reputation			Performance			
	Stakeholders	Public / Media	Legal / Compliance	Project Delivery	Project Cost	Health & Safety	Environmental
Severe	Disruption to stakeholder relationship slowing progression of nationally strategic activity, and/or Loss of route availability of a national strategic high-volume highway	Sustained national and/or international media coverage AT/Waka Kotahi NZ Transport Agency and the PAB do not envisage any exposure in reputational risks at this level	High profile prosecution(s) with potential for custodial sentence	Programme slippage resulting in late delivery by more than 180 days	Negative financial impact of more than \$25M	Loss of life, permanent disability or injury, or multiple serious injuries	Permanent pollution damage or other environmental damage
Major	Disruption to stakeholder relationship slowing progression of regionally strategic activity, and/or Loss of route availability of a national strategic highway	Sustained media coverage (weeks) Possible Ministerial inquiry leading to loss of Ministerial confidence/formal enquiry by OAG or statutory agency Widespread and significant community concern and/or high-profile community concerns raised	Individual prosecution Potential prosecution with maximum fine / imprisonment High profile legal challenge or prosecution with heavy fines	Programme slippage resulting in late delivery by between 90 and 180 days	Negative financial impact between \$10M to \$25M	Serious injury (injuries) requiring specialist medical treatment or lost time greater than three weeks	Significant and widespread pollution or other environmental damage, with long term effects
Moderate	Disruption to stakeholder relationship slowing progression of regional activity, and/or Loss of route availability of a regional strategic highway	Short term (days) media coverage Parliamentary/Ministerial questions or 3rd party investigation Community complaints	Breach with legal rebuke / abatement notice/restrictions Some legal constraints imposed, minimal fines	Programme slippage resulting in late delivery by between 30 and 90 days	Negative financial impact between \$2M to \$10M	Injury requiring medical treatment or lost time of one day to three weeks	Pollution or other environmental damage at a localised level, with medium term effects
Minor	Disruption to stakeholder relationship slowing progression of site-specific activity, and/or Loss of route availability of a regional connector highway	Local media coverage for 1-5 days Official information request. Negative feedback from Minister Reputation within industry is damaged Some community complaints Marginal impact on stakeholder confidence.	Breach with letter from authority requesting action	Programme slippage resulting in late delivery by between 7 and 30 days	Negative financial impact between \$0.5M to \$2M	Injury requiring short term medical treatment and workplace absence less than one day	Minimum pollution or other environmental damage. Short term effects only
Insignificant	Disruption to stakeholder relationship, and/or Loss of route availability of a regional distributor highway	Local media coverage for 1-day Reputation intact Internal knowledge only Minimal impact on stakeholder confidence	Breach managed at a regional level	Programme slippage resulting in late delivery by less than 7 days	Negative financial impact of less than \$0.5M	Injury requiring short-term first-aid care and no absence from the workplace	Small scale pollution or other environmental damage is localised with no resultant effects. Contained locally

1.4 Evaluation

Based upon the likelihood and consequence outcomes from the risk analysis, the risks have been evaluated using Table 1-3 and Table 1-4 to identify their Class from A to E. The significance of a Class A threat is 'very high' to Class E which is considered 'very low'. Likewise, for opportunities.

Table 1-3: Threat rating matrix

RISK RATINGS LIKELIHOOD x CONSEQUENCE						
Likelihood	5 Highly Likely (May occur this year) >85%	Class B (5)	Class B (10)	Class A (15)	Class A (20)	Class A (25)
	4 Likely (May occur once in the next 2 years) 55-85%	Class C (4)	Class C (8)	Class B (12)	Class A (16)	Class A (20)
	3 Possible (May occur once in the next 2-5 years) 30-55%	Class D (3)	Class C (6)	Class C (9)	Class B (12)	Class A (15)
	2 Unlikely (May occur once in 5-20 years) 5-30%	Class D (2)	Class D (4)	Class D (6)	Class C (8)	Class C (10)
	1 Rare (May occur once in 20 years) <5%	Class E (1)	Class E (2)	Class E (3)	Class D (4)	Class C (5)
		1 Insignificant	2 Minor	3 Moderate	4 Major	5 Severe
		Consequence				

Table 1-4: Opportunity rating matrix

Likelihood	5 Highly Likely (May occur this year) >85%	Critical Opportunity (25)	Critical Opportunity (20)	High Opportunity (15)	Medium Opportunity (10)	Low Opportunity (5)
	4 Likely (May occur once in the next 2 years) 55-85%	Critical Opportunity (20)	Critical Opportunity (16)	High Opportunity (12)	Medium Opportunity (8)	Low Opportunity (4)
	3 Possible (May occur once in the next 2-5 years) 30-55%	Critical Opportunity (15)	High Opportunity (12)	Medium Opportunity (9)	Medium Opportunity (6)	Low Opportunity (3)
	2 Unlikely (May occur once in 5-20 years) 5-30%	High Opportunity (10)	Medium Opportunity (8)	Medium Opportunity (6)	Low Opportunity (4)	Low Opportunity (2)
	1 Rare (May occur once in 20 years) <5%	High Opportunity (5)	Low Opportunity (4)	Low Opportunity (3)	Low Opportunity (2)	Low Opportunity (1)
		5 Severe	4 Major	3 Moderate	2 Minor	1 Insignificant
		Consequence				

1.5 Treatment

Risk Owners were responsible for identifying and then undertaking 'planned risk treatment' actions appropriate to the risk score identified during the evaluation. These actions were reviewed regularly in project team meetings to capture updates and identify further treatment actions where appropriate. Risks were also closed once further investigation into the risk found that the initial threat or opportunity was no longer a consideration.

2 Programme-wide risks

The table overleaf summarises the programme-wide risks for the Alliance, which are typically relevant.

