TE TUPU NGĀTAHI
SUPPORTING GROWTH

VOLUME 4

Takaanini Level Crossings Assessment of Flooding Effects

October 2023

Version 1.0

WAKA KOTAHI
NZ TRANSPORT AGENCY

AT

New Zealand Government

Document Status

Responsibility	Name
Author	Justin Kirkman
Reviewer	Roger Seyb
Approver	Liam Winter

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1.0	13/10/23	Final for lodgement

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Glossary of Defined Terms and Acronyms

We note that ‘Takaanini’ (with double vowels is used throughout the Report Acknowledging the ongoing kōrero and guidance from Manawhenua on the cultural landscape. ‘Takanini’ is used where reference is made to a specific and existing named place (e.g., Takanini Road, Takanini Town Centre etc.). Manawhenua is also used throughout the Report as while gifting the programme name as Te Tupu Ngātahi, Manawhenua confirmed this was an appropriate spelling (capital ‘M’ and one word). Notwithstanding this, the term is spelled as two words in other fora and the proposed designation conditions – Mana Whenua.

Acronym/Term	Description
AEE	Assessment of Effects on the Environment report
AEP	Annual Exceedance Probability
ARI	Average Recurrence Interval
AT	Auckland Transport
AUP:OP	Auckland Unitary Plan: Operative in Part
CEMP	Construction Environmental Management Plan
Council	Auckland Council
GIS	Geographic Information System
InfoWorks ICM	Auckland Council flood model
KiwiRail	KiwiRail Holdings Limited
MPD	Maximum probable development
NIMT	North Island Main Trunk rail line
NoR	Notice of Requirement
NoR 1	Notice of Requirement 1: Takaanini Level Crossings Project (Spartan Road, Manuia Road, Manuroa Road, and Taka Street
NoR 2	Notice of Requirement 2: Takaanini Level Crossings Project (Walters Road)
NPS:UD	National Policy Statement on Urban Development
OLFP	Overland flowpath
PC78	Plan Change 78 to the Auckland Unitary Plan: Operative in Part
RMA	Resource Management Act 1991
Te Tupu Ngātahi	Te Tupu Ngātahi Supporting Growth
TLC / the Project	Takaanini Level Crossings Project
Waka Kotahi	Waka Kotahi New Zealand Transport Agency

Executive Summary

This Assessment of Flooding Effects Report (**Report**) has been prepared to inform the Assessment of Effects on the Environment (**AEE**) for two Notices of Requirement (**NoR**) being sought by Auckland Transport (**AT**) for the Takaanini Level Crossings Project (**TLC / the Project**) under the Resource Management Act 1991 (**RMA**). The TLC is proposed to be a network of transport infrastructure to support east-west connectivity across the NIMT in Takaanini, this includes various interventions across five project areas.

Flooding is a natural hazard and has therefore been considered as part of the NoRs for the Project. The works required for the Project have the potential to lead to flooding effects and an assessment is provided to demonstrate that these effects can be appropriately avoided, remedied or mitigated in the future, closer to the construction of the Project. It is also acknowledged that there will be a subsequent process for seeking regional resource consents which will address a wider range of actual and potential stormwater quantity and quality effects. The future mitigation of actual and potential stormwater effects (stormwater quality and retention/detention) has been indicatively considered at this NoR phase. This is to test that sufficient land is available within the designation boundaries to provide for these potential requirements in future.

In general, the TLC programme of works may displace flood storage volume and divert/throttle the passage of floodwater. Flood effects can be categorised into peak water level increases, flood extent increases, new flood flowpaths, nuisance ponding and changes to the flood hazard (velocity-depth product). In the context of this assessment, flood hazard risk may include changes to:

- The flood freeboard to existing habitable buildings, overland flow paths;
- The ability to access property by residents and emergency vehicles; and
- The level of flooding to roads, cycleways and footpaths.

Flood effects have been identified using the latest Auckland Council flood model (**InfoWorks ICM**) and a qualitative effects assessment of the flood displacement and conveyance disruption has been carried out. Flood effect mitigation has been approached using culverts and compensatory flood storage.

1 Introduction

1.1 Purpose and scope of this Report

This Report has been prepared to inform the AEE for two NoRs being sought by AT for the the Project under the RMA. The Project proposes to construct five new bridges across five project areas: NoR 1 relates to four of the proposed Project areas (referred to as Spartan Road, Manuia Road, Manuroa Road and Taka Street) while NoR 2 relates to the remaining Project area (referred to as Walters Road). Specifically, this Report considers the actual and potential effects associated with the construction and operation of the TLC on the existing and likely future environment as it relates to flooding effects and recommends measures that may be implemented to avoid, remedy and/or mitigate these effects.

This Report draws a distinction between stormwater effects and flood hazard effects, which are a subset of potential stormwater effects.

Stormwater effects are broadly divided into stormwater quantity effects (such as flooding, erosion and changes to hydrology – which may cause effects on stream habitat, baseflow and sediment movement in streams), stormwater discharge quality (including the discharge of contaminants – which may cause effects on aquatic fauna, public health and amenity values) and the effects on streams due to the presence of in-stream structures. These effects are considered through sections 13, 14 and 15 of the RMA and are administered through regional consents by Auckland Council.

A designation is a land use or district planning mechanism. Accordingly, when assessing the actual or potential stormwater effects on the environment of allowing the requirement in terms of section 171 of the RMA, the assessment of effects has been limited to flood hazard matters being the specific matters that would trigger a District Plan consent requirement under the Auckland Unitary Plan (Operative in Part) (**AUP:OP**). Where Regional Plan consenting requirements are triggered, these will not be authorised by the designation, and will require further regional consents to be obtained prior to construction of the Project.

In the context of this assessment, flood hazard effects include:

- Increasing flood levels on adjoining property; and
- Increasing the flood hazard.

This Report should be read alongside the AEE, which contains further details on the history and context of the TLC. The AEE also contains a detailed description of works to be authorised within each NoR, and the typical construction methodologies that will be used to implement this work. These have been reviewed by the author of this Report and have been considered as part of this flooding effects assessment. As such, they are not repeated here. Where a description of an activity is necessary to understand the potential effects, it has been included in this Report for clarity.

1.2 Report Structure

The structure of the Report is set out in Table 1 below. The assessment considers the actual and potential effects of the NoRs as a whole in the first instance. Where required, the assessment then focusses on the actual and potential effects arising within individual project areas (i.e., Spartan Road, Manuia Road, Manuroa Road, Taka Street which falls within NoR 1 and Walters Road which falls within NoR 2). Where appropriate, measures to avoid, remedy or mitigate effects are also recommended.

Where the individual project areas are discussed, sub-sections are arranged by project area in geographical order along the North Island Main Trunk line (**NIMT**) moving north to south.

Table 1: Report Structure

Sections	Section number
Description of the TLC	2
Overview of the methodology used to undertake the assessment and identification of the assessment criteria and any relevant standards or guidelines	3
Identification and description of the existing and likely future the environment within the stormwater context	4.1
Assessment of general flooding matters for the overall TLC network and project areas	4.2, 4.3, 4.4, 4.5, 4.6, 4.7
Overall conclusion of the level of potential adverse flooding effects of the TLC.	5

2 Project Description

The overall Project proposes the removal and/or replacement of four existing road over rail level crossings at Spartan Road, Manuroa Road, Taka Street and Walters Road in Takaanini. As further discussed in the AEE, the Project responds to functionality and safety issues anticipated at these crossings from the increasing number of train movements along the NIMT. The Project and indicative design also take into account the long-term planned expansion of the NIMT from the current two rail tracks to up to four tracks. The increased rail frequency will lead to greater barrier arm down-time and therefore increased severance and congestion in the area.

The Project primarily involves the construction of five new bridges to support safe and reliable east-west transport movement across the NIMT in Takaanini. This includes dedicated active mode bridges at Spartan Road and Manuroa Road, and two-lane arterial road bridges with active mode facilities at Manuia Road, Taka Street and Walters Road. Manuia Road is a new east-west connection in the network, acting as a replacement for vehicular trips that would have used the closed Spartan and Manuroa Road level crossings. The bridges and associated works/improvements are located across five project areas and will be progressed as two NoR packages (refer to Figure 1 and Table 2).

The indicative design has been prepared for assessment purposes, and to indicate what the final design of the Project may look like. The final design will be refined and confirmed at the detailed design stage. Key features of the works common across project areas include the following:

- Bridge structures across the NIMT with a vertical clearance from existing ground level to road surface of approx.7.8m;
- Works to tie in with existing roads;
- Batters and/or retaining and associated cut and fill activities;
- Vegetation removal within the project areas to enable construction; and
- Areas identified for construction related activities including site compounds, construction laydown, alternative access, and construction traffic manoeuvring.

Further details of each project area are provided in the following sections below.

Table 2: The TLC project areas and NoR packages

NoR Reference	Project area	Description	Requiring Authority
Takaanini Level Crossings Project NoR 1	**Spartan Road**	Closure of the existing level crossing, construction of a new bridge with walking and cycling facilities across the NIMT and associated works.	Auckland Transport
	Manuia Road	Construction of a new bridge with general traffic lanes and walking and cycling facilities across the NIMT and associated works.	
	Manuroa Road	Closure of the existing level crossing, construction of a new bridge with walking and cycling facilities across the NIMT and associated works.	
	Taka Street	Closure of the existing level crossing, construction of a new bridge with general traffic lanes and walking and cycling facilities across the NIMT and associated works.	
Takaanini Level Crossings Project NoR 2	**Walters Road**	Closure of the existing level crossing, construction of a new bridge with general traffic lanes and walking and cycling facilities across the NIMT and associated works.	

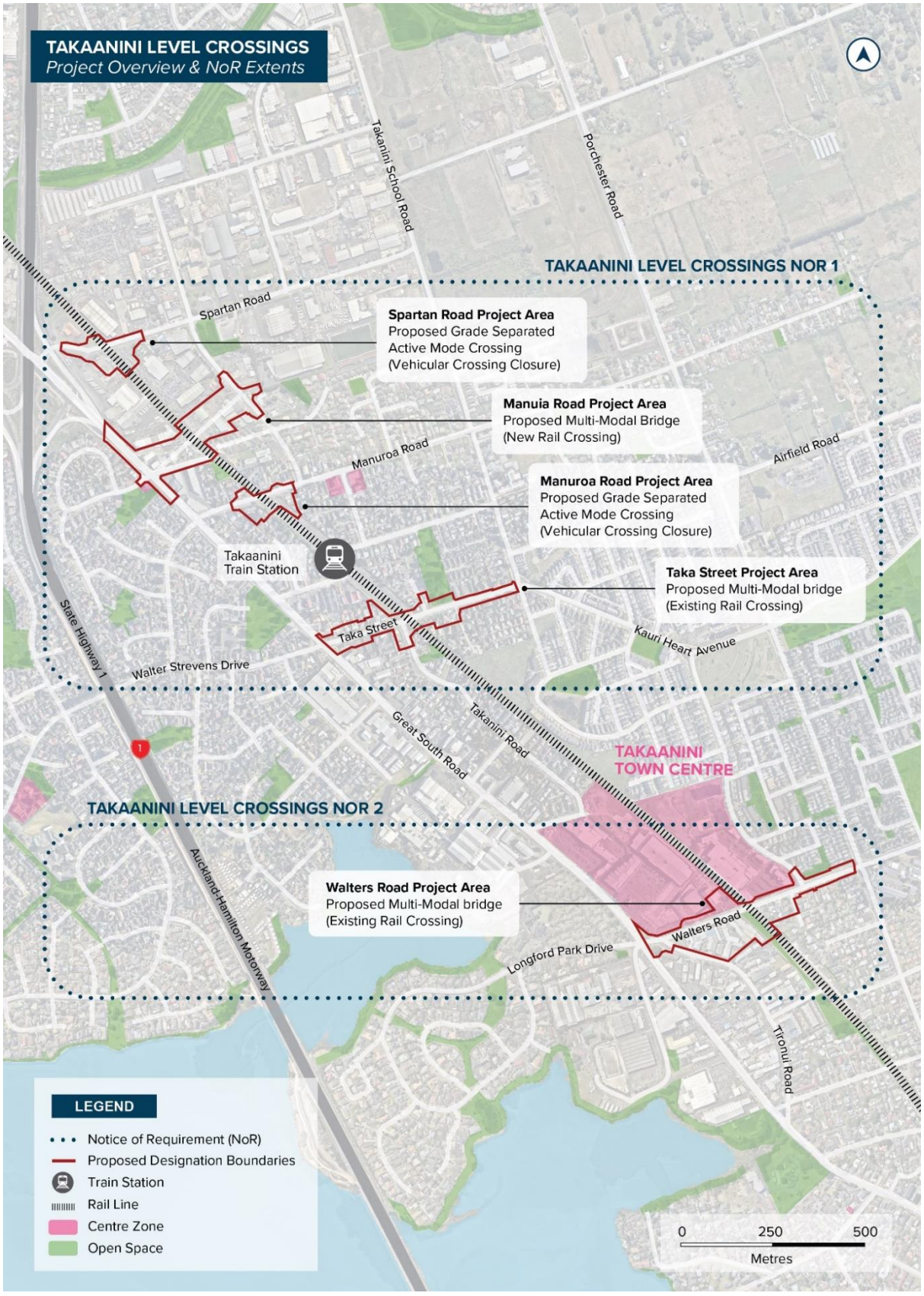


Figure 1: Overview of the project areas and extent of the NoRs.

2.1 NoR 1 – Spartan Road, Manuia Road, Manuroa Road and Taka Street

2.1.1 Spartan Road project area

As set out in Table 3 below, the proposed works within the Spartan Road project area include closure of the existing level crossing and replacement with a new active modes bridge across the NIMT.

Table 3: Overview of Spartan Road project area

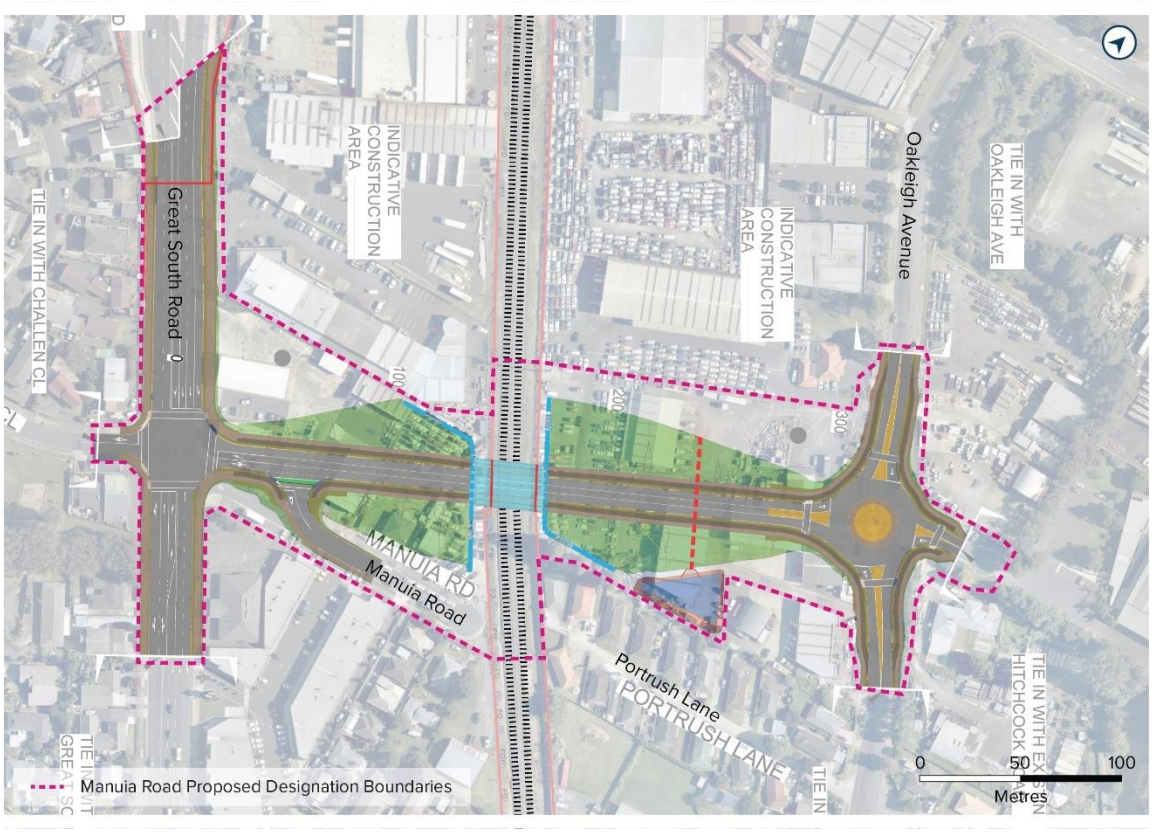
NoR 1 - Spartan Road project area	
	
Key features	
Overview	• Closure of the existing road corridor to vehicular traffic across the NIMT. • Construction of an active mode bridge across the NIMT. • Construction of cul-de-sacs (accommodating footpaths) and works to tie into the existing corridor on either side of the NIMT along Spartan Road. • Ramps and stairs will connect to the bridge on either side (east and west) of the NIMT and will tie into the cul-de-sacs.
Other structures	• None
Other road closures / cul-de-sacs	• None
Speed environment	• 50km/h (where it is trafficked)

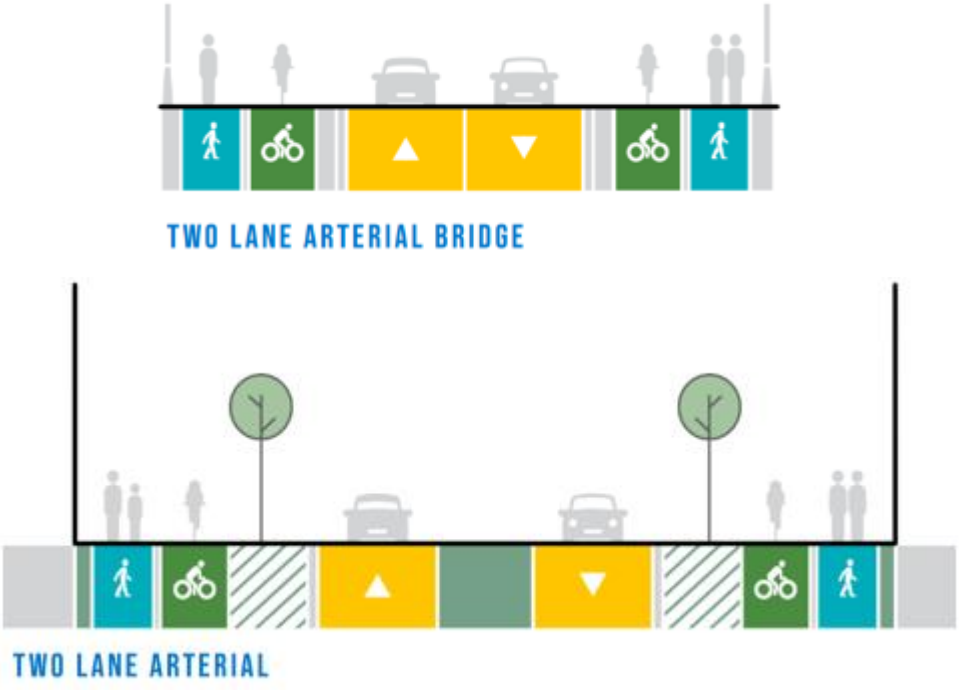
Access lanes	• None
Intersections	• None
Stormwater infrastructure	• Kerb and channel along road edge
Typical cross sections	 ACTIVE MODE BRIDGE

2.1.2 Manuia Road project area

As set out in Table 4 below, the proposed works within the Manuia Road project area include construction of a new grade-separated road crossing (bridge) across the NIMT. The new bridge will accommodate one vehicle lane in each direction and active mode facilities.

Table 4: Overview of the Manuia Road project area

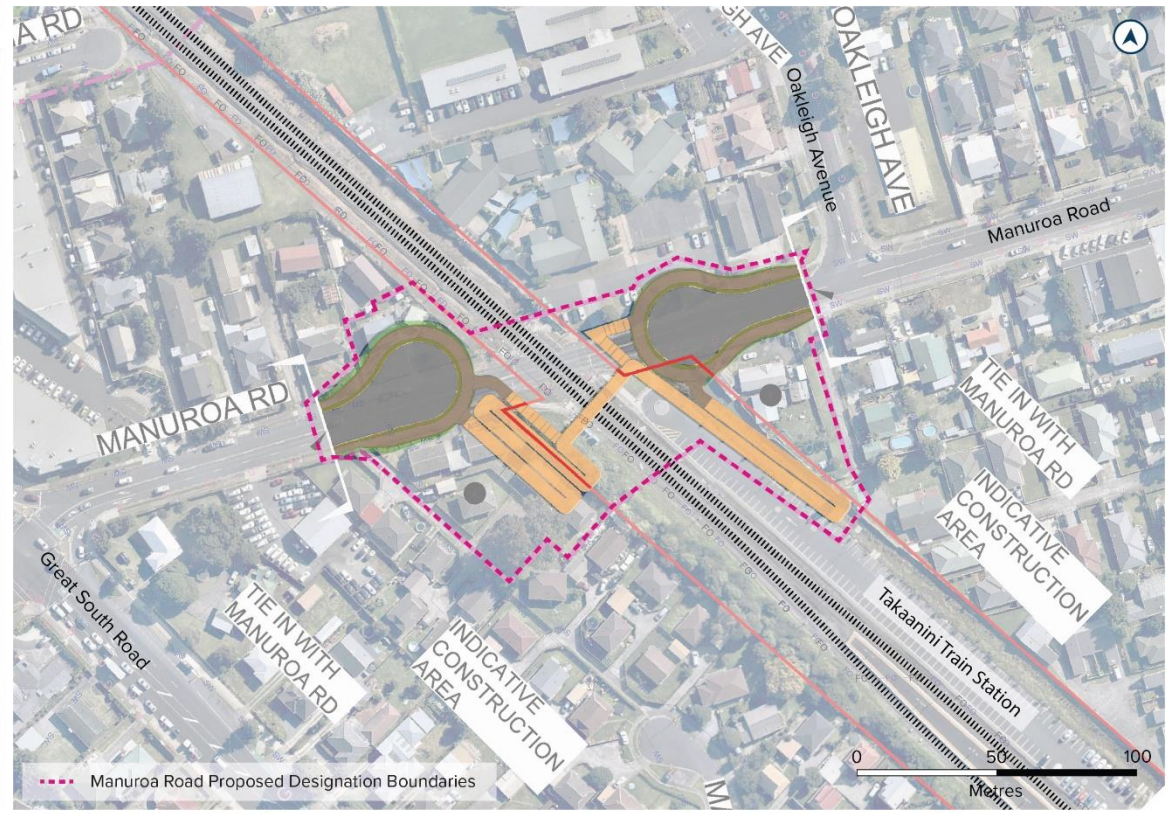
NoR 1 – Manuia Road project area	
	
Key features	
Overview	• There is currently no existing east-west corridor / level crossing across the NIMT in this project area. • Construction of a new arterial road bridge across the NIMT accommodating two lanes (one in each direction) and separated active mode facilities. • Construction of new arterial road corridors tying into either side of the bridge (east and west of the NIMT) accommodating two vehicle lanes (one in each direction) and separated active mode facilities.
Other structures	• Retaining/abutment walls (either side of the NIMT)
Other road closures / cul-de-sac	• Reconstruction of existing cul-de-sac at Hitchcock Road (east of the NIMT) to tie into the new intersection at Oakleigh Avenue / Manuia Road / Hitchcock Avenue (as described below) and upgrade with footpath.
Speed environment	• 50km/h

Access lanes	• Existing Manuia Road will be reconfigured into an access lane for remaining properties, tying in with the new Manuia Road corridor / bridge (west of NIMT).
Intersections	• Upgrade of the existing Great South Road / Challen Close / Manuia Road intersection to provide for signalisation, footpath upgrades and tie in works with the existing roads. • New roundabout intersection at Oakleigh Avenue/ Manuia Road / Hitchcock Avenue with active mode facilities and tie in works.
Stormwater infrastructure	• Stormwater culvert and associated flood offset storage area. • Kerb and channel along road edge. *Note: NoR has also considered space requirements for future stormwater treatment devices (though subject to future Regional Plan consenting process)*
Typical cross sections	

2.1.3 Manuroa Road project area

As set out in Table 5 below, the proposed works within the Manuroa Road project area include closure of the existing level crossing and replacement with a new active modes bridge across the NIMT.

Table 5: Overview of the Manuroa Road project area

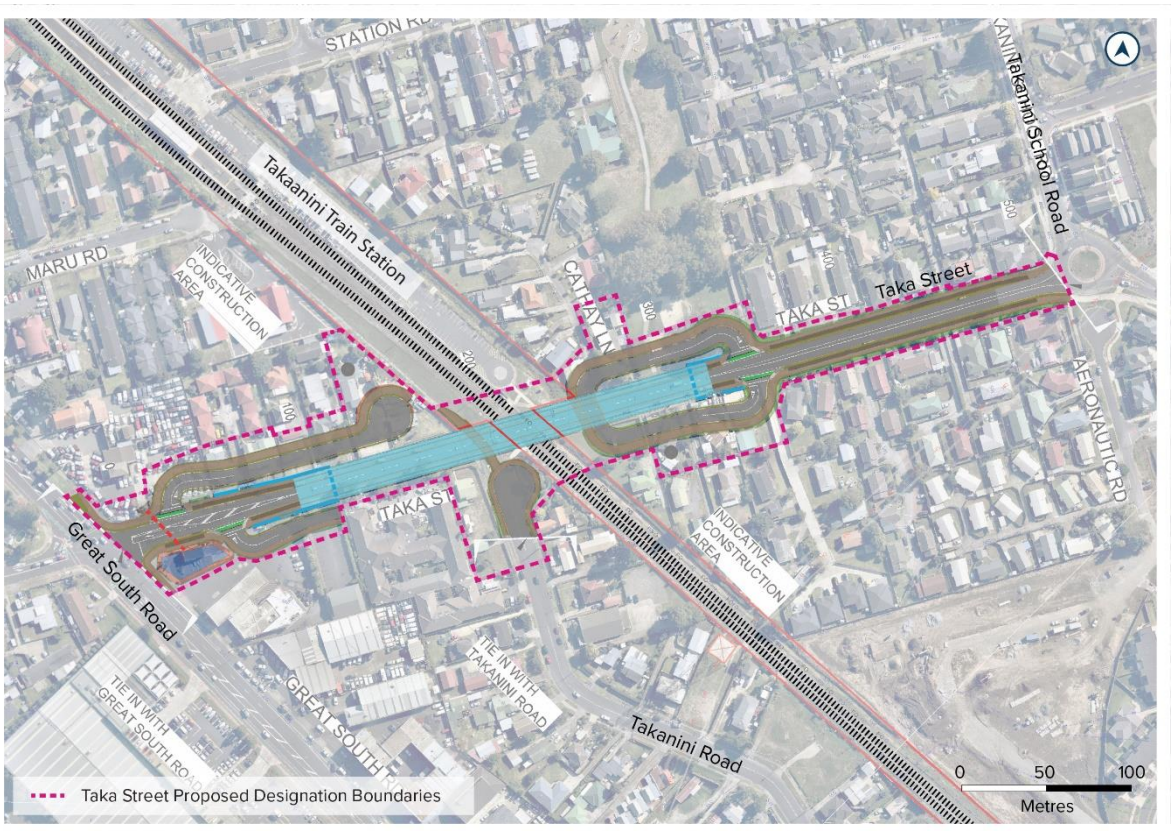
NoR 1 – Manuroa Road project area	
	
Key features	
Overview	• Closure of the existing road corridor to vehicular traffic across the NIMT. • Construction of an active mode bridge across the NIMT. • Construction of cul-de-sacs (accommodating footpaths) and works to tie into the existing corridor on either side of the NIMT along Manuroa Road. • Ramps and stairs will connect to the bridge on either side (east and west) of the NIMT and will tie into the cul-de-sacs.
Other structures	• None
Other road closures / cul-de-sac	• None
Speed environment	• 50km/h (where it is trafficked)
Access lanes	• None

Intersections	• None
Stormwater infrastructure	• Kerb and channel along road edge
Typical cross sections	 ACTIVE MODE BRIDGE

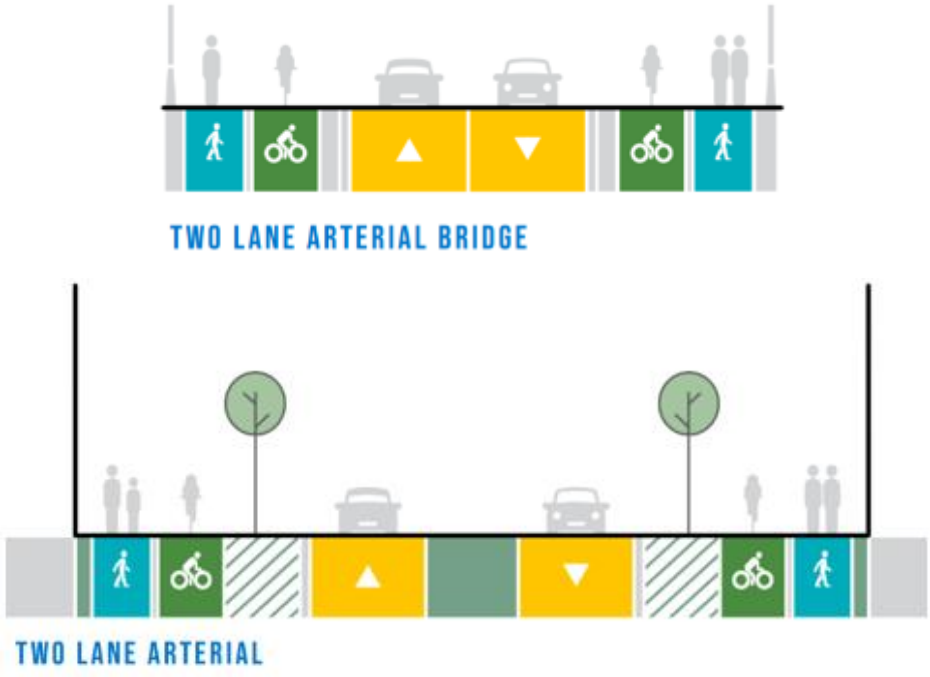
2.1.4 Taka Street project area

As set out in Table 6 below, the proposed works within the Taka Street project area include closure of the existing level crossing and replacement with a new grade-separated road crossing (bridge) across the NIMT. The new bridge will accommodate one vehicle lane in each direction and active mode facilities.

Table 6: Overview of the Taka Street project area

NoR 1 – Taka Street project area	
	
Key features	
Overview	• Construction of an arterial road bridge across the NIMT accommodating two vehicle lanes (one in each direction) and separated active mode facilities. • Construction of arterial road corridors tying into either side of the bridge and existing intersections (east and west of the NIMT). The corridors will accommodate two vehicle lanes (one in each direction) and separated active mode facilities.
Other structures	• Retaining / abutment walls
Other road closures / cul-de-sac	• Closure of existing Takanini Road (north) to vehicular traffic at the intersection with Taka Street bridge i.e., no through-traffic provision. Replacement with a cul-de-sac and works to tie into the existing corridor of Takanini Road to the south. Active modes connection from Takanini Road to Takaanini Station (under the new Taka Street bridge).
Speed environment	• 50km/h

Access lanes	• Construction of four access lanes:
	  • Construction of a new access lane (cul-de-sac) located west of the NIMT and north of the Taka Street road corridor. It accommodates a footpath on the northern side and bi-directional traffic. The access lane will tie in with the Taka Street corridor and allows access to existing properties to remain and Takaanini Station.
	  • Construction of a new access lane located west of the NIMT and south of the Taka Street road corridor. It accommodates a footpath on the southern side and bi-directional traffic. The access lane will tie in with the Taka Street corridor and allows access to existing properties to remain.
	  • Construction of two access lanes located west of the NIMT (north and south of the Taka Street road corridor and looping under the new Taka Street bridge). They accommodate a footpath on the outer edge and bi-directional traffic. The access lane(s) will tie in with the Taka Street corridor and allow access to existing properties to remain including Takaanini Reserve and Cathay Lane.

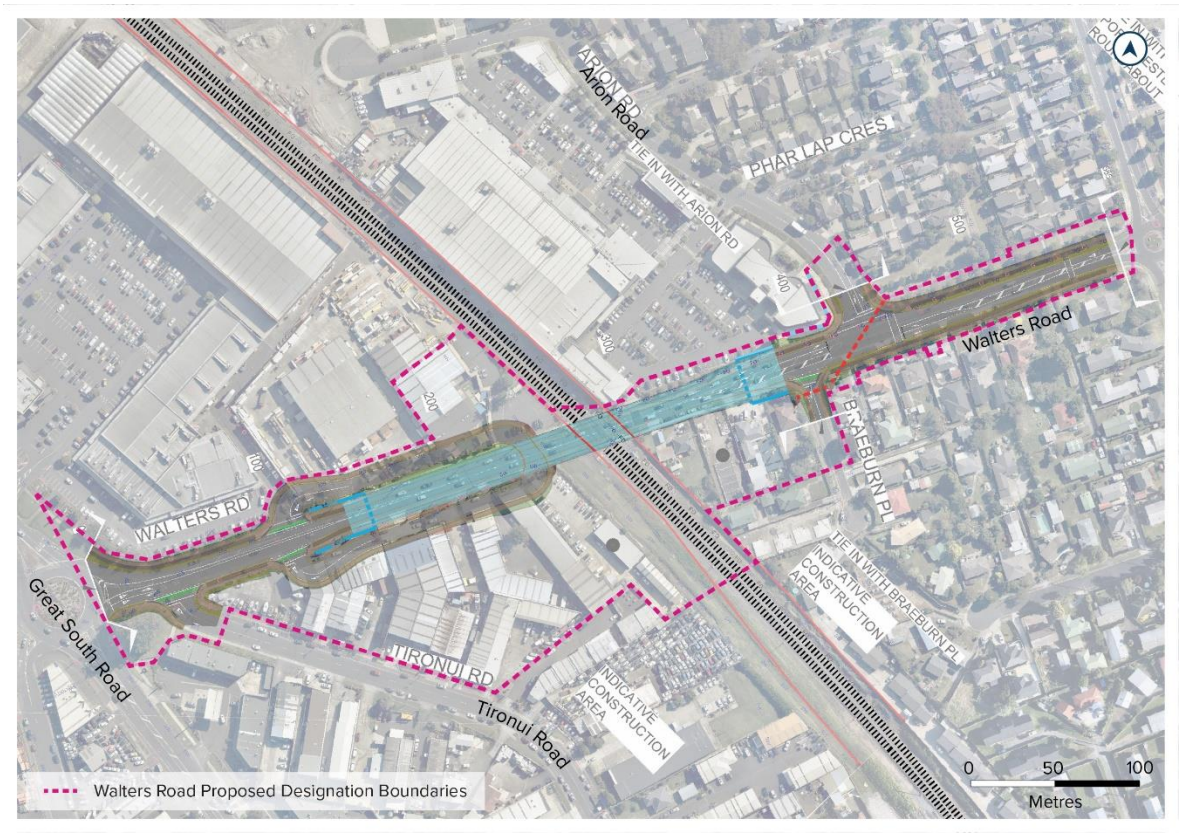
Intersections	• None
Stormwater infrastructure	• Stormwater culvert and associated flood offset storage area. • Kerb and channel along road edge. *Note: designation has also considered space requirements for future stormwater treatment devices (though subject to future Regional Plan consenting process)*
Typical cross sections	

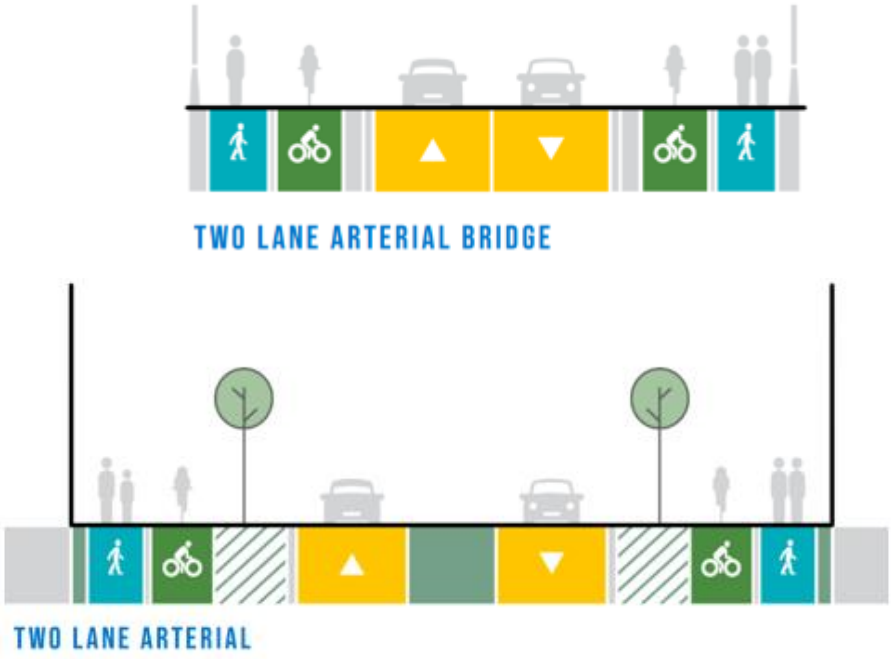
2.2 NoR 2 – Walters Road

2.2.1 Walters Road project area

As set out in Table 7 below, the proposed works within the Walters Road project area include closure of the existing level crossing and replacement with a new grade-separated road crossing (bridge) across the NIMT. The new bridge will accommodate one vehicle lanes in each direction and active mode facilities.

Table 7: Overview of Walters Road project area

NoR 2 – Walters Road project area	
	
Key features	
Overview	• Construction of an arterial road bridge across the NIMT accommodating two vehicle lanes (one in each direction) and separated active mode facilities. • Construction of arterial road corridors tying into either side of the bridge and existing intersections (east and west of the NIMT). The corridors will accommodate two vehicle lanes (one in each direction) and separated active mode facilities.
Other structures	• Retaining / abutment walls
Other road closures / cul-de-sac	• None
Speed environment	• 50km/h

Access lanes	• Construction of two access lanes located west of the NIMT (north and south of the Walters Road corridor and looping under the new Walters Road bridge). They accommodate a footpath on the outer edge and bi-directional traffic. The access lane(s) will tie in with the Walters Road corridor and allow access to remaining properties.
Intersections	• Upgrade of the existing Arion Road / Walters Road intersection to provide for footpath upgrades and works to tie into existing Arion Road. • Upgrade of the existing Braeburn Place / Walters Road intersection to provide for footpath upgrades and works to tie into existing Braeburn Place. • Upgrade of the existing Tironui Road / Walters Road intersection to provide for footpath upgrades and works to tie into existing Tironui Road.
Stormwater infrastructure	• Stormwater culvert. • Kerb and channel along road edge. *Note: NoR has also considered space requirements for future stormwater treatment devices (though subject to future Regional Plan consenting process).*
Typical cross sections	

3 Assessment Methodology

3.1 Preparation for this Report

This Report has been prepared in consultation with other AEE specialists, planners and the engineering design team. This Report has been prepared considering inputs from various technical specialists, flooding modelling sources and outcomes from team workshops. The AUP:OP was referenced to identify the existing and likely future environment.

3.2 Summary

The assessment of flooding effects covers all parts of the TLC. Generally, the assessment has involved the following steps:

- Desktop assessment to identify potential flooding locations, namely:
  - Using the Auckland Council (**Council**) and Te Tupu Ngātahi Supporting Growth (**Te Tupu Ngātahi**) Geographic Information System (**GIS**) to identify where existing buildings appear to be near/within the existing flood plains; and
  - Using the Council and Te Tupu Ngātahi GIS to identify where the Project involves work near stream crossings/major overland flow paths (**OLFP**).
- Inspection of other flood modelling sources (updates and adjacent projects) to identify refine and validate flood assessments. At key cross drainage locations such as bridges or culverts and where there are noticeable changes in flood extents or flood levels, consideration was given to flood hazard issues;
- Review of all external drainage flow paths entering the project areas and assessing the effects of the development on the upstream flood levels. Mitigation optioneering was required where effects were found to be unsatisfactory; and
- Hui with Manawhenua and listening to the flooding concerns of the catchment.

For the purposes of my assessment, I am satisfied that there are a range of mitigation options available within the proposed footprint to adequately manage flood effects resulting from the works without numerical flood modelling to validate the outcomes. Numerical flood modelling may be required to confirm the outcomes of this Report at the resource consent stage.

While stormwater effects apart from flooding are not assessed (as these are part of future consenting processes), the future mitigation of potential stormwater effects (stormwater quality and retention/detention) has been indicatively considered at this NoR phase. This to test that sufficient land is available within the designation boundaries to provide for these potential requirements in future

3.3 Assumptions and Limitations

In undertaking this assessment, the following limitations have been encountered and therefore the following assumptions have been made:

- The proposed project areas are located within a predominantly urban landscape which will evolve over time and is likely to experience change before the implementation of the Project. The National Policy Statement on Urban Development (**NPS:UD**) enables higher density dwellings within a

walkable catchment of rapid transit stops. In the context of this Project, it is anticipated that the following urban intensification will take place in line with proposed Plan Change 78 to the Auckland Unitary Plan: Operative in Part (**PC78**):

- Zoning within a walkable catchment of a rapid transit stop in the project areas will enable, at minimum, apartment buildings of six storeys; and
- Beyond walkable catchments, residential zoning will provide for three dwellings up to three storeys in height (subject to meeting the relevant development standards).

Considering the direction of the NPS:UD noted above, it is possible that significant change in the catchments may take place before or shortly after the Project is constructed. Therefore, it is anticipated that further modelling will be required during the detailed design phase of the Project to take account of catchment characteristics at that time and to confirm proposed mitigation.

3.4 Outcomes based approach

The stormwater and flooding considerations are based on a concept design and proposed designation boundary which includes sufficient space to respond to the future environment. The effects assessment is based on the Project being able to meet the outcomes set out below and provide any required mitigation within the designation boundary.

The Project includes some changes to the vertical alignment of existing roads within the urban areas. This has been mitigated where needed with additional pipe capacity under the road to offset the loss of weir flow capacity and flood offset areas to replace the loss of storage. Future detailed design for the Project will need to assess and manage potential flooding effects in concert with the mitigation measures proposed as part of this assessment. In some areas, the anticipated works pass through existing flood plains and detailed design geometry will need to match the existing levels so as to not exacerbate effects.

There will also be some increases in impervious area within the project areas – in the order of 10%. As the retention and detention volumes will be sized for the impervious area of the whole Project increases in runoff relate to the change in impervious area, the stormwater management can be handled at source in linear systems such as bioretention systems/raingardens. The changes in impervious areas are small in the context of the overall catchments and are not expected to cause considerable effects. As the project areas are located in the lower half of the catchment no flood attenuation is expected as this will only serve to increase coincident peak effects with the upper catchment flows.

During the future detailed design stage of the Project, measures should be implemented to achieve the following outcomes:

- No increase in flood levels in a 1% AEP event for existing authorised habitable floors that are already subject to flooding or have a freeboard less than 150mm (that is, no increase in flood level where the flood level using the pre project model scenario is above the habitable floor level);
- No more than a 10% reduction in freeboard in a 1% AEP event for existing authorised habitable floors with a freeboard over 150mm (that is, if existing freeboard was 500mm, an acceptable change would be to reduce freeboard to 450mm);
- No increase in 1% AEP flood levels for existing authorised community, commercial, industrial and network utility building floors that are already subject to flooding;

- No more than a 10% reduction in freeboard in a 1% AEP event for existing authorised community, commercial, industrial and network utility building floors;
- No increase of more than 50mm in flood level in a 1% AEP event on land zoned for urban or future urban development where there is no existing habitable dwelling;
- No new flood prone areas (with a flood prone area defined as a potential ponding area that relies on a single culvert for drainage and does not have an OLFP); and
- No more than a 10% average increase of flood hazard (defined as flow depth times velocity) for the main access to authorised habitable dwellings. The assessment shall be undertaken for the 1% AEP rainfall event.

Compliance shall be demonstrated in the Outline Plan, which shall include flood modelling of the pre-Project and post-Project 100-year ARI flood levels (for Maximum Probable Development land use and including climate change).

Where the above outcomes can be achieved through alternative measures outside of the designation such as flood stop banks, flood walls, raising existing authorised habitable floor levels and new overland flow paths, varied through agreement with the relevant landowner, the Outline Plan shall include confirmation that any necessary landowner and statutory approvals have been obtained for that work or alternative outcome.

This assessment identifies where existing flood effects occur and may require mitigation. The designation boundary allows for treatment and retention/detention devices which include some storage. However, the final geometric design will be more important in not exacerbating existing flood effects.

Compliance with these flooding outcomes should be demonstrated through a detailed stormwater design and further flood modelling of the pre-development and post-development 100-year Average Recurrence Interval (**ARI**) flood levels (with allowances for MPD and climate change) at the future resource consent stage of the Project.

3.5 Desktop assessment

To identify locations considered to be at risk of flooding effects a desktop study was carried out to identify areas where:

- Existing buildings are near / within the existing flood plains;
- The Project involves carrying out work near the stream crossings / major OLFPs; and
- The Project may alter the existing flood plains, ponding volumes, and natural drainage paths.

The following reference materials were used to perform the desktop study:

- AUP:OP;
- Auckland Council GIS resources (Auckland GeoMaps);
- Design drawings;
- Flood model results created by the SG modelling team;
- NZTA Stormwater Specification P46;
- The Auckland Code of Practice for Land Development and Subdivision Chapter 4: Stormwater, Version 3.0, January 2022;
- Auckland Transport Hīkina te Wero: Environment Action Plan, December 2021; and

- Waka Kotahi Toitū Te Taiao Sustainability Action Plan, April 2020.

4 The TLC NoRs – Overall network

This section assesses common or general stormwater matters across the entire TLC network i.e., the combination of road closures and/or grade separated crossings across the five project areas. This section also recommends measures to avoid, remedy, or mitigate actual or potential adverse effects considering the network as a whole. Where appropriate, the following sections include Project-area specific assessment and recommendations.

4.1 Assessment features

The AEE outlines the key attributes of the existing and likely future environment of the Project across each of the five project areas.

The existing and likely future environment specific to flooding matters include catchment drainage features, land cover, soil type/condition are further discussed below.

4.1.1 Stormwater catchment overview

The Project lies within the Papakura Stream and Pahurehure Inlet stormwater catchment. The catchment receiving environment for these stormwater catchments is the Manukau Harbour. There are no streams within the five project areas, but there are various OLFPs that pass through the project areas.

4.1.2 Catchment characteristics

The project areas are located within an existing urban environment with urban zoning under the AUP:OP. A breakdown of the zoning for each project area is provided in the AEE, but overall comprises of Residential (Mixed Housing Urban, Mixed Housing Suburban), Business (Heavy Industry, Light Industry and Town Centre) and Open Space (Informal Recreation) zones. The changes anticipated under PC78 (Figure 2) will also see up-zoning of the existing Residential – Mixed Housing Urban areas to Terrace Housing and Apartment Buildings zone[1] and Residential – Mixed Housing Suburban areas to Residential – Mixed Housing Urban.

[1] Within a walkable catchment of a Train Station.

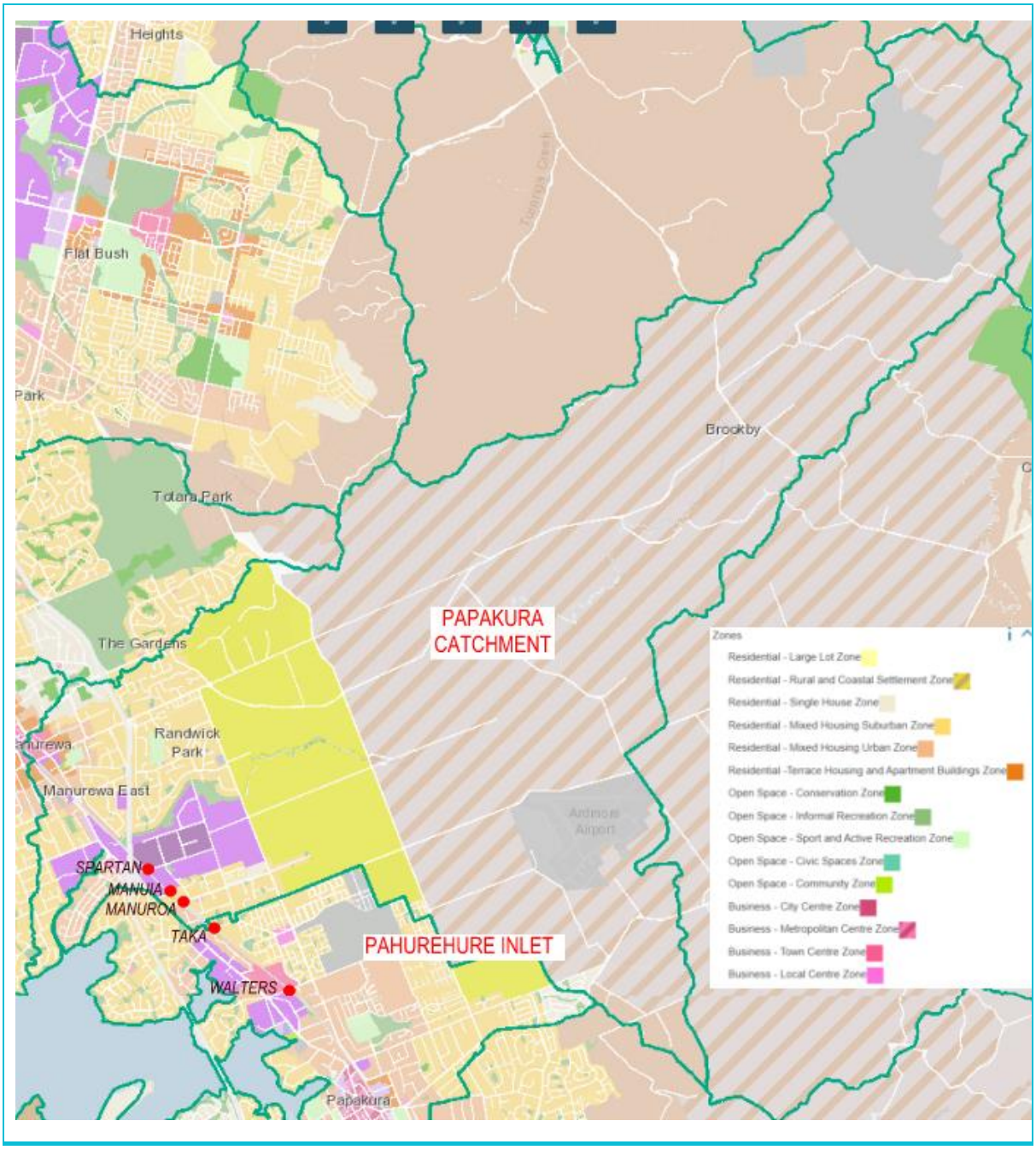


Figure 2: Map of Papakura catchment and anticipated changes following PC78

In terms of land use, the upstream area of Spartan Road, Manuia Road and Manuroa Road in the Papakura Stream catchment, is mainly rural land use with some industrial and residential land near the project areas. The downstream areas are largely residential with a fully realised development potential already in place (noting that further intensification is enabled and anticipated). Papakura Stream has a number of throttles, most notably at the NIMT Railway line and at Great South Road. These throttles are known to be the cause of high upstream flood levels in the surrounding area during large flow or significant blockage events.

The Taka Street and Walters Road project areas are in the Pahurehure Inlet catchment which is a smaller catchment and mostly fully developed with residential and industrial land use, only a small remaining rural area is zoned ”future urban” in the north east of the sub catchment. The Pahurehure

inlet drained via a series of piped networks with minimal overland flow channel areas available in the event of pipe network blockage or surcharge.

4.2 Positive effects

Positive effects associated with the Project include the potential to:

- Raise the existing road levels and introducing more bridge structures to roads subject to flooding;
- Improving drainage on roads, preventing flood flows along and across the road, reducing flood hazard (where this is not limited by existing flooding effects upstream) for road users;
- Improve existing culvert capacities and/or provide new stormwater infrastructure which improve ponding and stream flow in the area; and
- Provide stormwater quality treatment and retention/detention for existing and proposed impervious areas that do not otherwise have an adequate stormwater management system.

4.3 Assessment of construction effects

The following construction effects apply to the entire Project. Based on the location of works in terms of overland flows or known flood extents in the vicinity, the proposed construction works which could result in flooding effects include:

- Construction of new culvert crossings or upgrading of existing culvert or bridge crossings;
- Realignment of existing OLFPs;
- Works, such as regrading and raising levels, within existing floodplains; and
- Storage of materials and use of lay down areas within floodplains.

4.4 Recommended measures to avoid, remedy or mitigate construction effects

The proposed management and mitigation measures for construction effects across the Project are set out below.

General:

Flood hazard effects for the construction phase in existing high hazard areas should be addressed in a Construction Environmental Management Plan (**CEMP**). In preparing the CEMP, key matters to include are (but not limited to):

- Siting construction yards, laydown areas and stockpiles outside the predicted flood plains;
- Maintaining OLFPs around / through areas of work;
- Minimising the physical obstruction to flood flows at the road sag points;
- Staging and programming to provide new drainage prior to raising road design levels and carry out work when there is less risk of extreme flood events;
- Actions to take in response to heavy rain warnings which may include reducing the conveyance of materials and plant that are considered necessary to be stored or sited within the predicted flood plain or significant OLFP;
- Carrying out earthworks during the summer / dry months to reduce the risk of flooding; and
- Managing the OLFPs to make sure flows are not diverted toward existing buildings or properties.

Construction of new and existing bridges, culvert crossings and stormwater devices:

There may be some temporary flooding risk associated with the works required for the construction of new and existing bridges, culverts and stormwater devices. However, the details of the construction methodology will be confirmed in the future during detailed design. It is expected that that the works can be carried out in a manner that appropriately manages these risks and this can be defined through the flood risk mitigation measures in the CEMP.

4.5 Assessment of operational effects

The assessment of operational flood effects for the Project is based on the 100-year flood model results for the present-day (existing) terrain with a 2.1º climate change consideration and a maximum probable development (**MPD**) catchment imperviousness coverage. This assessment considers the flooding extents at existing culvert crossings and along existing roads. The following matters have been considered as part of this assessment:

- Existing flooding and freeboard at key points identified from modelling the existing terrain;
- The potential of flooding on existing properties due to the new Project corridor geometry;
- Incremental changes to the corridor impervious area; and
- Potential mitigation measures have been designed so that flood effects are adequately addressed during the future detailed design stage of the Project and that adverse flood effects are avoided, remedied or mitigated.

Each project area will generate similar operational flood effects based on the degree of floodplain volume displacement or the presence of an obstructed OLFP. Each level crossing modification is discussed separately below.

4.5.1 Spartan Road and Manuroa Road

The Spartan Road and Manuroa Road project area works both include the termination of the existing level crossing by turning both sides of the rail crossing into cul-de-sacs. At each location, a new active mode bridge across the rail is anticipated for safe pedestrian crossing with the rail. These anticipated features in both project areas do not include any major earthworks or alterations to OLFPs. Operational flood effects at Spartan Road and Manuroa Road will be minimal as there is negligible to zero storage displacement nor redirection of flow paths. Therefore, no operational flood effects are expected at these locations.

4.5.2 Manuia Road

The existing flood model depths within and around the Manuia Road project area as simulated in Auckland Council's InfoWorks ICM model by Te Tupu Ngātahi are shown in Figure 3. The flood depths shown do not reflect the altered flooding behaviour should the Manuia Road section be constructed. This does however give an overview of the flood interaction and magnitude of flooding in the project area.

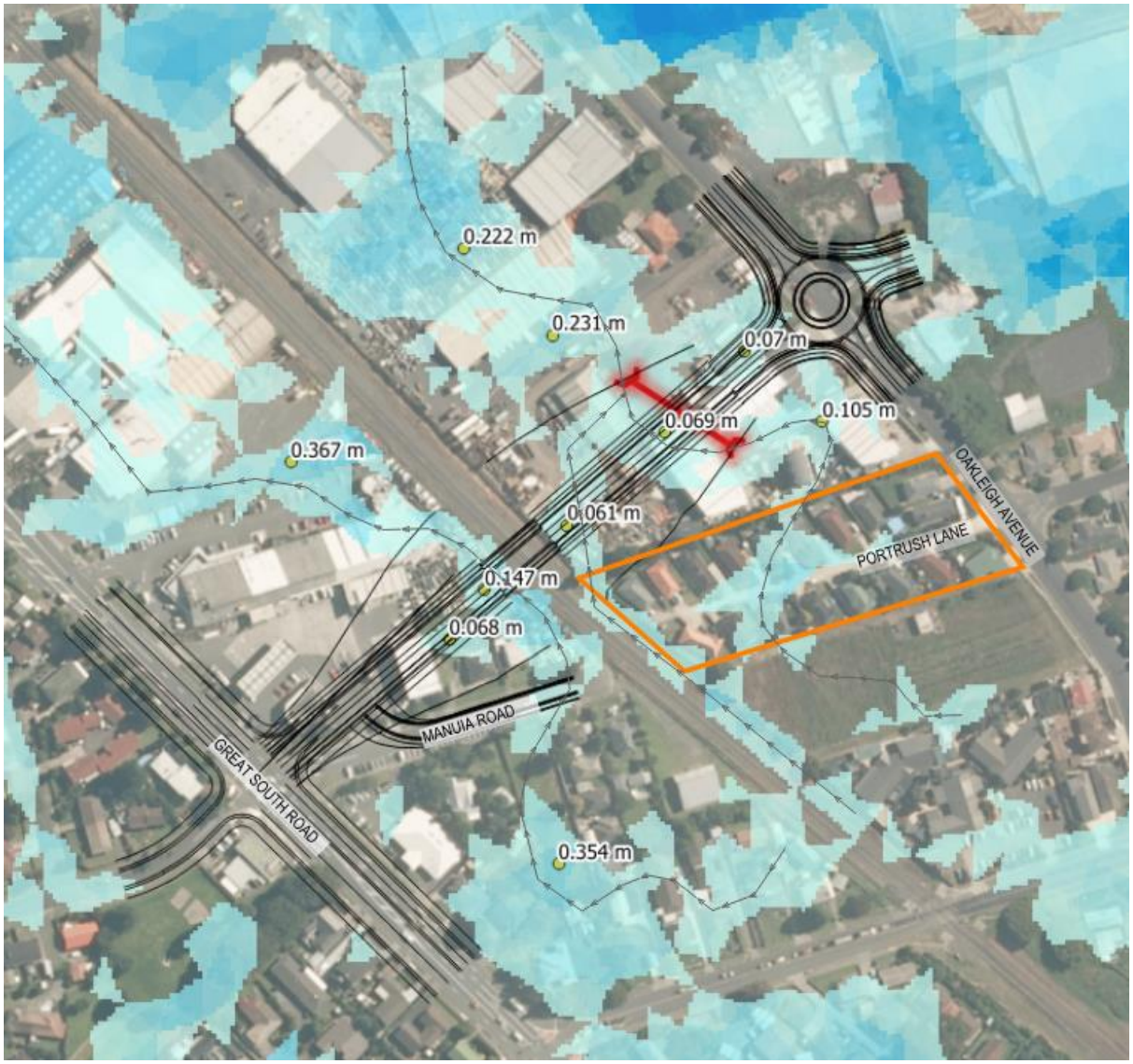


Figure 3: Auckland Council ICM model Flood Results (1% AEP+CC flood depths)

The depths within the footprint area will be displaced by fill earthworks and generate a localised increase in flood levels. Compensatory cut earthworks will be required to maintain a neutral flood effect. A culvert is required for flowpath continuity on the northern side of the railway line and a widened bridge across the rail will allow the OLFP to continue to flow along the railway tracks to the south.

The culvert shown in Figure 3 is located on land at approximately 12.4m RL (NZVD2000), this level is significantly lower than the houses on Portrush Lane (shown in orange on Figure 3) that have an elevation of approximately 13.8m RL (NZVD2000). The 1% Annual Exceedance Probability (**AEP**) freeboard to these houses is presently around 1.3m. This ground level difference and high freeboard values means the flood sensitivity of these residential properties from the Manuia Road level crossing works is low to negligible.

4.5.3 Taka Street

The Taka Street project area includes the removal of the existing level crossing and replacement with a new bridge structure across the rail. This new bridge will avoid a large amount of flood effects that

could have otherwise been generated by an earthworks embankment design. However, the greatest depth of flooding is noted at the Great South Road end of the works (western tie-in).

The existing flood model depths as simulated in Auckland Council's InfoWorks ICM model by Te Tupu Ngātahi are shown in Figure 4.

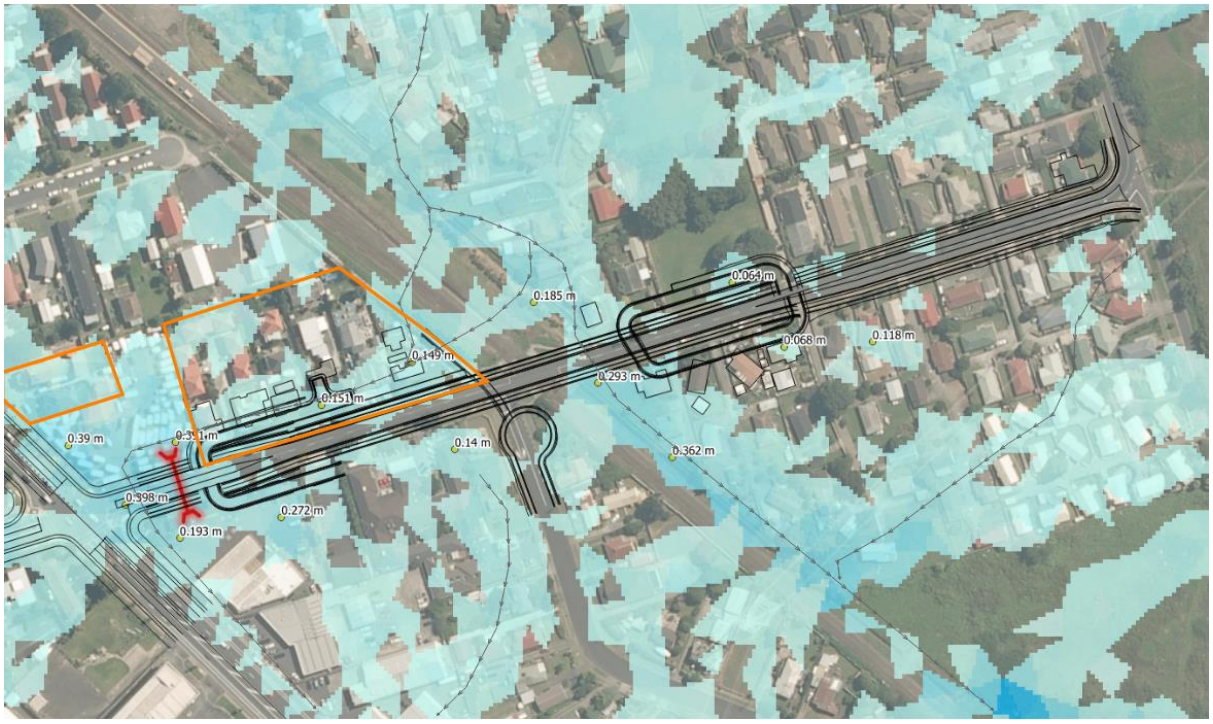


Figure 4: Auckland Council ICM model Flood Results (1% AEP+CC flood depths)

The depths within the footprint area will be displaced by fill earthworks and generate a localised increase in flood levels, particularly at the western end of the project. Compensatory cut earthworks will be required to maintain a neutral flood effect. A culvert is required for flowpath continuity on the northern side of the railway line and a widened bridge across the rail will allow the OLFP to continue to flow along the railway tracks to the south.

The culvert shown in Figure 4 is located on land at approximately 14.1m RL (NZVD2000), this level is approximately same level as the residential houses on Great South Road and on Taka Street (both shown in orange on Figure 4). The 1% AEP presently floods these houses which makes them vulnerable to flood effects with the changes to Taka Street. The upstream peak water level change will need to achieve a 0mm upstream water level change to maintain a no worsened state to these houses. The culvert and offset storage areas proposed as part of these works can be optimised to achieve this outcome.

4.5.4 Walters Road

The existing flood model depths within and around the Walters Road project area as simulated in Auckland Council's InfoWorks ICM model by Te Tupu Ngātahi are shown in Figure 5.

Figure 5: Auckland Council ICM model Flood Results (1% AEP+CC flood depths)

The flood depths within the road footprint area are minimal and displacement effects are expected to be negligible. The OLFP across the Arion Road – Walters Road intersection will be altered by the elevated road section and will cause flood effects to the upstream residential area. Similarly, flood waters are expected to be trapped in the eastern corner of the Braeburn Place and Walters Road intersection which could cause flood effects to nearby residential properties.

4.6 Recommended measures to avoid, remedy or mitigate operational effects

It is recommended that during detailed design that flood modelling be carried out and mitigation measures are implemented (as required) to achieve the following outcomes:

- No increase in flood levels in a 1% AEP event for existing authorised habitable floors that are already subject to flooding or have a freeboard less than 150mm (that is, no increase in flood level where the flood level using the pre project model scenario is above the habitable floor level);
- No more than a 10% reduction in freeboard in a 1% AEP event for existing authorised habitable floors with a freeboard over 150mm (that is, if existing freeboard was 500mm, an acceptable change would be to reduce freeboard to 450mm);
- No increase in 1% AEP flood levels for existing authorised community, commercial, industrial and network utility building floors that are already subject to flooding;
- No more than a 10% reduction in freeboard in a 1% AEP event for existing authorised community, commercial, industrial and network utility building floors;

- No increase of more than 50mm in flood level in a 1% AEP event on land zoned for urban or future urban development where there is no existing habitable dwelling;
- No new flood prone areas (with a flood prone area defined as a potential ponding area that relies on a single culvert for drainage and does not have an OLFP); and
- No more than a 10% average increase of flood hazard (defined as flow depth times velocity) for the main access to authorised habitable dwellings. The assessment shall be undertaken for the 1% AEP rainfall event.

Compliance shall be demonstrated in the Outline Plan, which shall include flood modelling of the pre-Project and post-Project 100-year ARI flood levels (for MPD land use and including climate change).

Where the above outcomes can be achieved through alternative measures outside of the designation such as flood stop banks, flood walls, raising existing authorised habitable floor levels and new overland flow paths, varied through agreement with the relevant landowner, the Outline Plan shall include confirmation that any necessary landowner and statutory approvals have been obtained for that work or alternative outcome.

Mitigation measures which may be implemented include:

- Maintaining existing road levels within the corridor at OLFPs and floodplains;
- Channelising existing OLFPs to discharge under the bridge across rail roads to increase capacity and reduce flood effects. This is a common approach where flood flow parallel to the existing NIMT railway line in a non-channelised flowpath;
- Adding new culverts or pipe systems to manage changes to flood levels and increased road heights (substituting the loss of flow over the road for more flow capacity under the road);
- Adding more live storage capacity at the upstream end of culverts by excavating the local area ground. This compensates for the culvert headwater effects to maintain a neutral flood hazard on upstream land; and
- Integrating development stormwater design requirements with adjacent development or wider upgrades to public infrastructure upstream and downstream of the proposed corridor.

Mitigation of operational effects will be proportional to the type and magnitude of the effect described in section 4.5 of this Report.

Each project area will generate similar operational flood effects based on the degree of floodplain volume displacement or the presence of an obstructed OLFP. Each project area is discussed separately below.

4.6.1 Spartan Road and Manuroa Road

Considering the assessment in Section 4.5.1 of this Report, no flood mitigation is recommended at these project areas as there are no expected adverse effects to be managed or resolved.

4.6.2 Manuia Road

The requirement for flood effect mitigation has been identified at Manuia Road as the anticipated earthworks will displace the floodplain storage on the site. Additionally, one OLFP has been obstructed by the anticipated earth fill embankment, so a culvert has been added at chainage 240 with a flood offset storage area at the inlet. The two features together will compensate for the storage loss, allow the OLFP to continue and offset localised culvert headwall effects.

This mitigation can only be effective with offset storage excavation below the flood level and above the out letting invert of drainage infrastructure. At this stage an approximate volume of offset forms part of the design for NoR application. The proposed mitigation is considered sufficient at this time, flood modelling to be undertaken during the future detailed design and / or consenting stage will be used to validate that the potential flooding effects can be adequately mitigated.

4.6.3 Taka Street

The requirement for flood effect mitigation has been identified at Taka Street as the anticipated earthworks will displace the floodplain storage on the site. Additionally, one OLFP has been obstructed by the earth fill embankment, a culvert has been added at chainage 40 with a flood offset storage area at the inlet. The two features together will compensate for the storage loss, allow the OLFP to continue and offset localised culvert headwall effects.

As above, this mitigation can only be effective with offset storage excavation below the flood level and above the out letting invert of drainage infrastructure. At this stage an approximate volume of offset forms part of the design for NoR application. The proposed mitigation options are considered sufficient at this time, and flood modelling undertaken to be undertaken during the detailed design and/or regional consenting stage can be used to validate that the potential flooding effects can be adequately mitigated.

4.6.4 Walters Road

Flood effects will be negligible at Walters Road on the southwestern side of the railway line as there is only a small and shallow portion of the area subject to flooding. The effect of OLFPs obstruction over the Arion Road and Waters Road intersection on the northeastern side of the railway line could be mitigated using a new culvert. This culvert should include an inlet structure at the corner of Braeburn Place and Walters Road to relieve ponding due to the elevated and widened Walters Road design at this intersection. The two inlet points will discharge to residential properties between Braeburn Place and the railway line.

No flood offset volume forms part of the design for NoR application as the effects are not volumetric and this type of mitigation would not be effective. The performance of the new culvert structure on the eastern side of the railway line is qualitative at this stage and modelling to be undertaken at the detailed design and/or regional consenting stage will be used to validate that the potential flooding effects can be adequately mitigated.

4.7 Effects of Climate Change

This assessment is based on the 100-year flood model results for the present-day (existing) terrain with a 2.1º climate change consideration and a MPD catchment imperviousness coverage. A 2.1º climate change increase is represented as a 16.8% increase on TP108 rainfall values (present day rainfall) as required by Section 4.2.10 of the Auckland Council Stormwater Code of Practice V3 (2022).

Consideration for 3.8º climate change increase is recommended at a future design stage to ascertain the Project's performance under more extreme flood conditions. A 3.8º climate change scenario would increase rainfall values by around 32% on present day values which would lead to deeper flood depths and more expansive floodplains. The flood effects from these project areas would likely change as a result of a 3.8º climate change. While there may be a greater volumetric displacement

effect, there may also be a larger floodplain over which the displacement would be distributed, leading to an overall reduction in peak water level change. Larger pipes and culverts may also be required to manage the increased runoff flowrates.

5 Summary and conclusions

Table 8 provides a summary of flooding assessment of effects and recommendations for the overall network. In general, the TLC will generate some new adverse flooding effects through flood water displacement, culvert constriction of otherwise wider OLFPs and raising road heights reducing flow capacity through a road. These effects can be managed by compensating the capacity and storage losses in the floodplain using new culvert capacities and flood offset storage.

Table 8: Summary of Assessment of Effects and Recommendations - Overall network

Effect	Assessment	Recommendation
Construction		
Flooding	Flood effect potential will change depending on the phase during construction. Regardless, effects from earthworks, culvert construction and temporary site configurations may give rise to flood effects in the event of a significant rainfall event	Flood hazard effects for the construction phase in existing high hazard areas should be addressed in a CEMP.
Operational		
Flooding	Operational flood effects may result from the overburdening of drainage systems at each Project area. Of particular concern is flood effects on residential areas and roads.	Flood effects should be modelled at detailed design and mitigation measures validated against the criteria for acceptable flood change outcomes. The mitigation measures proposed provide a reasonable estimate on the required measures needed to address the effects of each project area in the NoRs.