Appendix 11

Stormwater Effects Assessment

Eastern Busway

EB3 Commercial and EB4 Link Road

Stormwater Effects Assessment

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Eastern Busway

Quality Information

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List of Abbreviations and Definitions

Abbreviation and Definitions	Description
AC	Auckland Council
AT	Auckland Transport
AEE	Assessment of Effects on the Environment
AEP	Annual Exceedance Probability
AMETI	Auckland Manukau Eastern Transport Initiative
ARI	Average Recurrence Interval
AUP(OP)	Auckland Unitary Plan (Operative in Part) (Updated 20 July 2023)
BPO	Best Practicable Option
CEMP	Construction Environmental Management Plan
CLM	Contaminant Load Model
CMA	Coastal Marine Area
EB1	Eastern Busway 1 (Panmure to Pakuranga)
EB2	Eastern Busway 2 (Pakuranga Town Centre)
EB3C	Eastern Busway 3 Commercial (Pakuranga Creek to Botany)
EB3R	Eastern Busway 3 Residential (SEART to Pakuranga Creek)
EB4L	Eastern Busway 4 Link Road (link between Tī Rākau Drive and Te Irirangi Drive, Botany Town Centre)
EBA	Eastern Busway Alliance
GD01	Auckland Council 'Guidance Document 2017/001 Stormwater Management Devices in the Auckland Region'
Healthy Waters	Auckland Council Healthy Waters
ISC	Infrastructure Sustainability Council
km	Kilometre(s)
m	Metre(s)
m^2	Square Metre(s)
m^3	Cubic Metre(s)
MHWS	Mean High Water Springs
NDC	Auckland Council Network Discharge Consent
NZCPS	New Zealand Coastal Policy Statement 2010
NoR	Notice of Requirement
RL	Reduced Level
RMA	Resource Management Act 1991
RTN	Rapid Transit Network
SEART	South-Eastern Highway
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
VMS	Variable Message Signs

Executive Summary

General

The purpose of this Stormwater Effects Assessment is to provide an assessment of the potential stormwater effects of the Eastern Busway 3 Commercial (EB3C) and Eastern Busway 4 Link Road (EB4L) sections of the Eastern Busway Project (the Project).

Key elements of the proposed EB3C works include the construction of two bridges (Bridges A & B), noise walls and retaining walls, stormwater drainage, and a cycleway. The proposed EB3C bridge structures, new and upgraded stormwater outfalls and an area of reclamation will require works in the coastal marine area (CMA).

The proposed EB4L footprint traverses parts of Guys Reserve and Whaka Maumahara Reserve and includes road widening at the intersection of Te Irirangi and Town Centre Drive (Botany). Key elements of the proposed EB4L works include a bridge structure (Bridge C), retaining walls, stormwater drainage, and a new walking and cycling pathway.

The philosophy for the design of the drainage and treatment system for the Eastern Busway Project (the Project) is a 'maintenance-led' approach, seeking to reduce the maintenance and operational costs to Auckland Transport (AT) and ultimately, to the ratepayers of Auckland. The design philosophy has been developed to incorporate the aspirations of mana whenua and Auckland Council (AC) Healthy Waters (Healthy Waters) for the Project area. As a key partner, discussions with mana whenua are ongoing and these discussions will influence the development of the detailed design.

The proposed design avoids flood impacts to private properties and parks by designing independent stormwater networks that only connect to the existing network near their outfalls. The downstream sections of the networks from the connection point to the outfall will be upgraded where necessary (including the outfalls themselves).

The philosophy adopts a best practicable option (BPO) approach for water quality treatment and does not follow Guidance Document 2017/001 (GD01) "*Stormwater Management Devices in the Auckland Region"* as the default position. This is a risk-based approach, providing treatment efficiencies and options that are proportional to the contaminant generating risk. The use of a BPO approach is balanced by the target of achieving an overall reduction in the existing contaminant contributions from roads following completion of the Project.

The proposed stormwater networks, their connections and discharge of stormwater to existing and new outfalls are proposed to be authorised under Auckland Council's regionwide Healthy Waters Network Discharge Consent (NDC). Under the NDC, a Stormwater Management Plan (SMP) is required to be developed because of adopting a BPO approach and the SMP is required to be submitted during the NDC connection approval process which is part of the Engineering Plan Approval (EPA) process. The SMP is therefore developed based on the final detailed design and connection and SMP approval is obtained following completion of detailed design rather than during the resource consent application process.

EB3C

Eastern Busway 3 Commercial (EB3C) has several overland flow paths running through its extents, which cross roads in the 10 and 100-year Average Recurrence Interval (ARI) events. Tī Rākau Drive is

particularly subject to these flow paths. The existing stormwater networks were historically designed for a 5-year ARI event which is equivalent to the capacity of a 2-year ARI event when allowing for climate change (increased rainfall and sea level rise).

There is existing flooding during the 10 and 100-year ARI events due to the undersized networks. Existing flood depths within the EB3C Project area ranges from shallow (10-40 mm) to deep (100-800 mm) in the 10-year ARI event, with the 100-year ARI event featuring deeper flooding and an increase in the extent of the flooding.

Existing outfall catchments, including stormwater from roads, currently have no stormwater treatment.

The proposed stormwater treatment in the design reduces the existing total contaminant load from all roads discharging to EB3C outfalls. The predicted overall reductions are 21% for Total Suspended Solids (TSS), 9% for zinc (based on total zinc), 11% for copper (based on total copper) and 14% for total petroleum hydrocarbons (TPH). No additional mitigation is proposed for water quality as overall the Project improves water quality (i.e., reduces the total combined existing contaminant loads discharged from all roads within outfall catchments).

The EB3C stormwater design and Project works will have no flood impacts on private property and parks during the 10 and 100-year ARI events when the proposed mitigation (pipe size increases and geometric design changes) is implemented during detailed design. Instead, as a result of the proposed mitigation, EB3C will result in reduced flooding over large areas of the wider catchment.

There are some reduced overland flow path capacities as a result of the EB3C works as the EB3C stormwater network design has not provided enough additional pipe capacity to replace the reduced overland flow path capacity and therefore mitigation is required to address residual effects on private property at two locations. This is based on a secondary flow assessment where pipe blockages are applied to pipes, in accordance with the Auckland Council Stormwater Code of Practice (Version 3 January 2022). These reduced overland flow path capacities result in predicted small to modest flood impacts on private property at two locations during the 10 and 100-year ARI events where pipe blockages have been applied. Mitigation is proposed at these two locations to avoid impacts on properties and to ensure residual effects on the capacity of overland flow paths are appropriately managed. The mitigation involves appropriate pipe size upgrades and some minor localised geometric design changes to the ground surface levels. All potential impacts have been confirmed by updated flood modelling results to have been mitigated with no residual impacts.

In summary, the Project will have a positive impact on flooding and water quality. The EB3C design treats all the stormwater from the Project's roads and busway and a large amount of the existing roads outside of the Project area that are not currently treated. This achieves an overall decrease in contaminants discharged to the receiving environment across EB3C from that currently discharged from roads. The EB3C design also avoids generating flooding and overland flow impacts on private property and parks when the proposed mitigation is implemented and reduces flooding over large areas of the wider catchment within which EB3C is located.

EB4 Link Road

The Eastern Busway 4 Link Road (EB4L) design (including minimal changes (from a stormwater point of view) to the intersection of Te Irirangi Drive/Town Centre Drive)) result in an overall reduction of the existing total contaminant load generated from all roads discharging to EB4L outfalls by 6% for TSS, 8% for zinc (based on total zinc), 9% for copper (based on total copper) and 7% for total petroleum

hydrocarbons (TPH). The improvements are predominately achieved by reductions to existing contaminant loads generated by Tī Rākau Drive by treatment of previously untreated high contaminant generating roads. Contaminant loads for Culvert 127A and Outfall 1-1 have been combined as this provides a better understanding of the total discharges to Culvert 127A. No additional mitigation is proposed for water quality as overall the Project improves water quality (i.e., reduces the total combined existing contaminant loads discharged from all roads within outfall catchments).

EB4L has no flood impacts or reduced capacity of overland flow paths. In summary, the Project has a positive impact on flooding and water quality.

1 Introduction

1.1 Overview of the Eastern Busway Project

The Eastern Busway Project (the Project) is a package of works focusing on promoting an integrated, multi-modal transport system to support population and economic growth in southeast Auckland. This involves the provision of a greater number of improved public transport choices and aims to enhance the safety, quality and attractiveness of public transport and walking and cycling environments. The Project includes:

- 5 km of two-lane busway
- Two new bridges for buses across Pakuranga Creek (Bridges A and B)
- A new bridge for buses crossing Guys Reserve and Whaka Maumahara Reserve (Bridge C)
- Improved active mode infrastructure (walking and cycling) along the length of the busway
- Three intermediate bus stations
- Two major interchange bus stations.

The Project forms part of the previous Auckland Manukau Eastern Transport Initiative (AMETI) Programme (the Programme) which includes a dedicated busway and bus stations between Panmure, Pakuranga and Botany town centres. The dedicated busway will provide an efficient rapid transit network (RTN) service between the town centres, while local bus networks will continue to provide more direct local connections within the town centre areas. The Project is multi-modal, and includes new walking and cycling facilities, as well as modifications and improvements to the road network.

The Programme includes the following works which do not form part of the Eastern Busway Project:

- Panmure Bus and Rail Station and construction of Te Horeta Road (completed)
- Eastern Busway 1 (EB1) – Panmure to Pakuranga (completed).

The Project consists of the following packages:

- Early Works Consents – William Roberts Road (WRR) extension from Reeves Road to Tī Rākau Drive (LUC60401706); and Project Construction Yard at 169 – 173 Pakuranga Road (LUC60403744).
- Eastern Busway 2 (EB2) – Pakuranga Town Centre, including the Reeves Road Flyover (RRF) and Pakuranga Bus Station
- Eastern Busway 3 Residential (EB3R) – Tī Rākau Drive from the South-Eastern Arterial (SEART) to Pakuranga Creek, including Edgewater and Gossamer Intermediate Bus Stations
- Eastern Busway 3 Commercial (EB3 Commercial) – which commences from Riverhills Park along Tī Rākau Drive to Botany, including two new bridges, and an offline bus route through Burswood **(this Assessment)**
- Eastern Busway 4 Link Road (EB4L) – Guys Reserve to Botany Town Centre, including a link road through Guys and Whaka Maumahara Reserves to Te Irirangi Drive/Town Centre Drive intersection **(this Assessment)**.

The overall Project is shown in Figure 1.

Figure 1. Project alignment

1.2 Project Objectives

The Project objectives are:

1. Provide a multimodal transport corridor that connects Pakuranga and Botany to the wider network and increases choice of transport options.
2. Provide transport infrastructure that integrates with existing land use and supports a quality, compact urban form.
3. Contribute to accessibility and place shaping by providing better transport connections between, within, and to the town centres.
4. Provide transport infrastructure that improves linkages, journey time and reliability of the public transport network.
5. Provide transport infrastructure that is safe for everyone.
6. "Provide or Safeguard future" transport infrastructure at (or in the vicinity of) Botany Town Centre to support the development of strategic public transport connection to Auckland Airport.

2 Proposal Description

The following sections provide a brief description of both EB3C and EB4L. These descriptions consist of the construction and operation of both EB3C and EB4L packages, with further details provided in the AEE and Notices of Requirement (NoRs). A full set of proposed plans is attached to the AEE. EB3C is shown in purple, and EB4L is shown in green in Figure 2.

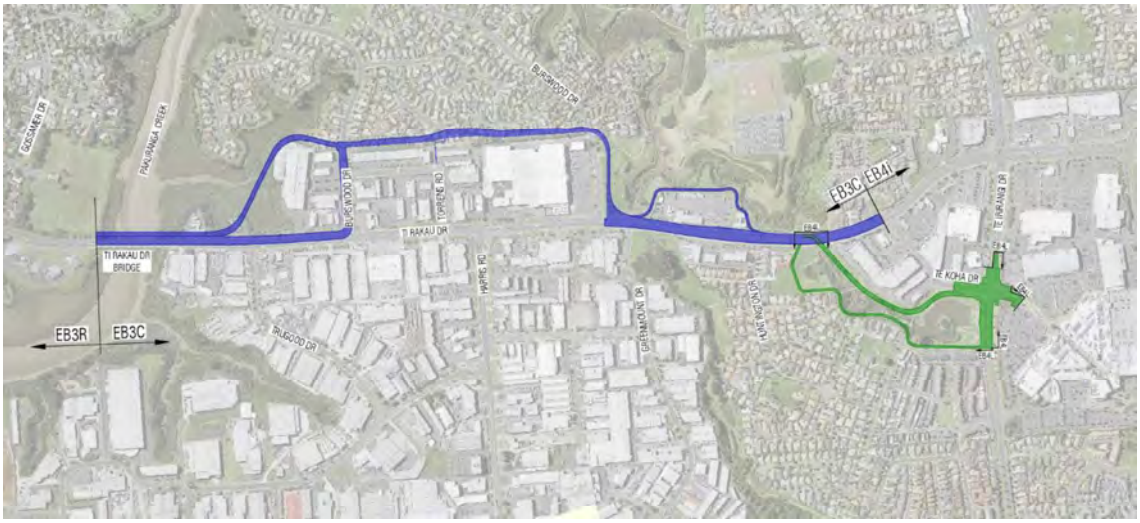

Figure 2. Eastern Busway 3 Commercial and Eastern Busway 4 Link Road Project Extent

2.1 Eastern Busway 3 Commercial

The EB3C works will involve the establishment of an 'off-line' busway, cycleway, and stormwater upgrades. These works will take place within existing road reserves, Council reserves[1] and privately held land. The extent of works for EB3C runs between Riverhills Park (i.e., adjacent to the terminus of the earlier EB3R package) in the west to Guys Reserve in the east, through the suburbs of Burswood and East Tāmaki.

The busway will be largely off-line (i.e., outside the current Tī Rākau Drive corridor), first crossing Pakuranga Creek by way of a new two-lane bridge (Bridge A) including abutments[2] and scour protection. It will then cross a coastal headland at 242 Tī Rākau Drive (a Mobil branded service station), and then an embayment within which a retaining wall, and a 4 m^2 coastal reclamation will be constructed. The busway will cross a second headland at 254 Tī Rākau Drive (currently occupied by a pet store), before crossing a mangrove filled bay to the west of 262 Tī Rākau Drive (the 'Chinatown' retail business) via a second bridge (Bridge B). Bridge B will include two abutments with scour protection. Bridge B will require construction of a reinforced embankment at its northern end which includes imported fill, rip rap and permanent wick drains, and 549 m^2 coastal reclamation. In parallel, a retaining wall will be constructed to the eastern side of the embankment. Following this, the busway runs between the commercial area and residential area north of Tī Rākau Drive, crossing several residential sites. The busway also crosses Burswood Drive twice, with raised signalised crossings established to control both the busway and road traffic.

A new 'intermediate' style bus station will be established at Burswood, before the busway then crosses over Burswood Esplanade Reserve and onto a widened Tī Rākau Drive (by the Howick and Eastern bus

[1] Including Burswood Esplanade Reserve and Bard Place Reserve
[2] The western abutment and associated scour protection was included in the EB3R consenting package

depot). The busway will then run beside the eastbound lanes of Tī Rākau Drive, before crossing over Tī Rākau Drive to connect with EB4L at Guys Reserve.

The busway will include a new cycleway, which will largely run parallel to the busway for most of this section of the Project. The exceptions to this include Bridge B, between 254 Tī Rākau Drive and Burswood Esplanade (west) – for this section the cycleway will continue along Tī Rākau Drive before turning into Burswood Drive West, as well as where the cycleway runs behind the Howick and Eastern bus depot.

Other works included in EB3C are the relocation of existing utility services, the provision of new or upgraded stormwater infrastructure and open space upgrades. Stormwater works will involve new outfalls discharging to Pakuranga Creek (and its tributaries) and rain gardens.

Lastly, EB3C involves the establishment of two laydown areas, one at 242 Tī Rākau Drive and the other within the boundaries of Burswood Esplanade Reserve. Both laydown areas are located on land that will be occupied by the Project upon its completion.

Figure 3. Eastern Busway 3 Commercial Project Area

2.2 Eastern Busway 4 Link Road

The EB4L works will involve the establishment of an 'off-line' dedicated two-way busway, shared pathway, and stormwater upgrades. These works will take place in Guys Reserve, Whaka Maumahara Reserve, existing road reserve and Botany Town Centre land for the intersection improvements on Town Centre Drive.

EB4L commences south of Tī Rākau Drive, crossing through Guys Reserve, Whaka Maumahara Reserve and ending at the intersection of Te Irirangi Drive/Town Centre Drive.

The works will primarily involve the construction of a new two-way busway corridor which will run along the eastern side of Guys Reserve and Whaka Maumahara Reserve to provide access for bus services between Pakuranga and Botany. The two-way busway is designed to integrate with EB3C and be a continuation of the EB3C busway.

This section of the busway will feature a bridge (Bridge C) approximately 350m long. This bridge is needed due to the sloping topography of the Reserves.

The busway will then connect to Te Irirangi Drive, following alterations to the existing Te Irirangi Drive/Town Centre Drive intersection.

A shared cycle and footpath and minor retaining walls will also be constructed along the southern and western boundaries of Guys Reserve and Whaka Maumahara Reserve. The shared pathway will connect to existing walkways and will terminate at Te Irirangi Drive.

A new shared pathway and retaining wall will also be constructed along the western boundary of Te Irirangi Drive and is partially located within the Whaka Maumahara Reserve.

A new stormwater outfall (including riprap) will be constructed within Guys Reserve. The outfall will discharge stormwater over scour protection prior to its entry into a tributary of Pakuranga Creek. Additionally, a new stormwater connection will be constructed in Whaka Maumahara Reserve, adjacent to Te Irirangi Drive. This new connection will discharge via an existing outfall into the existing stormwater pond within the Reserve.

Figure 4. Eastern Busway 4 Link Road Project Area

2.3 Authorisation of Stormwater Network Connections and Discharges

Based on discussions with Healthy Waters, the Project proposes to use the NDC connection approval via the Engineering Plan Approval (EPA) process. This approach will authorise stormwater discharges to new and existing outfalls. Schedule 4 of the NDC outlines the requirements for connection approval and this report is structured to demonstrate the Project meets these requirements. The connection approval process is part of the EPA process that approves the final detail design rather than up front during the resource consent application process. As the Project has adopted a BPO approach a Stormwater Management Plan (SMP) is required to be prepared and submitted for approval as part of the connection approval process.

2.4 Stormwater Design Philosophy

The philosophy for the design of the proposed stormwater drainage and treatment system for the entire Project is a 'maintenance-led' approach, seeking to reduce the maintenance and operational costs to AT and ultimately, to the ratepayers of Auckland. The design philosophy has been developed to incorporate the aspirations of mana whenua and Healthy Waters for the Project area. There are ongoing discussions between AT, the EBA and Healthy Waters on their aspirations for Project-wide renewals and upgrades of their assets as part of the Project. These discussions provide an opportunity for best-for-Auckland solutions to overland flows, flooding, and stormwater treatment. In parallel, EBA and Healthy Waters are meeting with the Project's key partners, mana whenua, to discuss their aspirations at ongoing hui.

The philosophy adopts a BPO approach for water quality treatment and does not follow Guidance Document 2017/001 (GD01) Stormwater Management Devices in the Auckland Region as the default position. This is a risk-based approach, providing treatment efficiencies and options that are proportional to the contaminant generating risk. The use of a BPO approach is balanced by the target of achieving a reduction in the existing contaminant contributions from roads, following completion of the Project. The target is assessed using the AC CLM which estimates loads for TSS, zinc, copper, and TPH and success is based on the total (sum of all outfalls) contaminant load (for each contaminant assessed in the CLM) for all outfalls that interact with the Project. Providing discretionary treatment that focusses on high contaminant generating roads and parking areas outside of the Project works is a key element of achieving this target.

The proposed stormwater networks and their connections and discharge of stormwater to existing and new outfalls are proposed to be authorised under the NDC.

See the full Design Philosophy Statement provided in Appendix 1.

2.5 EB3C Design Statement

2.5.1 Design Overview

The main influences on the EB3C stormwater design are bridge structures, major utilities (Transpower 220 kv cables and gas reticulation on Tī Rākau Drive), interaction with parks and reserves and several overland flow paths crossing the Project area. The design does address existing overland flows that cross Tī Rākau Drive (between Trugood Drive and 272 Tī Rākau Drive) subject to ongoing discussions with mana whenua and Healthy Waters (the asset owner of the existing stormwater networks and outfalls). The EB3C stormwater design drawings are provided in Appendix 2.

The increased stormwater flows generated by EB3C have the potential to overload the existing stormwater network. To manage the increased flows appropriately and minimise the number of new outfalls required, the stormwater drainage design provides new, independent stormwater networks that, where feasible, connect to the existing networks near their outfalls. This approach avoids increasing stormwater flows in existing networks and only requires upgrades to outfalls (and in most circumstances the last section of pipe connecting to outfalls). This approach minimises the number of new outfalls created and associated effects while ensuring stormwater flows are managed appropriately to avoid impacts from flooding and overland flow path capacity reductions. New outfalls are only proposed where a new connection to existing outfalls is unfeasible.

The only exceptions to creating new independent stormwater networks is where small areas are required to be connected to the existing network (e.g. for the cycleway) and where the existing catchment and imperviousness has been reduced (i.e. where houses and driveways have been removed from the existing network).

The design is in accordance with the project Minimum Requirements and AT Transport Design Manual's (TDM) Engineering Design Code for Road Drainage (Engineering Design Code) for AT assets and AC's Stormwater Code of Practice (Stormwater Code of Practice) for AC's assets.

2.5.2 Scope of networks

The proposed independent networks for EB3C will serve the following areas (refer to Figure 5):

- New Outfall 01A-1 – Is a new outfall for the cycleway on the new busway bridge (Bridge A) over the Pakuranga Creek.
- Existing Outfall MCC_108479 (SAP ID 2000029871) – a new network will connect to the existing stormwater network on the northern kerb of Tī Rākau Drive with upgrades to the downstream pipe to the outfall and an upgrade of the outfall. This existing and new network services a catchment covering:
    - Tī Rākau Drive westbound and eastbound carriageways from east of Bridge A to Trugood Drive
    - Commercial properties along the westbound carriageway between 247 and 257 Tī Rākau Drive
    - Commercial properties 242 and 254 Ti Rakua Drive along the eastbound carriageway
    - Bridge A across Pakuranga Creek
    - New busway between Bridge A and Bridge B
    - Bridge B between the southern abutment and the crest near the northern abutment.
- New Outfall 09-1 – Is a new outfall and pipeline upgrade between 257 and 269 Tī Rākau Drive. This upgrade is proposed to improve existing flooding at this location. The pipeline will have a small catchment, however, it will receive overland flow when the capacity of the larger existing stormwater network (refer to Outfall MCC_108480) capacity is exceeded
- Existing Outfall MCC_108480 – No busway stormwater will be directed to this existing network. A Gross Pollutant Trap (GPT) is proposed to be installed as part of the stormwater treatment strategy for EB3C to target high contaminant generating roads as discretionary treatment. The existing and new network services a catchment covering the following areas:
    - Commercial property along the southern side of Tī Rākau Drive (number 263 to 295), and the western side of Harris Road (numbers 142 to 150)
    - Commercial property along and to the north of Tī Rākau Drive (number 245 to 316), 32 Torrens Road and 212 Burswood Drive
    - Tī Rākau Drive (westbound from 263 to Harris Road and eastbound from 245 to Torrens Road), Burswood Drive (from 239 to Tī Rākau Drive), Harris Road (northbound from Cryers Road to Tī Rākau Drive).
- Existing Outfall MCC_108409 (SAP ID 2000893599) – a new network will tie into the existing outfall location to form one outfall with twin pipes (i.e. existing and new) with additional scour protection. The existing and new network services a catchment covering the following areas:
    - Residential properties along Burswood Drive (between Elderberry Road to the busway), Tullis Place (numbers 24 to 9)

  - Commercial properties along Burswood Drive (from 239 to the busway) and Torrens Road (from Burswood Drive to 32 Torrens Road)
  - Busway from Bridge B crest (near eastern abutment) to the bus station at Dulwich Place cul-de-sac
  - A section of the cycleway will connect to this network.

- Existing Outfall MCC_711303 (SAP ID 2000097466) is an existing outfall and network with proposed connections from the Project as follows:

  - Bus stop between Dulwich Place and Heathridge Place. The existing network receives stormwater from 14 properties that will become part of the busway and bus stop. The impervious area contributing to this network reduces as all but six properties will be diverted to new busway networks
  - A section of the cycleway will connect to this network.

- Existing Outfall MCC_108481 (SAP ID - 2000533442) the new network (pipeline 36) will connect into the existing manhole MCC_71866 (SAP ID - 2000924460) upstream of this outfall. The pipe downstream of the connection point has sufficient capacity and does not require upgrading. The existing and new network services a catchment covering the following areas:

  - Residential properties and road carriageway along part of Heathridge Place, Midvale Place, Burswood Drive east (between Heathridge Place and the boundary between Burswood Esplanade Reserve and properties at the southern end of Midvale Place)
  - Commercial property (Bunnings Warehouse and Supercheap Auto) and adjacent road carriageway along Burswood Drive
  - Busway from the bus station at Heathridge Place cul-de-sac to the activity path in Burswood Esplanade Reserve.

- Existing Outfall MCC_108482 (SAP ID - 2000380606) - the existing outfall and pipes from Tī Rākau Drive to the outfall are to be upgraded to accommodate the busway stormwater. The new pipes and upgraded outfall are shown on the design drawings as pipeline 43 with an upgraded outfall at 43-1. The existing and new network services a catchment covering the following areas:

  - Commercial property south of Tī Rākau Drive between Harris and Greenmount Drive.
  - Tī Rākau Drive westbound and eastbound carriageway between Harris Road and the eastern end of 380 Tī Rākau Drive (Howick and Eastern Bus Depot)
  - Busway from where it starts to run along the northern side of Tī Rākau Drive to the eastern end of 380 Tī Rākau Drive (Howick and Eastern Bus Depot).

- Existing Outfall MCC_496129 (SAP ID 2000507038) – the existing outfall is to be shifted in a new location to accommodate the cycleway (shown as pipeline 53 in the design). The existing outfall will be replaced with a new outfall (outfall 53-1) in a new location to accommodate the cycleway. The existing network receives stormwater from two catchpits on Tī Rākau Drive and the Gull service station (386 Tī Rākau Drive). The existing network will no longer receive stormwater from Tī Rākau Drive after the EB3C works and will only service the Gull service station site.

- Existing Outfall MCC_988531 (SAP ID 2000295186) – the new busway network connects to the existing network with an upgrade to the outfall and pipe sections downstream of the connection points. The existing and new network services a catchment covering the following areas:

- Commercial and residential land to the south of Tī Rākau Drive and Huntington Drive
- Tī Rākau Drive westbound and eastbound between the eastern end of 380 Tī Rākau Drive (Howick and Eastern Bus Depot) and Te Koha Road
- Busway between the eastern end of 380 Tī Rākau Drive (Howick and Eastern Bus Depot) and the end of the EB3C section of the busway immediately adjacent to the EB4 boundary.

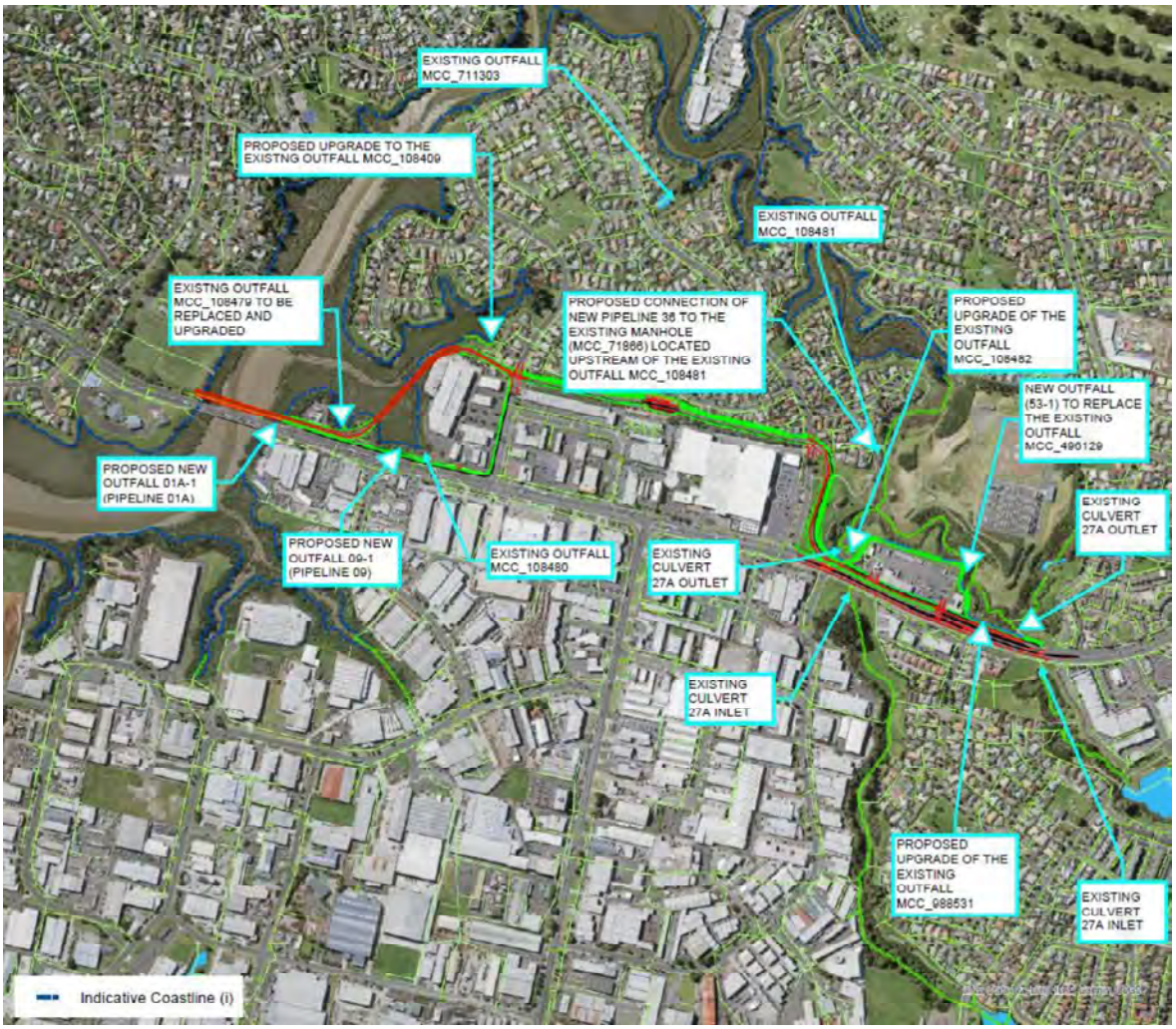

Figure 5. EB3C outfall locations and AUP(OP) indicative CMA boundary

2.5.3 Constraints and limitations

The proposed EB3C footprint has many constraints and limitations which make the stormwater design proposed complex and challenging to implement. The constraints and limitations are:

- Existing major utilities (220 kV high voltage cables)
- Local utilities (gas, electrical distribution, communications cables, local water and local wastewater)
- Topography
- Existing drainage was historically designed to a 5-year ARI standard and when climate change is considered the current capacity is approximately equal to a 2-year ARI event
- Coastal marine area (CMA)

- Freshwater wetlands and streams in the Burswood Esplanade Reserve
- Basalt outcrops which are difficult to trench through for stormwater pipes.

2.5.4 Stormwater Treatment and Discharge

EB3C will connect to existing outfalls, except for:

- One new outfall (Outfall 01A-1) for the cycleway on Bridge A over Pakuranga Creek
- One new outfall (Outfall 09-1) proposed for the flood relief pipe on Tī Rākau Drive
- The replacement of a small existing outfall (MCC_496129) to a nearby location (Outfall 53-1) pipe at Gull Botany Downs (does not receive busway stormwater and no longer receives stormwater from Tī Rākau Drive).

The outfalls are summarised in Table 1.

Table 1: Outfalls modified or proposed to receive discharges from EB3C stormwater networks

Outfall	Existing Outfall	Discharges to CMA or Stream	Outfall Works in CMA	Outfall Works in Stream or Wetland	Comment
New Outfall 01A-1	✗	CMA	✓	✗	New Outfall (Outfall 01A-1) will tie into the abutment scour protection for the busway bridge. The discharge is only from the cycleway and therefore is not treated.
Existing outfall MCC_108479 (SAP ID 2000029871)	✓	CMA	✓	✗	The existing outfall is to be replaced and upgraded to accommodate the new busway network (pipeline 04). Stormwater from the busway (including Bridges A and B) is treated within two raingardens/bio-retention devices. The outfall is within the AUP(OP) indicative CMA boundary (see Figure 5) and scour protection will further extend into CMA.
New Outfall 09-1	✗	CMA	✓	✗	New outfall (Outfall 09-1) and pipe (pipeline 09) to be constructed approximately 56 m to the northwest of MCC_108480. The proposed outfall provides flood relief at the low point of Tī Rākau Drive. The outfall is approximately 15 m landward of the AUP(OP) indicative CMA boundary (see Figure 5). However, the scour protection works will extend into the CMA.
Existing Outfall MCC_108480	✓	CMA	✗	✗	No works are proposed to this existing outfall. The project is not discharging new stormwater from the busway into the network. The only works is the installation of a treatment device (i.e. a GPT) to improve existing stormwater discharge quality in accordance with the treatment strategy. The outfall is approximately 15 m landward of the AUP(OP) indicative CMA boundary (see Figure 5).
Existing Outfall MCC_108409	✓	CMA	✓	✗	The existing outfall will be upgraded with a second pipe (pipeline 10) to be installed immediately adjacent to the existing pipe and the scour protection works to be extended to

(SAP ID 2000893599)					provide a single integrated outfall. The outfall is approximately 3 m landward of the AUP(OP) indicative CMA boundary (see Figure 5). However, the scour protection works will extend into the CMA.
Existing Outfall MCC_711303 (SAP ID 2000097466)	✓	Stream	×	×	No works are proposed to the outfall, which includes a stormwater treatment wetland. The Project connects a small section of cycleway (pipeline 27) and the bus station (pipeline 26) between Dulwich Place and Heathridge Place. The treatment wetland discharges to a short length of overland flow path before reaching the CMA based on the AUP(OP) indicative CMA boundary (see Figure 5).
Existing Outfall MCC_108481 (SAP ID - 2000533442)	✓	Stream	×	×	No works to this outfall with the new network (pipeline 36) connecting to upstream manhole (manhole MCC_71866). The existing outfall is within a natural wetland and stream in the Burswood Esplanade Reserve. The outfall is not within the CMA, based on the AUP(OP) indicative CMA boundary (see Figure 5).
Existing Outfall MCC_108482 (SAP ID - 2000380606)	✓	Stream	×	✓	The existing outfall will be upgraded. A new pipeline will be constructed to the upgraded outfall to accommodate the existing and new networks (pipeline 43). The outfall is within the stream in the Burswood Esplanade Reserve and not within the CMA based on the AUP(OP) indicative CMA boundary (see Figure 5).
Existing Outfall MCC_496129 (SAP ID 2000507038) and replaced with a new outfall (53-1)	✓	Stream	×	✓	The existing outfall will be removed and replaced with a new outfall (Outfall 53-1) in a new location to accommodate the cycleway. This new outfall will be within the stream in the Burswood Esplanade Reserve and not within the CMA based on the AUP(OP) indicative CMA boundary (see Figure 5).
Existing Outfall MCC_988531 (SAP ID 2000295186)	✓	Stream	×	✓	The existing outfall will be upgraded. A new pipeline will be constructed to the upgraded outfall to accommodate the new network (pipeline 47). The outfall will be within the stream in the Burswood Esplanade Reserve and not within the CMA based on the AUP(OP) indicative CMA boundary (see Figure 5).

The CMA landward boundary delineates a jurisdictional limit under the Resource Management Act 1991 (RMA) framework and is defined by the line of mean high water springs (MHWS). The MHWS is defined as "the long-term average of the highest high tide ('spring tide') that occurs after every new and full moon" by NIWA 2012 (Development of an updated Coastal Marine Area boundary for the Auckland Region) and can be retrieved from recorded measurements or NIWAs MHWS model. From a coastal management perspective, the CMA boundary is of significance because Section 12 of the RMA provides that various identified activities within the CMA can only be carried out if they are authorised by a national environmental standard, a regional coastal plan or resource consent. Conversely, from a landward perspective, the CMA boundary is of significance as it defines the boundary along the coast for land-based planning frameworks (i.e., Sections 9(2) and 9(3) of the RMA).

Based on the AUP(OP) indicative CMA boundary (see Figure 5) and the proposed outfall upgrades, works within the CMA are proposed at four outfalls (taking into consideration scour protection): Outfalls 01A-1, MCC_108479 (pipeline 04), Outfall 09-1 and existing Outfall MCC_108409 (pipeline 10). There are four outfalls in the freshwater environment. Three of these outfalls will be upgraded or replaced: outfalls MCC_108482 (pipeline 43), MCC_496129 (pipeline 53), and MCC_988531 (pipeline 47). The fourth outfall (MCC_108481) will remain unaltered. A pipe will be installed to the west (inland) of the outfall connecting to the closest manhole.

The stormwater treatment BPO includes a combination of:

- Green infrastructure (i.e., swales (Figure 6) and bio-retention raingardens (Figure 7)) where feasible (i.e., adjacent to the busway where there is sufficient space)
- GPTs designed to remove at least 50% of TSS, are proposed at the downstream end of a network at its outfall where the busway couldn't be treated by green infrastructure
- Discretionary targeted treatment of high use roads and carparks, outside of areas where the Project is modifying or creating new impervious areas, has been included where necessary to achieve an overall reduction in existing contaminant loads as stated in the design philosophy (subject to ongoing discussions between mana whenua, Healthy Waters and EBA).

A stormwater management options assessment based on integrated catchment management and whole of life approaches was carried out to identify the BPO. The Stormwater Management Option and BPO Report will be finalised and included in the SMP. The BPO treatment devices provided within EB3C are summarised in Table 2. The proposed treatment devices included in the BPO for the design, are subject to ongoing discussions with mana whenua and Healthy Waters.

Figure 6. Example of a Swale

This example is sourced from the AC Swales and Filter Strips Construction Guide.

Figure 7. Example of a Raingarden (Halsey Street Auckland CBD)

Table 2: Summary of proposed EB3C stormwater devices

Outfall	Treatment Category	Treatment Devices	Comment
New Outfall 01A-1	Not Treated	None	Cycleway stormwater from busway bridge.
Existing outfall MCC_108479 (SAP ID 2000029871)	EBA BPO	Bioretention swales and raingardens	Busway stormwater (including busway bridge over Pakuranga Creek and Bridge B around the back of China Town) treated by three green infrastructure devices.
New Outfall 09-1	Not Treated	None	This pipeline only conveys high flows that bypass the network for outfall MCC_108480 to reduce flooding at the low point on Tī Rākau Drive.
Existing Outfall MCC_108480	EBA discretionary for existing network	GPT	A GPT (designed to remove 50% TSS) will be provided for the existing network targeting stormwater from high use roads (Tī Rākau Drive and Harris Road).
Existing Outfall MCC_108409 (SAP ID 2000893599)	EBA BPO and discretionary for part of existing network	Bioretention raingardens and swale	Bioretention raingardens and a swale will provide treatment for the busway and discretionary treatment targeting roads within commercial land (i.e. Burswood Drive, Torrens Road).
Existing Outfall MCC_711303 (SAP ID 2000097466)	EBA BPO	Existing wetland	Cycleway stormwater from an area at the back of the commercial land discharges to this existing network, which is treated by an existing wetland, no additional treatment is proposed.

Existing Outfall MCC_108481 (SAP ID - 2000533442)	EBA BPO and discretionary for existing network	Bioretention raingarden and GPT	A bioretention raingarden in the median will provide treatment of the busway and eastbound carriage way and a GPT will provide treatment of the existing network and the west bound carriageway.
Existing Outfall MCC_108482 (SAP ID - 2000380606)	EBA BPO and discretionary for existing network	Bioretention raingarden and GPT	A bioretention raingarden in the median will provide treatment of the busway and eastbound carriage way and a GPT will provide treatment of the existing network and the west bound carriageway.
Existing Outfall MCC_496129 (SAP ID 2000507038)	Not treated	None	No Project networks discharge to this outfall and the outfalls' existing Tī Rākau Drive catchment will be diverted to Outfall MCC_988531. The outfall will only service the Gull branded service station site once the busway is constructed.
Existing Outfall MCC_988531 (SAP ID 2000295186)	EBA BPO for Busway and eastbound lane of Tī Rākau Drive Discretionary treatment for westbound lane of Tī Rākau Drive	Bioretention raingarden and GPT	The eastbound lane of Tī Rākau Drive and the busway are treated by bioretention raingardens, while a GPT upstream of the outfall ensures the westbound lane of Tī Rākau Drive has discretionary treatment.

A CLM (see Section 4.2.1 for methodology and analysis) for EB3C has been developed to compare the BPO treatment option with existing contaminant load contributions from roads to each outfall that receives discharges or has had its catchment changed (i.e., road source areas reduced). The CLM estimates the percent change from the existing situation for TSS, zinc, copper, and TPH as summarised in Table 3. Given that the CLM is a model the predicted percent changes should be considered indicative.

Except for outfalls MCC_108479 (all contaminants), MCC_108482 (all contaminants) and MCC_988531 (zinc), all outfalls that receive Project stormwater will have a modelled reduction in contaminant loads for each contaminant. It is noted that outfall MCC_108482 discharges very close to the outlet of Culvert 127B and there is a reduction for the combined location. As discussed in the design philosophy, the target is to reduce the existing contaminant load contributions from all roads to outfalls that interact with the Project, on an overall basis. The CLM currently predicts EB3C is achieving an overall improvement for TSS, zinc, copper and TPH (see Table 3).

Outfalls MCC_108479, MCC_108482 and MCC_988531 are predicted to receive an increase (MCC_988531 is only for zinc) in contaminant loads for zinc, copper and TPP which is caused by an increase in road catchment area and constraints preventing the use of green infrastructure (i.e., treatment is only by a GPT designed for at least 50% removal of TSS). As stated MCC_108482 discharges very close to Culvert127B and the two locations combined have a predicted improvement in contaminants discharged from roads (i.e. predicted improvement of13% for TSS, 7% zinc, 7% copper and 8% TPH).

Table 3: Summary of EB3C predicted change in contaminant loads

Outfall	TSS[1]	Zinc[1]	Copper[1]	TPH
Existing Tī Rākau Bridge	0%	0%	0%	0%
MCC_108479 (Line 4)	17%	2%	2%	1%
MCC_108480 & Culvert 09-1	-38%	-11%	-13%	-18%
MCC_108409 (Line 10)	-57%	-40%	-45%	-52%
MCC_108481 (Line 36)	-20%	-20%	-22%	-25%
CULVERT 127B	-24%	-21%	-21%	-21%
MCC_108482 (Line 43)	154%	215%	208%	187%
MCC_988531 (Line 47)	-20%	7%	0%	-12%
MCC_496129 (Line 53)	-100%	-100%	-100%	-100%
CULVERT 127A / Outfall 1-1	-14%	-30%	-30%	-30%
Total EB3C change	-21%	-9%	-11%	-14%

Note: [1] Refer to Section 4.2.1 for general level of uncertainty associated with the CLM outputs.

2.5.5 Flood Management

A comprehensive flood model for EB3C (that includes EB4L for assessing cumulative effects) has been developed for the Project based on an existing AC flood model for the Pakuranga Creek Catchment. The methodology of the modification of the model is discussed in Section 4.3. The results of the flood modelling for the existing situation (the 'base case') are discussed in Sections 5.1.5 (Overland Flow Paths and Flooding) and 5.1.6 (Overland Flow Path Capacity). The results for the design case are discussed in Sections 6.1.3 (Flooding Assessment) and 6.1.4 (Overland Flow Path Assessment).

2.6 EB4L Design Statement

2.6.1 Design Overview

The main characteristics influencing stormwater design for this section of the Project are the adjacent stream in Guys Reserve and the Bridge C structure. Major utilities do not significantly influence the stormwater design. The proposed busway design philosophy statement is discussed in more detail in Appendix 1. The EB4L design drawings are provided in Appendix 3.

In accordance with the design philosophy for stormwater drainage, EB4L provides new independent stormwater networks to avoid flooding impacts from increased flows within existing stormwater networks. The new stormwater networks discharge to the stream in Guys Reserve near Tī Rākau Drive at the inlet of Culvert 12B and into Whaka Maumahara an existing stormwater pond adjacent Te Irirangi Drive via a connection to the existing stormwater networks 2100 mm pipe near its outfall. The 2100 mm pipeline has sufficient capacity for the small EB4L flows and does not need to be upgraded.

There are minimal changes (from a stormwater point of view) to the intersection of Te Irirangi Drive and Town Centre Drive (refer to Figure 8). As a result, modifications to the existing stormwater may be required to accommodate the geometrical changes. However, these modifications will be negligible in nature and 'like for like' with no upgrades of pipe sizes or modifications to the outfall required. These stormwater modifications will be subject to detailed design and addressed at EPA and NDC connection approval.

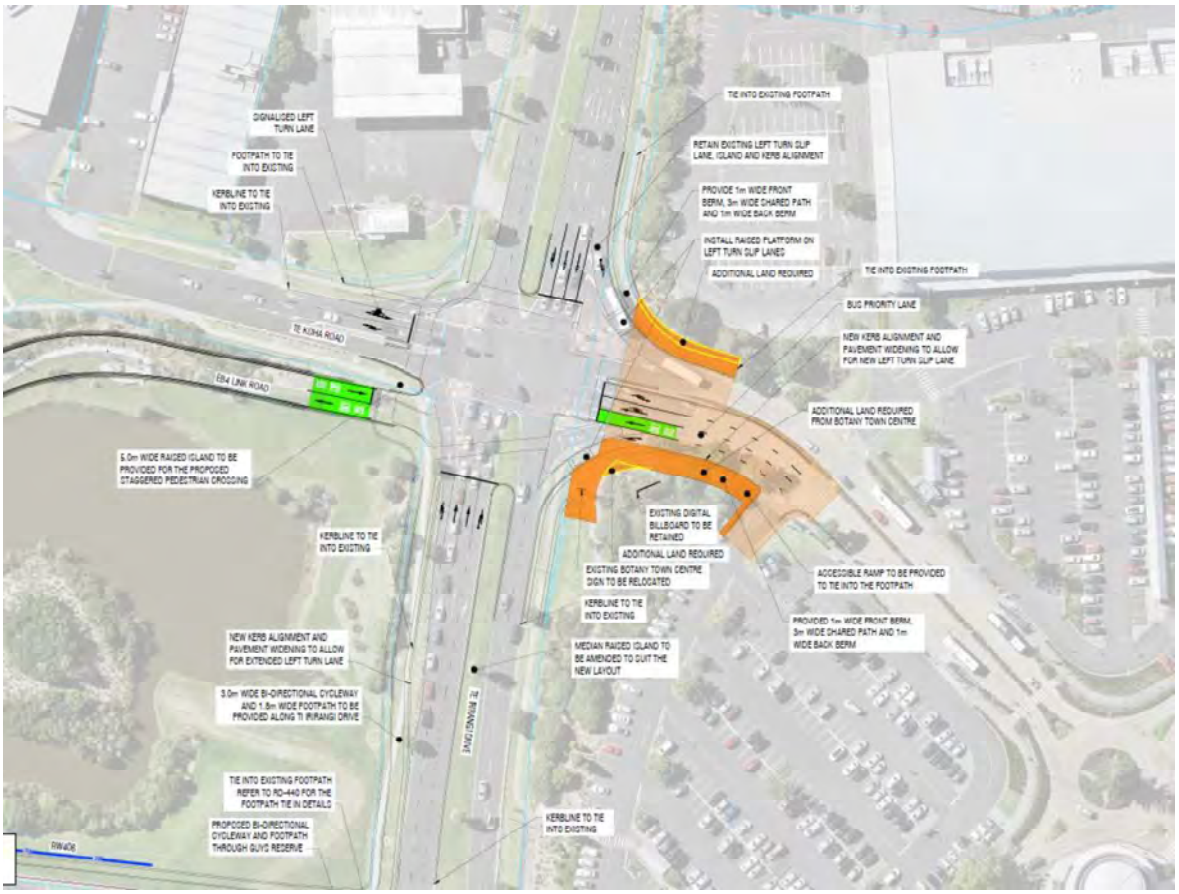

Figure 8. Proposed Intersection improvements on Te Irirangi Drive/Town Centre Drive.

No stormwater works are proposed where existing kerb positions are retained and where only slight modification of existing pavements is proposed (i.e., pavement overlays and repairs), unless flood mitigation is required.

The design is in accordance with the Engineering Design Code and the Stormwater Code of Practice.

2.6.2 Scope of networks

The proposed independent networks for EB4L serve the following areas:

- New Outfall 1-1 services approximately half the busway. It will be constructed adjacent to the inlet of Culvert 12A
- MCC_480841 services a large residential and commercial catchment to the east. The project network will service the eastern half of Bridge C and connect to manhole SAP ID 2000061181.

2.6.3 Constraints and limitations

EB4L is not overly constrained, with a stream adjacent and minimal utilities in Guys Reserve.

2.6.4 Stormwater Treatment and Discharge

EB4L will connect to the existing network at the eastern end of the link road and a proposed new network at its western end. Discharges will occur at outfalls near or within streams at the locations summarised in Table 4.

Table 4: Summary of EB4L outfalls proposed to receive discharges

Outfall	Existing Outfall	Discharges to CMA or Stream	New Outfall in CMA	New Outfall in Stream or Wetland	Comment
New Outfall 1-1	✗	Stream	✗	✓	A new outfall in the stream in Guys Reserve is proposed on the stream bank.
Outfall MCC_480841	✓	Wet Pond / Stream	✗	✗	The connection point is the last manhole (SAP PI 2000061181) before the existing outfall. No work is proposed to the last pipe section or the outfall.

The stormwater treatment BPO includes a combination of:

- Green infrastructure (i.e., swales (Figure 6) and bio-retention raingardens (Figure 7)) where feasible (i.e., adjacent to ramps, within residual land and some in the busway medians where the width permits)
- GPTs designed to remove litter via a 5 mm screen and at least 50% of TSS, are proposed at the downstream end of each network at each outlet within the road reserve or other locations convenient for maintenance access
- Discretionary targeted treatment of high use roads and carparks, outside of areas where the Project is modifying or creating new impervious areas, has been used where necessary to achieve the desired reductions to existing contaminant loads as stated in the design philosophy (subject to ongoing discussions between mana whenua, Healthy Waters and EBA).

A stormwater management options assessment following integrated catchment management approaches was carried out to identify the BPO. The Stormwater Management Option and BPO Report will be finalised and included in the SMP. The BPO treatment systems provided within EB4L for each outfall that receives EBA stormwater discharges are summarised in

Table 5. The proposed treatment devices included in the BPO for the design, are subject to ongoing discussions with key Project partner mana whenua and Healthy Waters.

Figure 9. EB4L outfall locations

Table 5: Summary of proposed EB4L stormwater devices

Outfall	Treatment Category	Treatment Devices	Comment
New Outfall 1-1	EBA BPO	GPT	Busway treated by GPT that can remove at least 50% TSS.
Outfall MCC_480841	EBA BPO	GPT	Busway treated by GPT that can remove at least 50% TSS.

A CLM (see Section 4.2 for methodology and analysis) for EB4L has been developed to compare treatment options with existing contaminant load contributions from roads to each outfall that receives discharges or has had its catchment changed (i.e., road source areas reduced). The CLM estimates the percent change from the existing situation for TSS, zinc, copper and TPH (see Table 6). Given that the CLM is a model the predicted percent changes should be considered indicative.

As discussed in the design philosophy, the target is to reduce the existing contaminant load contributions from all roads to outfalls that interact with the Project, on an overall basis. In addition, the final outcomes will be influenced by ongoing joint EBA and Healthy Waters hui with mana whenua. The CLM currently predicts EB4L will have a small reduction in existing contaminant loads for each of the contaminants assessed (see Table 6).

Table 6: Summary of EB4L predicted change in contaminant loads

Outfall	TSS[1] (%)	Zinc[1] (%)	Copper[1] (%)	TPH (%)
New Outfall 1-1 / Culvert 127A	**-14%**	**-30%**	**-30%**	**-30%**
Outfall MCC_480841	5%	1%	1%	1%
Outfall MCC_695723 (no change_	0%	0%	0%	0%
Total EB4L	-6%	-8%	-9%	-7%

Note: [1] Refer to Section 4.2.1 for general level of uncertainty associated with the CLM outputs.

2.6.5 Flood Management

The busway link road is an elevated structure with the reference design's philosophy being to ensure the bridge piers are located outside of the 100-year ARI flood extents of the stream in Guys Reserve (see Figure 34). However, two piers are located within overland flow from the VTNZ site. Ground surface modification around the piers could be included in the detailed designed if further assessment identifies there is potentially an impact on the overland flow path capacity from the VTNZ side. However, given the bank is steep it is very unlikely any design modifications will be required to avoid loss of overland flow capacity. Therefore, there are no flood impacts from the placement of the bridge structure and the stormwater discharges are negligible compared to the existing flows of the Guys Reserve stream. The overland flow path capacity will be assessed during detailed design and addressed by the NDC and EPA process.

3 Specialist Assessment

Chapter Summary
Summary of key points/ findings • *AT proposes to use the NDC to authorise EB3C and EB4L discharges of stormwater* • *This stormwater assessment covers stormwater discharges, flooding, and overland flow path capacity* • *The proposed works for EB3C and EB4L either exceed 1,000 m² of new and modified impervious carriageway on high use roads and 5,000 m² on other roads based on conservative estimates thereby triggering Category 3 NDC requirements* • *AT will meet the Category 3 connection requirements under Schedule 4 of the NDC to obtain connection approval by AC* • *The proposed works will modify entry and exit points and capacity of overland flow paths due to geometric design changes to existing roads to accommodate the busway and other Project elements.*

3.1 Assessment Content

This report describes the assessment of stormwater effects associated with the operation of EB3C and EB4L sections of the Project. The Project proposes to use the NDC to authorise stormwater discharges to new and existing outfalls. Schedule 4 of the NDC outlines the requirements for connection approval and this report is structured to demonstrate the Project meets these requirements. The connection approval process is part of the EPA process that approves the final detail design rather than up front during the resource consent application process. As the Project has adopted a BPO approach a SMP is required to be prepared and submitted for approval as part of the connection approval process.

Stormwater effects being assessed include permanent discharge of stormwater, and associated flooding and overland flow path capacity management.

This stormwater assessment covers:

- Permanent (post-construction) stormwater discharges
- Permanent (post-construction) flooding
- Permanent (post-construction) overland flow path capacity.

This stormwater technical assessment excludes an assessment of:

- Construction of the stormwater system
- Temporary discharges of stormwater during construction phase (refer to technical assessment for erosion and sediment control)
- Removal and modification of asbestos cement pipes during construction (refer to technical assessments for construction methodology and contaminated land)
- Potential effects on marine ecology (refer to the Marine Ecology and Coastal Avifauna Effects Assessment).
- Potential effects on natural wetlands (refer to the Terrestrial and Freshwater Ecological Effects Assessment).

3.2 Specific Project Elements

The elements of the proposal that are relevant to this technical assessment are:

- The road design for the busway and all associated cycleways and pedestrian paths
- The design of the stormwater system for EB3C and EB4L including stormwater treatment systems, and flood and overland flow management measures

- New or the redevelopment of existing impervious carriageway areas greater than 1,000 m^2 of high use roads, and greater than 5,000 m^2 of other roads
- The development of BPO (ongoing), contaminant load modelling and life cycle cost analysis will be documented in the final Stormwater Management Options and BPO Report which will be included in the SMP
- The existing flooding and overland flow paths and the flood modelling methods and model development is documented in the Flood Model Build Report provided in Appendix 4.

3.3 NDC Connection Requirements

3.3.1 Overview

The existing stormwater network and associated discharges are authorised by the NDC (AC Reference: DIS60069613). The NDC replaced 116 different consents and multiple authorisations with a single consent containing a comprehensive set of requirements for use across Auckland. The NDC defines clear targets to lift water quality, reduce flooding and protect streams and other water assets.

The proposed stormwater networks and their connections and discharge of stormwater to existing and new outfalls are proposed to be authorised under the NDC. Under the NDC, AT Projects are covered under a special section for AT, Kiwi Rail and Waka Kotahi in Schedule 4, which outlines connection requirements for four different size or risk categories. These categories are:

- Category 1 - small Projects up to 1,000 m^2 of new impervious area
- Category 2 - off-pedestrian and cycling facilities and ferry terminal facilities. New impervious area greater than 1,000 m^2
- Category 3 - development of new/redevelopment of impervious area for:
    - existing high use roads that include new impervious area greater than 1,000 m^2
    - other roads that include new impervious area greater than 5,000 m^2
    - rail corridor Projects with new impervious area greater than 1,000 m^2
- Category 4 - development/redevelopment of a high contaminant generating carpark (new/redeveloped area greater than 1,000 m^2).

The AUP(OP) defines a 'high use road' as "A road, motorway or state highway that carries more than 5,000 vehicles per day, excluding cycle lanes, footpaths and ancillary areas that do not receive stormwater runoff from the road carriageway."

The proposed EB3C works modify Tī Rākau Drive, which meets the definition of 'high use road'. However, the busway is not a 'high use road' with only approximately 700 bus movements a day. Burswood Drive is a 'high use road' with approximately 5,230 vehicle movements a day. The busway intersects with Burswood Drive at two locations, and only tie in works are proposed. EB3C includes new or redevelopment of impervious carriageway area greater than 1,000 m^2 on high use roads (Tī Rākau Drive and Burswood Drive), and/or areas greater than 5,000 m^2 on other roads. Therefore, EB3C is within the scope of Category 3 (individual and combined) of Schedule 4 connection requirements for the NDC.

The proposed EB4L works involve an elevated busway on a bridge structure with tie in works on Tī Rākau Drive and Te Irirangi Drive and intersection improvements at Te Irirangi Drive/Town Centre Drive. As indicated above, the busway is not a 'high use road'. EB4L includes only minimal tie in works and includes new or redevelopment of impervious carriageway area much less than 1,000 m^2 on high use

roads, and areas greater than 5,000 m^2 on other roads (i.e. the busway). Therefore, EB4L is covered under Category 2 of Schedule 4 connection requirements for the NDC when considered separately to EB3C and Category 3 when combined with EB3C.

3.3.2 NDC Requirements for Category 3

The following section assesses the proposed EB3C and EB4L stormwater system against the NDC connection requirements for Category 3 of Schedule 4. Category 3 connection requirements are summarised in Table 7 with only the applicable requirements included based on the EB3C and EB4L Project area:

- Is not within an adopted SMP and is therefore covered by 'in other areas'
- Is not within a Stormwater Management Area Flow (SMAF) zone
- Has more than 5,000 m^2 of new impervious area.

The analysis of the Project against the Category 3 connection requirements is provided in Section 4.4.

Table 7: Summary of NDC Schedule 4 connection requirements for category 3

Issue/Receiving Environment	Connection Requirements
Catchment/Area	C1 No new/additional habitable floor affected by flooding in 1% AEP event and no increase in frequency of existing flooding
	C2 No significant increase in risk to the operation and structural integrity of other infrastructure in 1% AEP event
	C3 No increase in inundation that affects a building on a property in 10% AEP
	C4 No loss in overland flow path capacity, unless provided by other means
	C5 Or where these requirements cannot be met, a SMP that includes supporting information to justify an alternative as the BPO for the Project is required.
Water Quality	WQ1 Treatment of new road area and any existing road area directed to same point by a water quality device designed in accordance with GD01/TP 10 for the relevant contaminants **OR** WQ2 Treatment of equivalent area of high use road within same catchment by a water quality device designed in accordance with GD01 for the relevant contaminants **OR** WQ3 An alternative level of mitigation determined through a SMP that: - applies an Integrated Stormwater Management Approach (as per above) - meets the NDC Objectives and Outcomes in Schedule 2 - is the BPO for the given Project.
Stream Hydrology	SH1 Where discharge is to a stream via public stormwater network outside of SMAF there is no additional requirements to those in the AUP(OP) and general requirements above.
Flooding (10% AEP)	F1 Ensure that there is sufficient capacity within the pipe network downstream of the connection point (at maximum probable development of the contributing catchment) to cater for the additional stormwater runoff associated with the new impervious area in a 10% AEP event **OR** F2 Attenuate stormwater flows and volume such that there is no increase in peak flow in a 10% AEP event from the total road impervious area draining to

Issue/Receiving Environment	Connection Requirements
	the pipe network downstream of the connection point to that prior to the new impervious area
	OR F3 Demonstrate that flows in excess of the pipe capacity in a 10% AEP event downstream of the connection point will not increase flooding of any other property and will not create a nuisance or hazard.
Assets	A1 All new stormwater assets to be operated by Healthy Waters are to be built in accordance with the Stormwater Code of Practice.

Note: The wording in the above table is copied directly from Schedule 4 of the NDC.

3.4 Auckland Unitary Plan (Operative in Part)

The entry and exit point, as well as the capacity of several overland flow paths will be modified by the proposed road alignment. Several overland flow paths will be partly or entirely piped to offset the loss of overland flow path capacities. An assessment against the AUP (OP) provisions is contained within the AEE.

Changes to entry and exit points of overland flow paths for EB3C are covered by the NoR and resource consents. There are no changes to entry and exit points or the capacity of overland flow paths for EB4L, with Bridge C elevated and its piers outside the 100-year ARI flood extent in Guys Reserve. Two piers are within a smaller overland flow path from the VTNZ site. The two piers are very unlikely to impact the overland flow path capacity from the VTNZ site due to the steepness of the bank but this can be assessed in further during detailed design and if necessary the ground surface adjacent the pier can be modified to increase overland flow path capacity The slight changes for EB3C have been mitigated by providing additional piped drainage capacity with the pipe size determined by flood modelling for the 10 and 100-year ARI events with pipe blockages applied in accordance with the AC Stormwater Code of Practice (Version 3).

Overland flow path entry, exit locations and capacity will be modified at the following locations:

- Overland Flow Path 1 along Tī Rākau Drive from Harris Road towards Trugood Drive (see Figure 14) crosses Tī Rākau Drive to the CMA on the eastern side of the Pet Stop Shop will have changes to its exit location and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2)
- Overland Flow Path 2 (see Figure 14) runs adjacent to Torrens Road towards Burswood Drive then along Burswood Drive to the north and through residential property to the CMA. Path 2 will have changes to its exit location and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2)
- Overland Flow Path 3 (see Figure 14) overland flow path from Torrens Road through commercial and residential properties to Heathridge Place will have changes to its exit location and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2)
- Overland Flow Path 4 (see Figure 14) Along the back of Bunnings Warehouse and across Burswood Drive through residential properties to a stream in the Burswood Esplanade Reserve will have changes to its exit location and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2)
- Overland Flow Path 5 (see Figure 14) along a stream in the Greenmount Drainage Reserve and across Tī Rākau Drive (and through Culvert 12B into a stream in the Burswood Esplanade

Reserve) will have changes to its exit location and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2)

- Overland Flow Path 6 (see Figure 14) follows a stream in Guys Reserve and crosses Tī Rākau Drive (and through Culvert 12A) into a stream in Burswood Esplanade Reserve. Path 6 will have changes to its exit location and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2)
- Overland Flow Path 6 Branch A (see Figure 14) runs through Piccolo Park properties and across Tī Rākau Drive into a stream in the Burswood Esplanade Reserve. Path 6 Branch A will have changes to its exit location and capacity (see Section 6.1.4) with the reduction in overland flow path capacity being offset by the proposed design (Appendix 2).

4 Methodology and Analysis

Chapter Summary
Summary of key points/ findings • *EBA has carried out flood modelling for EB3C and EB4L in one combined flood model* • *Contaminant load models have been developed to compare the total existing and future road contributions to each outfall within the Project* • *A water quality objective, subject to further discussions with mana whenua and Heathy Waters, of reducing existing road contributions of contaminants to the overall receiving environments has been adopted* • *EB3C and EB4L can and will meet all connection requirements of the NDC for category 3 under schedule 4* • *The final connection approval for the stormwater system will be obtained through the EPA process once the design is completed which includes connection and SMP approval.*

4.1 General

The following sections outline the methodology and analysis used to assess the potential impacts of EB3C and EB4L based on the design and how the connection requirements of the NDC are achieved.

4.2 Stormwater Treatment Performance

4.2.1 Methodology

A CLM model has been developed for each EB3C and EB4L footprint based on the AC CLM Version 2. The development of the CLM is documented in Technical Report No.2010/004 (ARC, 2010A) and predicts contaminant loads for TSS, zinc, copper and TPH. The Project CLM has been developed in general accordance with Technical Report (TR) 2010/003 the CLM User Manual (ARC, 2010B) except that it only includes contributions from AT assets (i.e., roads, the busway and any car park areas proposed to receive targeted discretionary treatment to achieve the discharge quality objectives). The CLM has not been developed to attempt to quantify annual contaminant loads for each outfall, rather to allow comparison of options and changes from the existing situation and following the implementation of the design. Contaminant loads in kilograms have therefore not been reported in this report, instead the percentage change has been reported relative to the existing situation. The development of the CLM will be documented in more detail in the Stormwater Management Options and BPO report which will be included in the SMP along with a comparison of options considered in developing a BPO.

The percentage change in contaminant load from the existing situation to that predicted following implementation of the design is discussed in Sections 2.5.4 (Table 3 for EB3C), 2.6.4 (Table 6 for EB4L) and 6.3.1 (Table 9 for Project wide). Further analysis of other stormwater treatment options considered in developing the BPO will be documented in the Stormwater Management Options Report which will be included in the SMP.

4.3 Flooding and Overland Flow Paths

4.3.1 Methodology

A flood assessment was undertaken for the Project to ascertain the existing flood risks and the effects the proposed Eastern Busway design would have across the four EB zones (EB2, EB3R, EB3C and EB4L). The Eastern Busway extent has been split across the following two flood models:

- EB2 and EB3R flood model which sits within the Pakuranga – Tāmaki River catchment and Pakuranga Creek catchment (see Figure 10 for model extents).

- EB3C and EB4L flood model which sits within the Pakuranga Creek catchment (see Figure 10 for model extents).

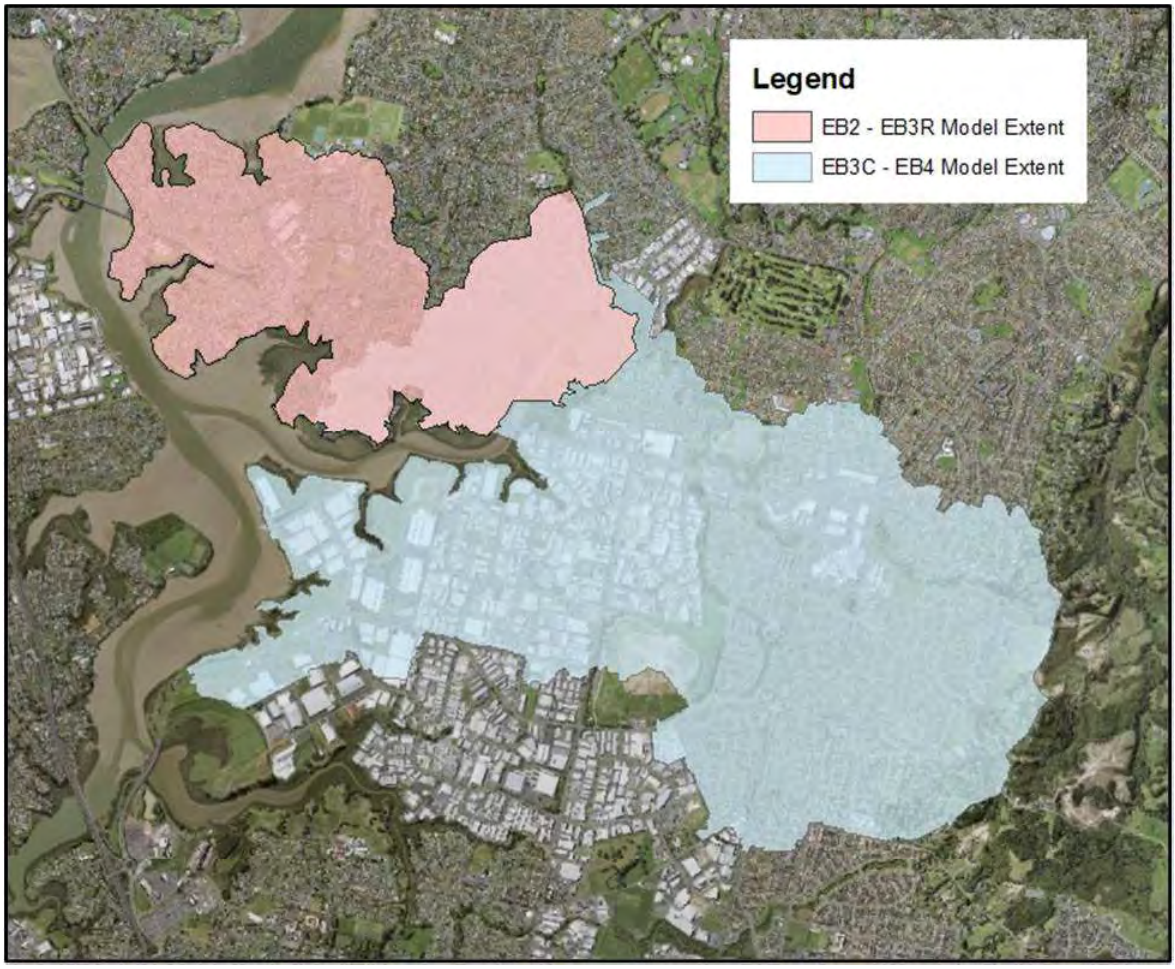

Figure 10. Eastern Busway Flood Model Extents

Flood modelling has been carried out in accordance with TP 108 – *"Guidelines for stormwater runoff modelling in the Auckland Region"* (April 1999) and the AC Modelling Methodology (Nov 2011). The current flood model build report is provided in Appendix 4.

The flood models have been used for the following two types of assessment:

- Flooding and overland flow assessment using the ground surface model (including geometric design) and the drainage design (pipes and catchpits/inlets). This scenario assesses primary stormwater systems
- Overland flow path capacity assessment which applies pipe blockages, in accordance with the Stormwater Code of Practice, to existing and proposed pipes for the base case (i.e., existing situation) and design case (ie proposed case). This scenario assesses secondary stormwater (flow paths) systems. The pipe blockages applied are:
    - 100% pipe blockage of pipes 600 mm or less
    - 50% reduction in pipe capacity for pipes between 600 mm and 1050 mm
    - 10% reduction in pipe capacity for pipes larger than 1050 mm.

4.3.2 Analysis

The flood modelling results are discussed in the following sections:

- Section 5.1.5 for the EB3C base case (existing situation) for the flooding assessment
- Section 5.1.6 for the EB3C base case (existing situation) for the overland flow path capacity assessment (with pipe blockages applied)
- Section 5.2.5 for the EB4L base case (existing situation) for the flooding assessment and overland flow assessment (with pipe blockages applied)
- Section 6.1.3 for the EB3C design case and the impacts from the flooding assessment
- Section 6.1.4 for the EB3C design case and impacts from the overland flow path capacity assessment (with pipe blockages applied)
- Section 6.2.3 for the EB4L design and impacts from the flooding assessment and impacts from the overland flow path capacity assessment (with pipe blockages applied)
- Section 6.3.2 for the cumulative impacts from the flooding assessment
- Section 6.3.3 for the cumulative impacts from the overland flow path capacity assessment (with pipe blockages applied)
- Sections 7.1.2 and 7.1.3 for the mitigation proposed for EB3C for flooding and overland flow path capacity impacts.

4.4 NDC Connection Requirements

4.4.1 Methodology

The methodology applied for assessing the stormwater design and potential impacts (water quality and quantity) has been to use water quality (based on CLM) and BPO development as outlined in Section 4.2 and flood modelling as outlined in Section 4.3 to demonstrate the design meets the NDC connection requirements outlined in Section 3.3.

4.4.2 Analysis

The following section summarises the analysis of the stormwater design proposed for EB3C and EB4L against the NDC connection requirements for category 3 (see Table 8). The analysis will be updated as design progresses through detailed design and incorporated into the EPA documentation for the submission of the final detailed design. The summary of compliance with Schedule 4 is provided in Table 8 and has been assessed based on the following EBA decisions where options are provided for in the NDC connection requirements:

- The Stormwater Management Option and BPO Report which will be finalised and included in the SMP, demonstrates treatment in accordance with GD01/TP 10 is not possible for all Project areas or elsewhere in the catchment and therefore EBA has selected the BPO option for water quality
- As a result of existing flooding and overland flow activation during 10-year events due to the existing stormwater networks being under sized, EBA has chosen to demonstrate that flows in excess of the pipe capacity in a 10% AEP event downstream of the connection point will not increase flooding of any other property and will not create a nuisance or hazard.

Table 8: Summary of compliance with NDC Schedule 4 connection requirements for category 3

NDC Requirements	Achieves		Comment
	EB3C	EB4L	
Catchment/Area			
C1 (see Table 7)	✓	✓	Sections 6.1.3 and 6.1.4 in conjunction with the mitigation proposed in Section 7.1 demonstrate the EB3C design meets this requirement. Section 6.2.3 demonstrates the EB4L design meets this requirement.
C2 (see Table 7)	✓	✓	
C3 (see Table 7)	✓	✓	
C4 (see Table 7)	✓	✓	
C5 (see Table 7)	n/a	n/a	A SMP is proposed to be developed, due to adoption of a BPO approach for water quality. The SMP will be provided as part of submission of the final detailed design to the EPA process.
Water Quality			
WQ3 (see Table 7)	✓	✓	The development and adoption of the BPO will be documented in the final Stormwater Management Option and BPO Report and included in the SMP. This report confirms that the development of the BPO applied an integrated stormwater management approach which meets the objectives and outcomes of Schedule 2. A SMP will be developed and provided as part of the final detailed design submission to the EPA process. EBA will work with AT, Healthy Waters, and mana whenua in developing the SMP to ensure it meets the aspirations of mana whenua and requirements of AT and Healthy Waters.
Stream Hydrology			
SH1 (see Table 7)	✓	✓	The Project is not within a SMAF zone on the planning maps of the AUP(OP).
Flooding – 10% AEP event			
F3 (see Table 7)	✓	✓	Sections 6.1.3 and 6.1.4 in conjunction with the mitigation proposed in Section 7.1 demonstrates the EB3C design meets this requirement. Sections 6.2.2 and 6.2.3 demonstrate the EB4L design meets this requirement.
Assets			
A1 (see Table 7)	✓	✓	EBA will work with AT and Healthy Waters to confirm which assets will be operated by each organisation. Healthy Waters assets will be designed to the Stormwater Code of Practice. AT assets will be designed to the Engineering Code of Practice and where this code provides no guidance for elements of the design the Stormwater Code of Practice will be followed. EBA and Healthy Waters will meet regularly to discuss design development and Project stormwater outcomes. Final detailed design approval will be via the EPA process with an 'in principal approval' obtained prior to the EPA process to minimise risks associated with dual AT and Healthy Waters approval of the detailed design for construction.

5 Existing Environment

Chapter Summary
EB3C summary of key points/ findings: • *The footprint of EB3C includes several overland flow paths that crossroads in the 10 and 100-year ARI events* • *The existing stormwater networks were designed for a 5-year ARI event which is equivalent to a capacity of a 2-year ARI event when allowing for climate change (increased rainfall and sea level rise)* • *There is similarly extensive flooding during the 10 and 100-year ARI events due to the under sized networks* • *Flood depths within the EB3C Project area ranges from shallow (10-100 mm) to deep (100-700 mm) in the 10-year ARI event and in the 100-year ARI event the areas with deeper flooding increase in extent* • *Large parts of the existing outfall catchments currently have no stormwater treatment, except for a wetland upstream of Outfall MCC_711303 (SAP ID 2000097466).* *EB34L summary of key points/ findings:* • *EB4L crosses or follows one overland flow path. The overland flow path crosses Tī Rākau Drive just to the east of the busway intersection to enter the link road bridge during the 10 and 100-year ARI events* • *The existing stormwater networks were designed for a 5-year ARI event which is equivalent to a capacity of a 2-year ARI event when allowing for climate change (increased rainfall and sea level rise)* • *Flooding is contained within the stream in Guys Reserve during the 10 and 100-year ARI events* • *There is a large wet pond at the eastern end of the link road bridge within the Whaka Maumahara Reserve.*

5.1 EB3C

5.1.1 Climate and Geology

EB3C is in the Pakuranga Creek Catchment (see Figure 11). The geology of the Project area is characterised by soils mainly composed of volcanic ash soils and are generally silty, friable, and free-draining (McEwen, 1987). The Project area experiences warm, humid summers and relatively mild winters. Rainfall is typically plentiful throughout the year, with sporadic heavy falls, with a total rainfall of approximately 1,100 to 1,450 mm per annum (Chappell, 2012). The sub-catchments of the Pakuranga Creek Catchment are shown on Figure 12.

5.1.2 Topography

The topography of EB3C (see Figure 13) undulates slightly as shown in Figure 13. The existing road (Tī Rākau Drive) gently rises from approximately RL 7.0m at Tī Rākau Drive Bridge to RL 13.0 m at the intersection of Tī Rākau Drive and Harris Road. The existing road then dips slightly to approximately RL 10.0 m around the Pakuranga Creek crossings. Finally, the road starts rising eastwards towards Botany Road at approximately RL 25.0m.

Figure 11. Pakuranga Creek Catchment Boundary

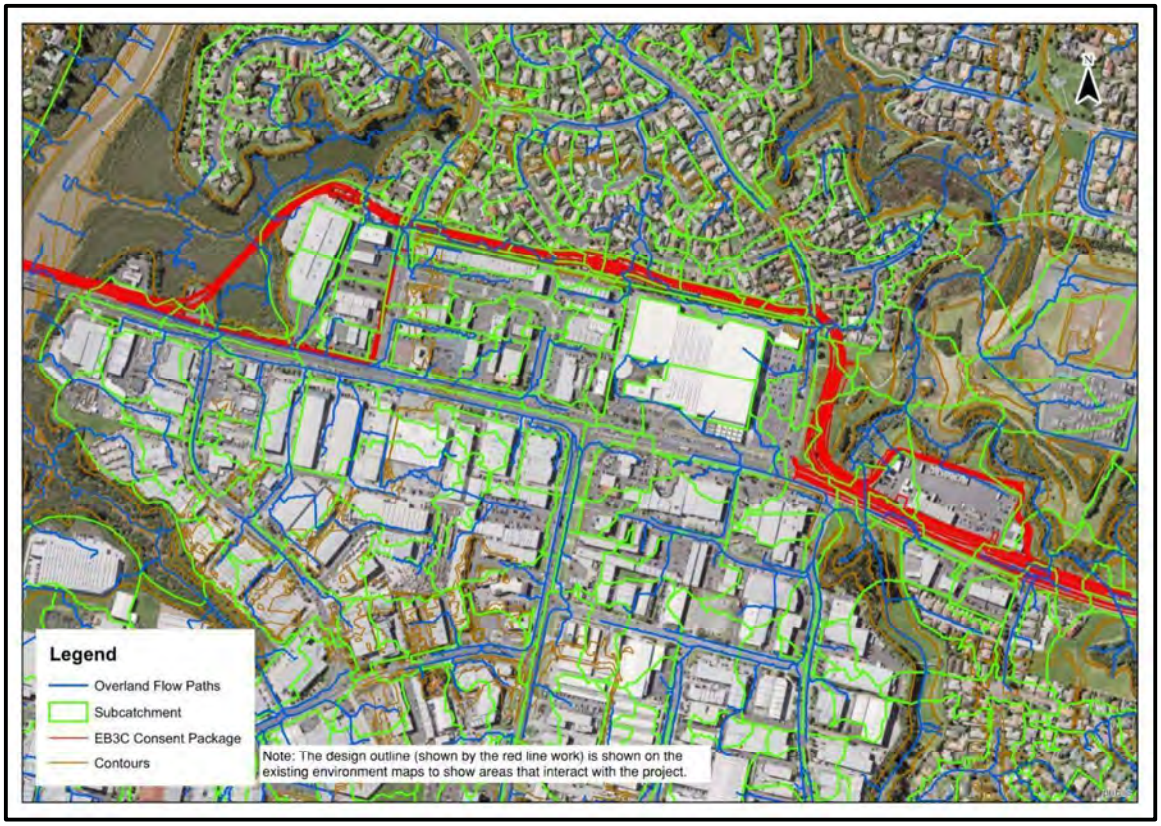

Figure 12. EB3C sub-catchments

Figure 13. EB3C topography

5.1.3 Existing Stormwater Networks and Outfalls

Runoff from the existing EB3C area is currently collected via a kerb and channel system and conveyed to 5 CMA outfalls (see Figure 11) and 6 stream outfalls in the Burswood Esplanade Reserve:

- Tī Rākau Bridge (diffused discharge directly to Pakuranga Creek) discharge to CMA
- Outfall MCC_108479 (SAP ID 2000029871) between the Mobil service station site and the Pet Stop site on Tī Rākau Drive discharges to the CMA
- Outfall MCC_108480 (SAP ID 2000822231) adjacent China Town off Tī Rākau Drive discharges to the CMA
- Existing Outfall MCC_108409 (SAP ID 2000893599) at the back of 201 Burswood Drive discharges to the CMA
- Existing Outfall MCC_711303 (SAP ID 2000097466) a treatment wetland between 85 and 89 Burswood Drive discharges to the CMA
- Outfall MCC_108481 (SAP ID - 2000533442) at the back of 10 Midvale Place discharges to a stream in the Burswood Esplanade Reserve
- Outfall MCC_108482 (SAP ID - 2000380606) west of 380 Tī Rākau Drive (Howick and Eastern Bus Depot) adjacent to Culvert 27B outlet discharges to a stream in the Burswood Esplanade Reserve

- Culvert 27B under Tī Rākau Drive receives direct connections from the stormwater network and outlets to a stream in the Burswood Esplanade Reserve
- Outfall MCC_496129 (SAP ID 2000507038) adjacent to Gull Botany Downs discharges to a stream in the Burswood Esplanade Reserve
- Outfall MCC_988531 (SAP ID 2000295186) 45 m east of the Gull Botany Downs discharges to a stream in the Burswood Esplanade Reserve
- Culvert 27A under Tī Rākau Drive 95 m west of Tiger Grove receives direct connections from the stormwater network and outlets to a stream in the Burswood Esplanade Reserve.

The existing stormwater reticulation network within the Project extent was historically designed to achieve previous Manukau City Council's standards (i.e., to a 5-year ARI event with no allowance for climate change). This is a significantly lower requirement than the standard that superseded it, the current Stormwater Code of Practice Version 3 (Jan 2022), which requires 10-year ARI flow capacity with allowance for climate change. The required climate change scenario in the Stormwater Code of Practice is a 2.1 degrees Celsius temperature increase by 2090 (i.e., a 13.2 and 16.8 per cent increase in rainfall with a duration of 24 hours for the 10% and 1% AEP events respectively) and one metre of sea level rise. AC has completed a catchment-wide study of the performance of the existing stormwater network in the Pakuranga Creek Catchment. The study confirmed the extent and consequences of the existing network capacity issue within the catchment. The existing network is undersized and there are large secondary overland flows (refer to Section 5.1.5).

The existing stormwater network and associated discharges are authorised by the Healthy Waters NDC which supports growth in line with the Auckland Plan 2050 and AUP(OP). The NDC defines clear targets to lift water quality, reduce flooding and protect streams and other water assets.

5.1.4 Stormwater Treatment

The existing stormwater network that services the EB3C Project area has limited treatment. Only Outfall MCC_711303 (SAP ID 2000097466) is treated (by a wetland).

5.1.5 Overland Flow Paths and Flooding

EB3C has the following overland flow paths (see Figure 14):

- Overland Flow Path 1 along Tī Rākau Drive from Harris Road towards Trugood Drive which then crosses Tī Rākau to the CMA on the eastern side of the Pet Stop Shop
- Overland Flow Path 2 runs adjacent to Torrens Road towards Burswood Drive then along Burswood Drive to the north and through residential property to the CMA
- Overland Flow Path 3 from Torrens Road through commercial and residential properties to Heathridge Place
- Overland Flow Path 4 runs along the back of Bunnings Warehouse and across Burswood Drive through residential properties to a stream in the Burswood Esplanade Reserve
- Overland Flow Path 5 follows a stream in the Greenmount Drainage Reserve and crosses Tī Rākau Drive (through Culvert 12B) into a stream in the Burswood Esplanade Reserve
- Overland Flow Path 6 follows a stream in Guys Reserve and crosses Tī Rākau Drive (through Culvert 12A) into a stream in the Burswood Esplanade Reserve
- Overland Flow Path 6 Branch A runs through Piccolo Park properties to and across Tī Rākau Drive into a stream in the Burswood Esplanade Reserve.

A large percentage of overland flow (i.e. any flow greater than a 2-year ARI event) is runoff that is either not intercepted by the primary reticulated drainage system or it cannot enter due to capacity constraints within the existing stormwater network, as discussed in Section 5.1.3.

Figure 14. EB3C existing overland flow paths

Figure 14 is sourced from AC Geomaps March 2022.

As a result of the limited capacity of the existing stormwater networks, very little of the 10-year ARI event is intercepted and captured by the existing networks, as is demonstrated in Figure 15 where the 10-year and 100-year ARI events have similar flood extents. The existing flood areas are extensive for the 10-year and 100-year events, with overland flow crossing Tī Rākau Drive and other locations where the busway is proposed.

The existing depths of flooding within EB3C for the 10-year and 100-year ARI events are similar as shown in Figure 16 and Figure 17 respectively. The overland flows crossing Tī Rākau Drive are extensive and deep (see Figure 16 and Figure 17), with depths of approximately 800 mm in the area adjacent the Pet Stop Shop low point. Outside of the low points (i.e. the intersection of Tī Rākau Drive and Trugood Drive and Tī Rākau Drive either side of the Burswood Drive (West) intersection and adjacent to Guys Reserve) large areas of general traffic lanes have flood depths of between 200 and 605 mm. These overland flows represent potential safety risks to all modes of transport as well as environmental risks associated with erosion, scouring and deposition of debris. These risks do not relate to insufficient capacity in the road drainage, but rather insufficient capacity in the catchment-wide drainage.

Figure 15. EB3C base case 10 and 100-year flood extents

Figure 16. EB3C base case 10-year flood depths

Figure 17. EB3C base case 100-year flood depths

5.1.6 Overland Flow Path Capacity

The Stormwater Code of Practice requires secondary flow (i.e., overland flow paths) design to be assessed with pipe blockages applied to the pipe networks as outlined in Section 4.3. These blockage factors have been applied to the existing pipe network in the base case flood model (see Appendix 4) and the resulting flood extents are provided in Figure 18. As expected, with the 10 and 100-year flood extents being very similar for the flooding assessment (i.e., without pipe blockages), when pipe blockages are applied (see Section 4.3 for pipe blockage details) the 10 and 100-year flood extents are more widespread for both the existing situation (i.e., base case) and for the design case. The flood depths for the 10 and 100-year ARI events are shown in Figure 19 and Figure 20 respectively. Again, as expected, the flood depths are deeper, and the extents of deeper flooding are larger than without the pipe blockages.

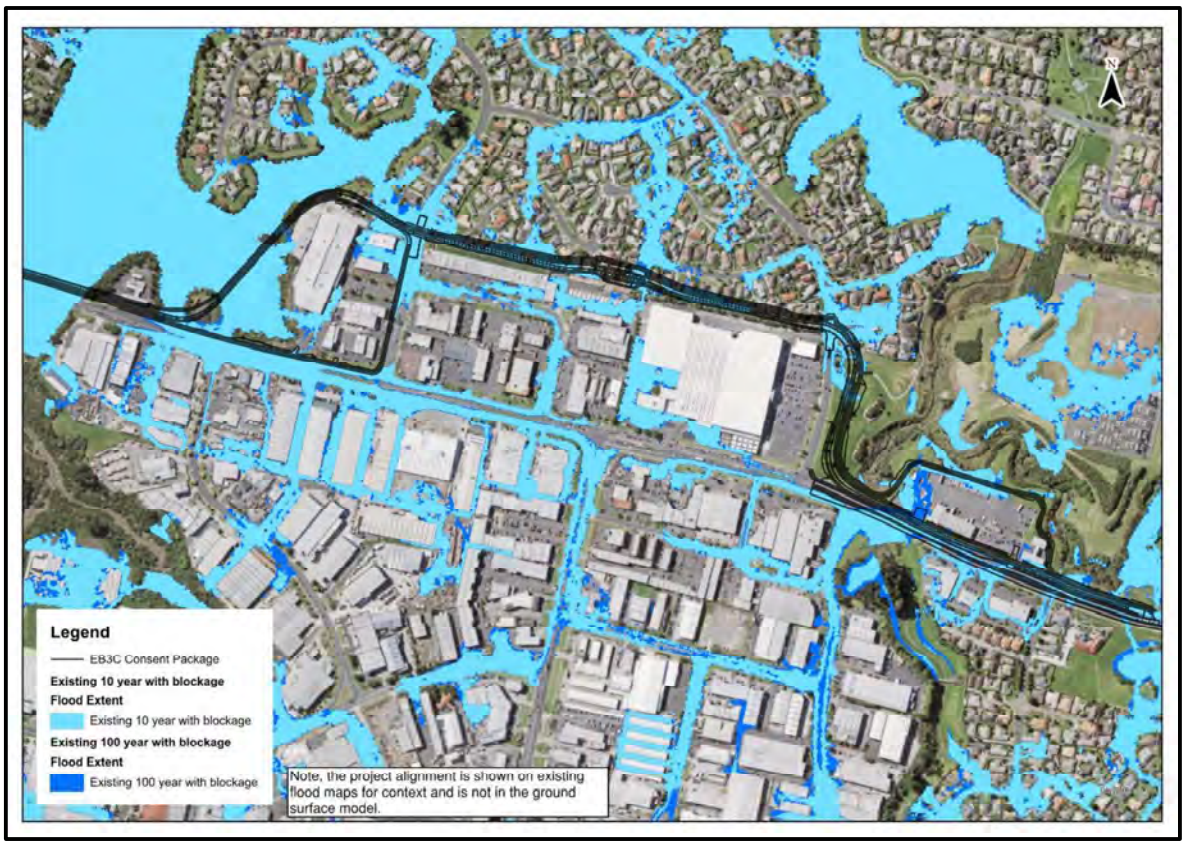

Figure 18. EB3C base case 10 and 100-year flood extents (pipe blockage)

Figure 19. EB3C base case 10-year flood depths (pipe blockage)

Figure 20. EB3C base case 100-year flood depths (pipe blockage)

5.2 EB4L

5.2.1 Climate and Geology

EB4L is in the same Pakuranga Creek Catchment as EB3C and has the same climate and geology (see Section 5.1.1).

5.2.2 Topography

The proposed link road Bridge C is elevated and located in the Guys Reserve stream. The topography (see Figure 21) has steep stream banks along Guys Reserve from RL 15 m down to RL 6 m near the invert of the stream.

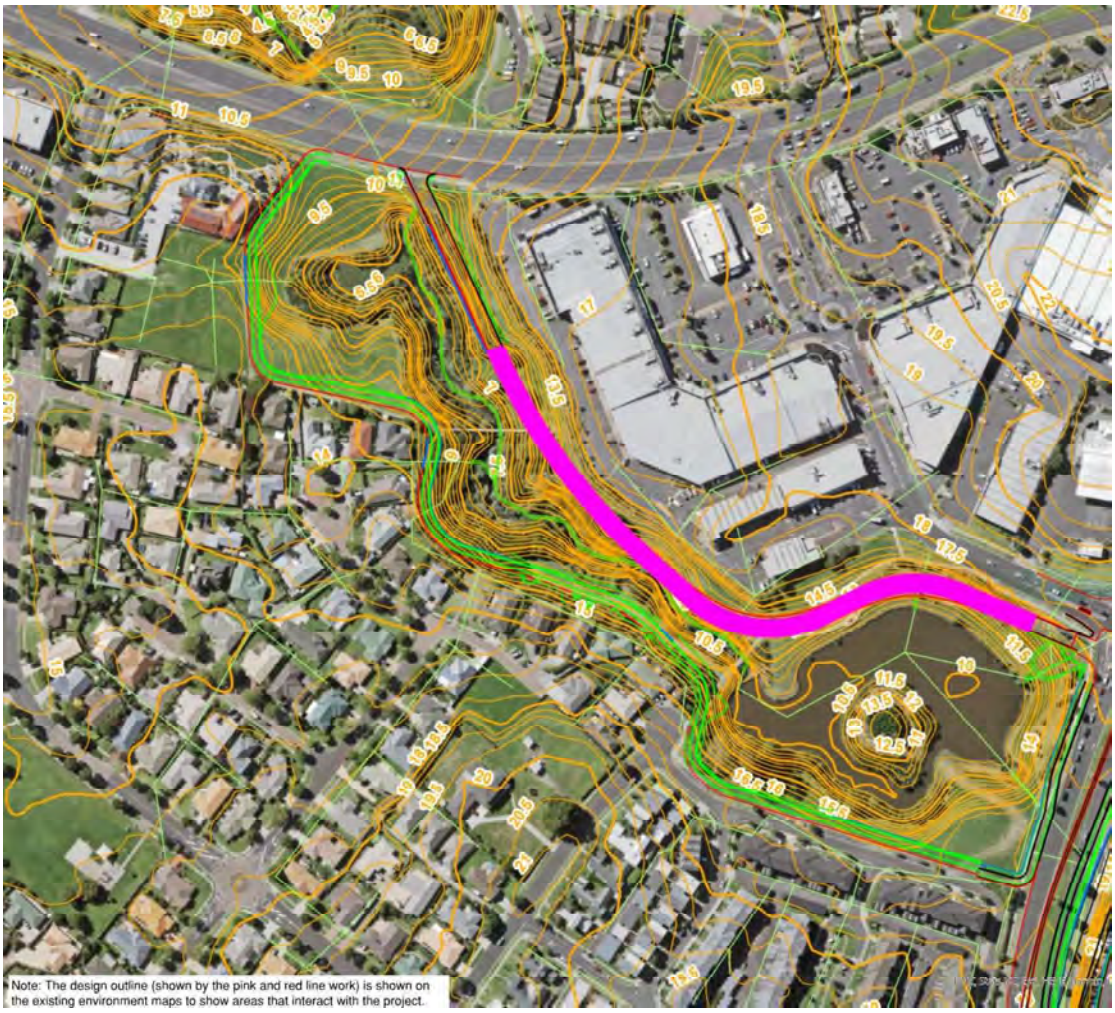

Figure 21. EB4L topography

5.2.3 Existing Stormwater Networks and Outfalls

Runoff from the existing EB4L Project area is currently collected via a kerb and channel system and conveyed to the following two outfalls (see

Figure 9) relevant to the EB4L works:

- Outfall MCC_480841 receives stormwater from a large commercial and residential catchment to the west of the outfall
- Outfall MCC_ 695723 receives stormwater from a large commercial and residential catchment to the west and south of the outfall.

The existing stormwater reticulation network within the Project extent has been historically designed to the previous Manukau City Council's standards (i.e., to a 5-year ARI event with no allowance for climate change). This is a much lower requirement than the standard that superseded it, the current Stormwater Code of Practice, which requires 10-year ARI flow capacity with allowance for climate change. The required climate change scenario in the Stormwater Code of Practice is a 2.1 degrees Celsius temperature increase by 2090 (i.e., a 13.2 and 16.8 percent increase in rainfall with a duration of 24 hours for the 10% and 1% AEP events respectively) and one metre of sea level rise. The existing stormwater network is undersized and there are large secondary overland flows (refer to Section 5.2.5).

The existing stormwater network and associated discharges are authorised by the NDC which supports growth in line with the Auckland Plan 2050 and AUP(OP). The NDC defines clear targets to lift water quality, reduce flooding and protect streams and other water assets.

5.2.4 Stormwater Treatment

The existing stormwater networks that service EB4L are treated by the existing stormwater pond (Whaka Maumahara) located to the east of Guys Reserve adjacent Te Irirangi Drive, Te Koha Road and Kirikiri Lane.

5.2.5 Overland Flow Paths and Flooding

The stream within Guys Reserve is a major overland flow path with several smaller ones entering the stream along its length. There is also a smaller overland flow path from the VTNZ site to Guys Reserve.

The existing 100-year ARI flood extents within EB4L are shown in Figure 22.

Figure 22. EB4L Existing 100-year Flood Extents

Figure 22 is sourced from AC Geomaps.

6 Stormwater Effects Assessment

Chapter Summary
EB3C Summary of key points/ findings • *The proposed stormwater treatment design reduces the existing overall contaminant load to EB3C outfalls. The overall predicted reductions for specific contaminants are 21% for TSS, 9% for zinc, 11% for copper and 14% for TPH which provides an indicative indication of improvements achieved* • *All individual outfalls have their existing contaminant loads from roads reduced except for three outfalls: Outfall MCC_108479, MCC_988531 and MCC_108482 which all receive a larger road catchment as a result of the Project works and are offset by reductions at other outfalls* • *Modelling shows there are some small flood impacts on private property during the 10 and 100-year events as a result of the EB3C stormwater design and Project works. Mitigation is proposed (i.e. additional pipe size upgrades) to avoid these impacts* • *Modelling shows there are some reduced overland flow path capacities as a result of the EB3C works, based on the secondary flow assessment where pipe blockages are applied to pipes in accordance with the Stormwater Code of Practice. These reduced overland flow path capacities result in predicted small to modest flood impacts on private property during the 10 and 100-year events. Mitigation is proposed to avoid these impacts on properties.* *EB4L Summary of key points/ findings* • *The proposed stormwater treatment design reduces the existing overall contaminant load to EB4L outfalls. The overall predicted reductions for specific contaminants are 6% for TSS,8% for zinc, 9% for copper and 7% for TPH which provides an indicative indication of improvements achieved* • *All individual outfalls have existing contaminant loads from roads. Outfall MCC_*480841 *has a small increase predicted. Not all of the roads contributing to MCC_480841 have been included due to the very large size of the catchment, instead main roads and roads near the pond have been included in the CLM which results in the CLM overestimating the predicted increase.* • *The link road Bridge C piers are outside of the 100-year flood extent of the stream in Guys Reserve and there are no flooding or overland flow path capacity impacts. There is a small overland flow path from the VTNZ site that will interact with two bridge piers, however this can be managed during detailed design by localised ground surface modification if necessary and implemented through the NDC process.*

6.1 EB3C

6.1.1 Construction

The discharge of stormwater during construction is excluded from this technical assessment and is documented in the erosion and sediment control technical assessment, as well as both the Construction Environmental Management Plan (CEMP) and Erosion and Sediment Control Plan (ESCP).

6.1.2 Discharge of Stormwater

The proposed stormwater design for EB3C collects stormwater in independent networks that connect to existing networks near their outfalls and, where necessary, the design proposes to upgrade the existing pipes from the connection points to the outfalls. The outfalls proposed to receive Project discharges are summarised in Table 4.

All of the existing, upgraded, and new outfalls that the EB3C stormwater networks propose to connect to are to be authorised by the NDC and will discharge to or to streams adjacent to the CMA. In addition, network pipe sizes downstream of the connection point will be upgraded where necessary. As such, there are no flooding or capacity impacts on the receiving environment from any increased discharge rates. The proposed typical outfall detail (see Figure 23), which is a naturalised rip rap-armoured basin without concrete headwalls, provides outfall erosion and scour protection and the required energy dissipation to avoid downstream erosion within the CMA (two new outfalls with scour protection and

two upgraded existing outfalls with scour protection) and streams (one relocated outfall with scour protection and two upgraded existing outfalls with scour protection). The proposed outfall detail will be further developed for each location by a multidisciplinary design team, incorporating landscape architects, ecologists, coastal scientists, and stormwater engineers to achieve appropriate form and outcomes for each receiving environment location.

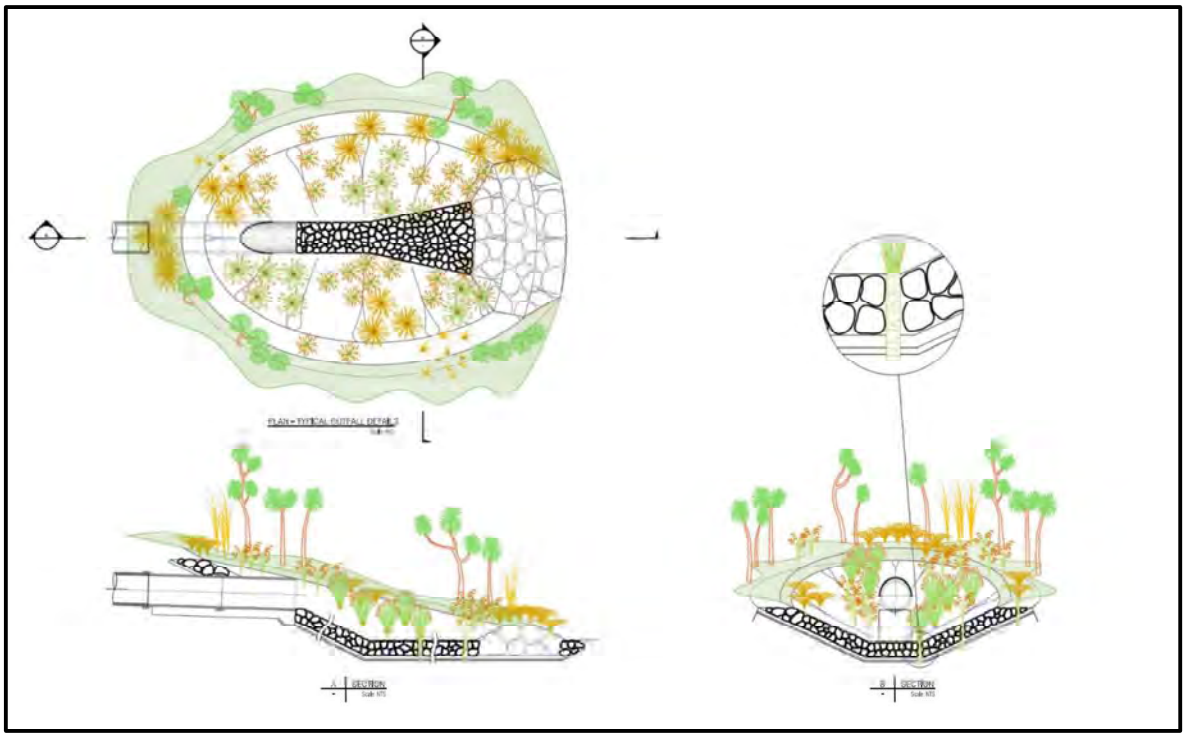

Figure 23. Outfall Concept.

As discussed in the design philosophy (see Section 2.1), the EB3C design is aligned with the Project's stormwater treatment target of achieving a reduction in existing contaminant load contributions from roads discharging to outfalls, on a combined total basis over the whole Project, rather than for individual outfalls. This approach is aligned with the BPO option supported by a SMP within the NDC framework. The final outcomes will be influenced by ongoing joint EBA and Healthy Waters hui with mana whenua. The CLM (see Table 3) currently predicts indicative outcomes that the EB3C design and associated stormwater treatment will achieve this target, with approximate overall reductions of 21% for TSS, 9% for zinc, 11% for copper and 14% for TPH. On an individual outfall basis, outfalls MCC_108479, MCC_988531 and MCC_108482 do not achieve reductions.

Outfall MCC_108479 will receive additional road catchment (i.e. approximately 500 m of busway) and the proposed stormwater treatment is not sufficient to achieve a reduction of the existing contaminant loads for that outfall. However, discretionary treatment is proposed to be provided for the existing network of outfall MCC_108480. The treatment of the existing untreated stormwater network of Outfall MCC_108480 results in a reduction for the two outfalls combined of 25% for TSS, 8% for zinc (based on total zinc), 9% for copper (based on total copper) and 14% for TPH. Outfall MCC_108482 has increases in contaminant load contributions due to an increase in overland catchment area. However, this outfall discharges immediately adjacent to the outlet of Culvert 127B. When Culvert 127B and Outfall MCC_108482 are combined there is a reduction in the existing contaminant loads at this locality of 13% for TSS, 7% for zinc (based on total zinc), 7% for copper (based on total copper) and 8% for TPH. Outfall MCC_988531 has an approximate increase of 7% for zinc which relates to diverting the Tī Rākau Drive

catchment from MCC_496129 (50 m of westbound and 79 m of eastbound carriageway) and Culvert 127A (106 m of westbound and 115 m of eastbound carriageway). When these two outfalls are combined there is a reduction in contaminant loads of 32% for TSS, 18% for zinc (based on total zinc), 22% for copper (based on total copper) and 28% for TPH.

The outcomes for EB3C stormwater treatment are a positive effect on existing contaminant loads from roads, when considered on an EB3C wide basis since the contaminant loads are predicted to be between 10% and 23% (for the contaminants assessed) less than for the existing situation.

6.1.3 Flooding Assessment

The flood model for the design case (i.e., with the design geometric surface and drainage pipes) predicts reduced flooding extents for the 10 and 100-year ARI events. This is demonstrated by comparing the flood extents in Figure 24 to the existing extents shown in Figure 15. The results show reduced flood depths for the 10-year ARI event as demonstrated by comparing Figure 25 to the existing flood depths in Figure 16. The results also show reduced extents of the larger depths in the 100-year ARI event. This is demonstrated by comparing Figure 26 to the existing flood depths in Figure 17. For the majority of the modelled area there are no predicted increases in depths or extents for the 10-year ARI event (see Figure 27) and 100-year ARI event (see Figure 28). There are some exceptions as follows:

- 26 Dulwich Place has a small area (less than 1 m into the property) of increased flooding shown for the 100-year event.
- 380 Tī Rākau Drive (Howick and Eastern Bus Depot) during the 10 and 100-year event is predicted to be impacted by increased flood depths of up to 100 mm due to the geometric design of the cycleway increasing the height of the ground levels at which point the overland flow crosses the cycleway area to the adjacent stream.

Overall, the Project will have significant positive flood effects with the proposed works predicted to reduce the flooding frequency, extents, and depths over large parts of EB3C, thereby improving the capacity of the networks and resilience against flooding.

Figure 24. EB3C design case 10 and 100-year flood extents

Figure 25. EB3C design Case 10-year flood depths

Figure 26. EB3C design case 100-year flood depths

Figure 27. EB3C design case 10-year flood depth difference

Figure 28. EB3C design case 100-year flood depth difference

6.1.4 Overland Flow Path Assessment

The modelled pipe network has had pipe blockages added in accordance with the Stormwater Code of Practice (see Section 4.3.1) to assess overland flow capacity to ensure it has been maintained or replaced by pipes with sufficient capacity when pipe blockages are applied. The 10 and 100-year ARI event overland flow and flooding extents are shown in Figure 29. Again, the 10-year and 100-year flood extents are similar, although the flood extents are more substantial as would be expected when most of the stormwater network capacity is removed via pipe blockages. The 10 and 100-year ARI event overland flow and flooding depths are shown in Figure 30 and Figure 31 respectively. As would be expected given the stormwater network capacity has been reduced, by adding pipe blockages, the flood depths are greater (i.e. between 30 mm and 200 mm) than for the scenario without blockages (see Section 6.1.3). However, there are areas where the overland flow and flooding depths are less than the base case (i.e. between 30 mm and 500 mm) (i.e., existing situation with climate change included) indicating the drainage and geometric designs have increased overland flow capacity in some areas.

The difference between the existing base case (with blockages applied to pipes) and the proposed design case (with blockages applied to pipes), is shown in Figure 32 and Figure 33 for the 10 and 100-year ARI events. The results show that adding the pipe blockages does not result in widespread increases as a result of the EB3C works. This is because the overland flow path capacity hasn't been reduced in most cases or it has been supplemented with network drainage capacity, even after pipe blockages are applied (i.e. by using larger pipes between 600 and 1050 mm that only lose 50% of their capacity or pipes greater than 1050 mm that lose 10% of their capacity).

As shown in Figure 32, there are areas of increased overland flow and flooding depths as a result of the Project during the 10-year event. It is noted that private properties with increased flood depths shown

on Figure 32 includes private properties that previously had overland flow and/or flooding within their property in the base case. The properties that have or will be purchased by AT are not considered affected. The private properties that are not being purchased by AT, with increased overland flow and flooding depths for the 10-year ARI event when the pipe blockages are applied are:

- 22, 24 and 26 Dulwich Place have small areas of increased flooding depth of up to 100 mm
- 25, 27 and 38 Heathridge Place have small areas of increased flooding depth of up to 100 mm
- 18 and 22 Shenton Place have small areas of increased flooding depth of up to 100 mm
- 320 Tī Rākau Drive has overland flow increases along the rear of the property depth of up to 100 mm
- 25 and 27 Burswood Drive have small areas of increased flooding depth of up to 100 mm
- 9a and 9b Midvale Place have small areas of increased flooding depth of up to 100 mm
- 380 Tī Rākau Drive has areas of existing flooding. Flooding will increase in depth by up 100 mm due to the geometric design of the cycleway.

The mitigation that is recommended to be included in the final detail design to avoid these effects is outlined in Section 7.1.

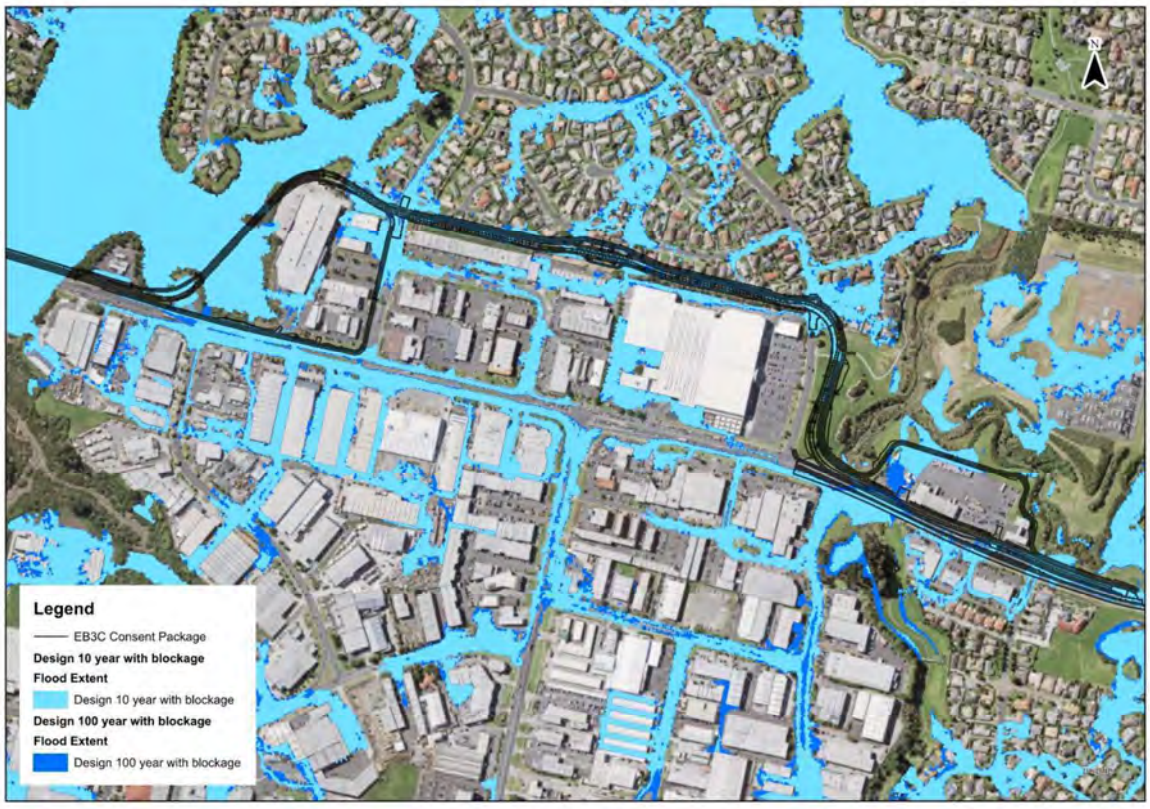

Figure 29. EB3C design case 10 and 100-year flood extents (pipe blockage)

Figure 30. EB3C design case 10-year flood depths (pipe blockage)

Figure 31. EB3C design case 100-year flood depths (pipe blockage)

Figure 32. EB3C design case 10-year flood depth difference (pipe blockage)

Figure 33. EB3C design case 100-year flood depth difference (pipe blockage)

As shown in Figure 33, there are several areas of increased overland flow and flooding depths as a result of the Project during the 100-year event. The private properties with increased flood depths shown on Figure 33 includes private properties that previously had overland flow and/or flooding within the property in the base case. The properties that have been or will be purchased by AT are not considered impacted. The private properties, not purchased by AT, with increased overland flow and flooding depths during the 100-year ARI event when pipe blockages are applied are:

- 22, 24 and 26 Dulwich Place have small areas of increased flooding depth of up to 100 mm
- 25, 27 and 38 Heathridge Place have small areas of increased flooding depth of up to 100 mm
- 18 and 22 Shenton Place have small areas of increased flooding depth of up to 100 mm
- 320 Tī Rākau Drive has overland flow increases along the rear of the property depth of up to 100 mm
- 25 and 27 Burswood Drive have small areas of increased flooding depth of up to 100 mm
- 9a and 9b Midvale Place have small areas of increased flooding depth of up to 100 mm
- 38 Tī Rākau Drive has areas of increased flooding depths of up to 100 mm due to the geometric design of the cycleway.

Mitigation for EB3C is proposed for all the properties identified as being affected by increased overland flow depths and flooding for the 10 and 100-year events when pipe blockages are applied to the model. The mitigation consists of upgrading pipe diameters. The proposed pipe size upgrades and flood modelling results demonstrate that the potential impacts have been fully mitigated and are outlined in Section 7.1. These mitigation measures, or alternative measures that can achieve the same outcomes (such as changes to the road geometric design), will be incorporated into the detailed design which will be verified during the NDC connection approval process via the EPA process once the design is completed.

6.2 EB4L

6.2.1 Construction

The discharge of stormwater during construction is excluded from this technical assessment and is documented in the erosion and sediment control technical assessment, as well as both the CEMP and the ESCP.

6.2.2 Discharge of Stormwater

The design for EB4L collects stormwater on the bridge structure and discharges to either end of the busway link road. Project discharges are summarised in Table 4. One discharge is to a new outfall (Outfall 1-1) at the inlet of Culvert 12A while the second is a connection to a manhole just before the outfall in a stormwater pond in Whaka Maumahara Reserve. Busway stormwater will be treated by GPT before discharge. The proposed typical outfall detail (see Figure 23) which is a naturalised rip rap armoured basin without concrete headwalls, provides outfall erosion and scour protection and the required energy dissipation to avoid downstream erosion. The proposed outfall detail will be further developed for each location by a multidisciplinary design team incorporating landscape architects, ecologists, and stormwater engineers to achieve appropriate form and outcomes for each receiving environment location.

Changes to the intersection of Te Irirangi Drive/Town Centre Drive are likely to require minimal modifications to the existing stormwater system. These do not change the quality of stormwater being discharged from areas of road to the pond within the Whaka Maumahara Reserve which has a very large catchment.

As discussed in the design philosophy (see Section 2.1) the stormwater treatment target is to achieve a reduction in contaminant load contributions from roads discharging to outfalls, based on the combined total of all the outfalls, rather than for each individual outfall. The final outcomes will be influenced by ongoing joint EBA and Healthy Waters hui with mana whenua. The CLM (see Table 6) currently predicts that the EB4L design will achieve an overall reduction of 6% for TSS, 8% for zinc (based on total zinc), 9% for copper (based on total copper) and 7% for TPH which provides an indicative indication of improvements achieved. On an individual outfall basis, outfall MCC_480841 has a small increase predicted while Culvert 12A has small decreases. Not all road contributions to MCC_480841 have been included due to the size of the catchment, instead main roads and roads near the pond have been included in the CLM. The actual CLM change is unlikely to be measurable.

6.2.3 Flooding Assessment and Overland Assessment

The flood model for the design case (i.e. with the link road Bridge C piers locations and deck level) predicts that the 100-year flood extent of the Guys Reserve overland flow path does not interact with the proposed bridge pier locations. This is demonstrated in Figure 34 which shows the flood extent stops at the outer edge of the bridge deck. The design alignment was selected based on avoiding bridge piers being in the 100-year flood extents. However, there are two piers located in a small overland flow path from the VTNZ site which can be managed during detailed design by modifying ground surface levels around the two piers if necessary. Further assessment will confirm if ground surface modification is required and addressed as part of the NDC connection approval process and EPA. Given the piers are on a steep bank the likelihood of the piers reducing the capacity of this small overland flow path is very low.

Changes to the intersection of Te Irirangi Drive and Town Centre Drive will only require minimal modifications to the existing stormwater system on a like for like basis with no upgrades. These changes to the intersection will result in a very small increase to the area of impervious catchment contributing to the existing stormwater networks 2100 mm pipeline. Given the large catchment serviced by the 2100 mm pipeline, the modifications will result in no change in existing flooding.

Overall, the EB4L design does not impact the flow capacity of the stream within Guys Reserve.

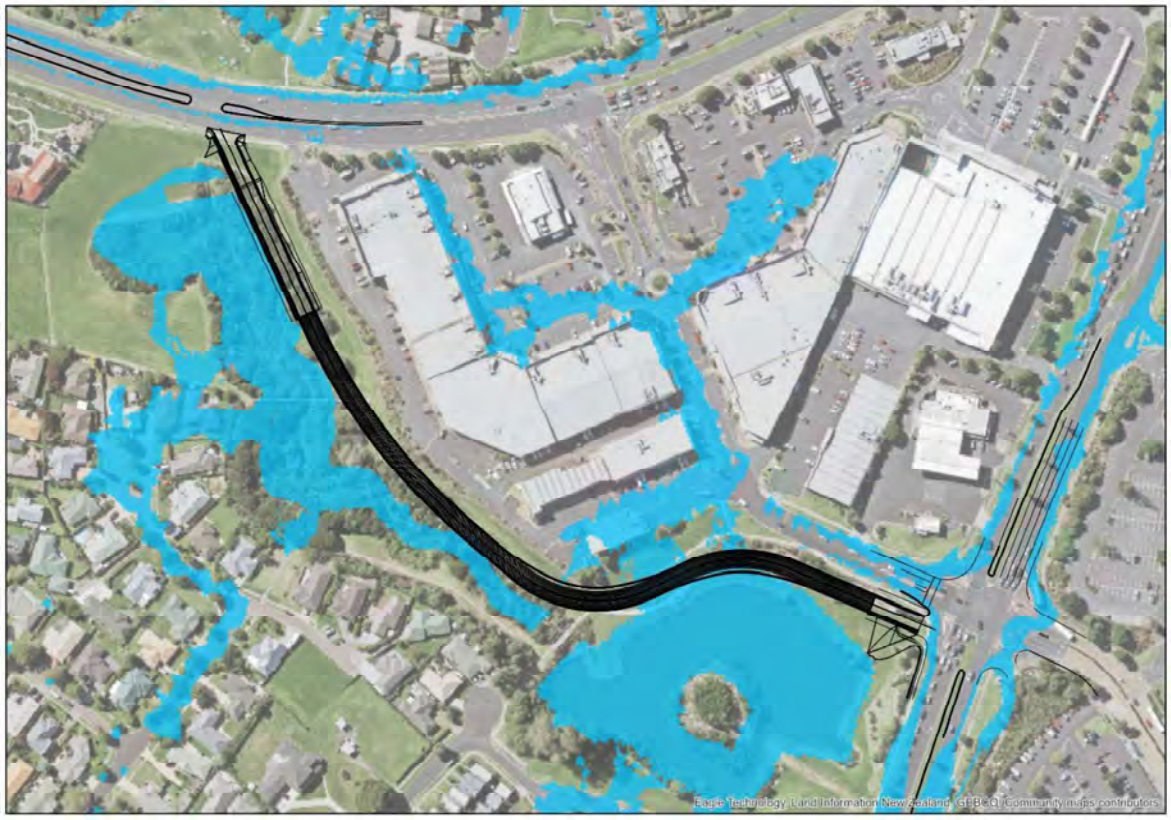

Figure 34. EB4L design case 100-year flood extents

6.3 Cumulative Effects

6.3.1 Discharge of Stormwater

For the purpose of assessing the discharge of stormwater in this assessment, cumulative effects have been considered to be any increase in total contaminant discharges across the entire project (i.e. all four stages of the project) which could lead to further decline in ecological values. The approach is to avoid cumulative effects by the project reducing the existing annual contaminant loads discharged to either the outfalls that the project discharges stormwater to or diverts catchment from.

Cumulative water quality effects have been considered by assessing changes in annual contaminant loads at each of the outfalls that the Project interacts with across the entire Project extents (i.e. for EB2, EB3R, EBC3 and EB4L). The results are summarised for each zone and a total for the Project are provided in Table 9.

The CLM will be updated as design progresses through detailed design. This will track changes, allow adaptive responses (i.e. where new constraints prevent the use of a device at a particular location, its impact can be assessed, and other locations and options can be considered) and identify the final reductions achieved at the time of issuing the final design for EPA and connection approval under the NDC.

The current results (see Table 9) show the Project can achieve a reduction of the existing contaminants from roads discharging to the receiving environments on an overall Project basis. Although the predicted contaminant loads calculated are only from road sources, the results do represent an improvement on the existing situation. Although not accounted for in the contaminant load model,

where discretionary treatment of high use roads outside the Project area is provided by installing a GPT (design to remove at least 50% of TSS on an annual average basis) over an existing network pipe, some commercial and residential land is also treated. Based on the CLM predictions which provide an indication of the contaminant load trends, the Project is predicted to have a positive impact by reducing annual contaminant loads discharging to the receiving environments and cumulative impacts are not an issue.

Table 9: Summary of overall predicted change in contaminant loads

Outfall	TSS	Zinc	Copper	TPH
EB2	-35%	-22%	-26%	-31%
EB3R	-60%	-57%	-60%	-65%
EB3C	-21%	-9%	-11%	-14%
EB4L	-6%	-8%	-9%	-7%
Total EBA	-33%	-23%	-25%	-29%

Cumulative quantity impacts have not been assessed as the project is not in a SMAF zone and the project is upgrading or duplicating networks to ensure they have sufficient capacity to their outfalls. As such attenuation is not needed for stream bed erosion or to manage peak flows to avoid exceeding pipe capacity. See Section 6.3.2 for the assessment of cumulative flooding impacts and Section 6.3.3 for cumulative assessment of overland flow path capacity impacts.

6.3.2 Flooding Assessment

For the purpose of assessing flooding in this assessment, cumulative effects have been considered where flooding in one project stage has the potential to interact and cause cumulative effects on parks or private property or parks and private property in another stage. EB3R and EB3C are separated by the Pakuranga Creek and therefore there is no interaction and cumulative effects between the two project areas. Therefore, only EB3C and EB4L have been modelled together to ensure any flooding interactions are appropriately modelled.

Cumulative flooding effects have been considered by using comprehensive flood modelling, with EB3C and EB4L covered by the same flood model, noting that it includes all outfall catchments within these zones. This approach allows assessment of changes to geometric and drainage design (or other disciplines) in one zone on potential flooding impacts in the other zone.

The design mostly achieves flood management outcomes that avoid new flood extents or increasing existing flood depths on private property for the 10-year ARI event (see Figure 27) and the 100-year ARI event (see Figure 28) except for the properties identified in section 6.1.3. Mitigation (see Section 7) is proposed to avoid these flooding effects.

6.3.3 Overland Flow Assessment

For the purpose of assessing overland flow path capacity in this assessment, cumulative effects have been considered where overland flow in one project stage has the potential to interact and cause cumulative effects on parks or private property or parks in another stage. EB3R and EB3C are separated by the Pakuranga Creek and therefore there is no interaction between the two project areas. Therefore, only EB3C and EB4L have been modelled together in one model to ensure any overland flow interactions between project stages are correctly modelled and assessed to ensure any cumulative effects are identified.

The design achieves overland flow path outcomes that avoid new flood extents or increasing existing flood depths on the majority of private property for the 10-year ARI event (see Figure 30) and 100-year ARI event (see Figure 31). However, while there are locations where flood depths have increased (see Sections 6.1.4) it has been demonstrated these impacts can be mitigated by further drainage upgrades (see Sections 7.1.2 and 7.1.3), or potentially by geometric changes during detailed design.

7 Mitigation

Chapter Summary
EB3C Summary of key points/ findings • *No mitigation is required for water quality as the proposed EB3C design is predicted to improve the total overall (i.e. all the outfalls combined) contaminant loads discharged from roads when compared to existing contaminant loads discharged from roads* • *No mitigation is required for water quantity (i.e. SMAF) as EB3C is not located within an AUP(OP) SMAF overlay and no attenuation of peak flows is required because pipes will be upgraded or duplicated to ensure there is enough capacity to convey design flows to the outfalls* • *Mitigation is required for flooding in two locations to avoid impacts on properties in EB3C as some impacts to private property have been identified in EB3C by the flooding assessment* • *Mitigation is required at two locations to avoid impacts on properties in EB3C where an assessment of overland flow path capacity (i.e. pipe blockages applied in accordance with the Stormwater Code of Practice) has identified the Project has reduced overland flow path capacity slightly in several locations and stormwater network pipes have not sufficiently replaced the loss of capacity. The mitigation involves relatively small additional inlet capacity upgrades (i.e. two MetroPits and associated 675 mm pipe) at one location and some small localised geometric design changes to the cycleway adjacent the bus Depot.* *EB4L Summary of key points/ findings* • *No mitigation (i.e. additional treatment) is required for water quality as the proposed EB4L design is predicted to have no measurable change to the total overall (i.e. all the outfalls combined) contaminant loads discharged when compared to the existing contaminant loads discharged from roads. In addition, the project overall is reducing the existing contaminant loads from roads to the environment* • *No mitigation (i.e. SMAF attenuation or retention is required for water quantity as EB4L is not located within an AUP(OP) SMAF overlay and no attenuation of peak flows is required because pipes will be upgraded or duplicated to ensure there is enough capacity to convey design flows to the outfalls.* • *No flood mitigation is required as no impacts have been identified by the flood modelling* • *No overland flow path capacity mitigation is required as no impacts have been identified as the link road bridge piers are out of the 100-year event flood extent of the stream in Guys Reserve and do not reduce the overland flow path capacity. Although unlikely, ground surface modification around two piers may be required if further assessment during detailed design identifies any reduction in the capacity of a small overland flow path from the VTNZ site.*

7.1 EB3C

7.1.1 Mitigation of Stormwater Discharge Effects

No water quality mitigation is required for the discharge of stormwater to EB3C outfalls with the CLM predicting reductions in the total (i.e. all outfalls combined) existing annual contaminant loads from roads as a result of the Project's stormwater treatment approach in the design as discussed in Section 6.1.2.

No water quantity mitigation (i.e. SMAF) is required for EB3C discharges as the project is not within a AUP(OP) SMAF overlay and no attenuation of peak flows is required because the stormwater design upgrades networks or duplicates pipes to the outfalls to ensure design flows can be conveyed to outfalls.

7.1.2 Mitigation of Flooding Effects

To address potential flood effects (without pipe blockages applied), several design changes were made in the flood model to achieve appropriate mitigation for the private properties that were identified in Section 6.1.3 as being potentially impacted. The proposed mitigation for EB3C consists of the following:

- Location (1): impacts have been mitigated by providing two new MetroPits (i.e. catchpits) upstream of the raised table at the busway intersection with Burswood Drive to intercept flow obstructed by the raised table. A 675 mm pipe conveys the intercepted stormwater to the existing stormwater network (see Figure 35)
- Location (2): the design surface of the geometric design of the cycleway between the stream in the Burswood Esplanade Reserve and the bus depot site has been lowered to allow flood water to flow across the location of the proposed cycleway to the stream as it would currently (see Figure 36).

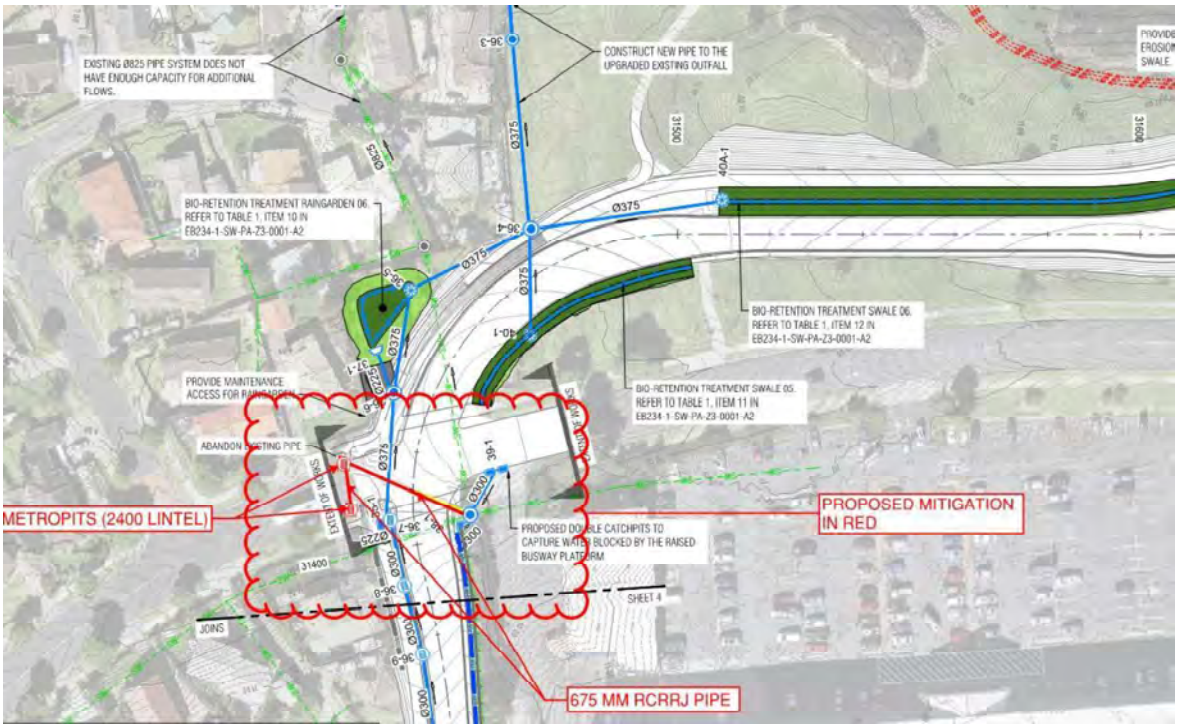

Figure 35. EB3C proposed mitigation for location 1

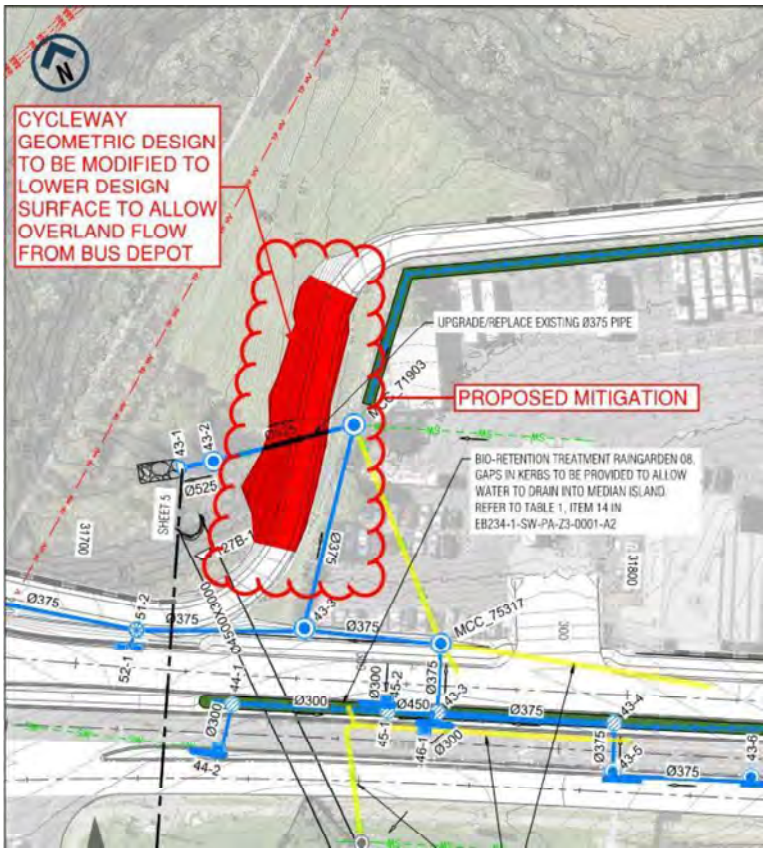

Figure 36. EB3C proposed mitigation for location 2

The recommended mitigation removes all the impacts to private property and parks as demonstrated in Figure 37 and Figure 38 for the 10 and 100-year events respectively. Alternatively, the final detailed design could include geometric design solutions at location 1 that could either replace the pipe upgrades or reduce the amount and diameter of the pipe upgrades.

Figure 37. EB3C design case with mitigation 10-year flood depth difference

Figure 38. EB3C design case with mitigation 100-year flood depth difference

7.1.3 Mitigation of Overland Flow Path Capacity Effects

For the overland flow path capacity assessment with pipe blockages applied, several design changes (see Figure 35 and Figure 36) were made in the flood model to achieve mitigation for the potentially affected private properties. The required mitigation removes all the impacts to private property as demonstrated in Figure 39 and Figure 40 for the 10 and 100-year events respectively.

Alternatively, the final detailed design at location 1 could include geometric design solutions that could either replace the pipe upgrades or reduce the amount and diameter of the pipe upgrades.

Figure 39. EB3C design case with mitigation 10-year flood depth difference (pipe blockage)

Figure 40. EB3C design case with mitigation 100-year flood depth difference (pipe blockage)

7.2 EB4L

7.2.1 Mitigation of Stormwater Discharge Effects

No water quality mitigation has been proposed for the discharge of stormwater to EB4L outfalls with the CLM predicting overall reductions in the total existing annual contaminant loads from roads as a result of the Project's stormwater treatment approach.

No water quantity mitigation (i.e. SMAF) is proposed for EB4L discharges as EB4L is not within a SMAF overlay and no attenuation of peak flows is required because the stormwater networks are upgraded or duplicated to outfalls.

7.2.2 Mitigation of Flooding and Overland Flow Effects

As discussed in Section 6.3.2, there are no flood impacts or overland flow path capacity effects on private property predicted within EB4L. No mitigation is required.

8 Recommendations and Conclusions

Chapter Summary
EB3C Summary of key points/ findings • *The existing EB3C environment has some areas of substantial flooding and overland flows as a result of existing stormwater networks being undersized (approximately 2-year ARI event capacity when climate change is considered)* • *Stormwater within the EB3C area is currently mostly untreated* • *The EB3C design achieves an overall improvement in contaminant loads being discharged from roads (within and outside of the Project extents)* • *There are no flooding or overland flow path capacity impacts predicted for EB3C after recommended pipe sizes are implemented as part of proposed mitigation* • *EB3C meets the network connection requirements under Category 3 from Schedule 4 of the NDC.* *EB4L Summary of key points/ findings* • *The existing EB4L environment has no significant flooding or overland flow path capacity issues as it has a stream in Guys Reserve that has large flow capacity* • *Stormwater from roads within the EB4L catchment is mostly treated in an existing wet pond* • *The EB4L design achieves no measurable change to contaminant loads while the overall project has an overall improvement in contaminant loads being discharged from roads (within and outside of the Project extents). No mitigation is proposed for water quality* • *There are no flooding or overland flow path capacity impacts predicted for EB4L* • *EB4L meets the network connection requirements under category 3 from schedule 4 of the NDC.*

8.1 EB3C

EB3C has several overland flow paths running through its extents which crossroads in the Project footprint in the 10 and 100-year ARI events in particular Tī Rākau Drive and Burswood Drive. The existing stormwater networks were historically designed for a 5-year ARI event which is equivalent to a capacity of a 2-year ARI event when allowing for climate change (increased rainfall and sea level rise).

Under the existing situation, there is some flooding of similar extent during the 10 and 100-year ARI events due to the undersized networks. Flood depths within the EB3C Project area range from shallow (10-40 mm) to deep (100-800 mm) in the 10-year ARI event and in the 100-year ARI event the areas with deeper flooding increase in extent.

The existing outfall catchments, including stormwater from roads, have no stormwater treatment except one outfall that discharges to a wetland although this outfall will only receive project stormwater from some areas of cycleway.

There are no flood impacts on private property or parks during the 10 and 100-year events as a result of the EB3C stormwater design and Project works provided that pipe sizes are increased in certain locations as mitigation to avoid the impacts on property. The Project will result in large areas of reduced flooding throughout the wider catchment that EB3C is located within.

There are some reduced overland flow path capacities as a result of the EB3C works based on the secondary flow assessment where pipe blockages are applied to pipes in accordance with the Stormwater Code of Practice. These reduced overland flow path capacities result in predicted small to modest flood impacts on private property during the 10 and 100-year events. Mitigation is proposed for these properties to appropriately manage these potential impacts. The mitigation involves relatively minor pipe size upgrades at several locations and some minor localised geometric design for the cycleway through Burswood Esplanade Reserve behind 380 Tī Rākau Drive (Howick and Eastern Bus Depot). All identified potential impacts on private property and parks can be avoided by implementing

the proposed mitigation measures through the NDC approval process during EPA. The mitigation ensures the proposed design meets the network connection requirements of Category 3 under Schedule 4 of the NDC.

The proposed stormwater treatment in the design reduces the overall contaminant load from all roads discharging to EB3C outfalls. The predicted reductions are 21% for TSS, 9% for zinc (based on total zinc), 11% for copper (based on total copper) and 14% for TPH. All individual outfalls have reductions in their existing contaminant loads from roads on an individual outfall basis, except for Outfalls MCC_108479, MCC_988531 and MCC_108482. MCC_108479 is mitigated by discretionary treatment (i.e. offset treatment) of existing network outfall MCC_108480. Outfall MCC_108482 has increases in contaminant load due to an increase in overland catchment area. However, this outfall discharges immediately adjacent to the outlet of Culvert 12B. When Culvert 12B and Outfall MCC_108482 are combined there is a reduction in the existing contaminant loads. Outfall MCC_988531 has a 7% increase in zinc which relates to diverting the Tī Rākau Drive catchment from MCC_496129. When these two outfalls are combined there is a reduction in contaminant loads.

No mitigation is required for water quality as overall the Project improves water quality (i.e. reduces the overall combined existing contaminant loads discharged from all roads within outfall catchments) in accordance with the BPO and will be further detailed in the SMP. The SMP will be submitted for network connection approval via the EPA process. The quality outcomes meet the connection requirements of category 3 under schedule 4 of the NDC.

8.2 EB4L

EB4L is located within Guys Reserve which has a stream that is a large overland flow path.

Stormwater from some roads within EB4L are treated by a stormwater pond in Whaka Maumahara Reserve.

There are no flooding or overland flow path capacity impacts on private property or parks during the 100-year ARI events (and therefore also the 10-year ARI) as a result of the EB4L stormwater design and Project works. Consequently, no mitigation is proposed for flooding.

The proposed stormwater treatment is predicted to achieve an overall reduction of 6% for TSS, 8% for zinc (based on total zinc), 9% for copper (based on total copper) and 7% for TPH which provides an indicative indication of improvements achieved. One individual outfall has their existing contaminant loads from roads slightly increased (i.e. Outfall MCC_480841). The actual CLM change at MCC_480841 is unlikely to be measurable as it receives runoff from a larger road catchment as a result of the Project works which has not been completely modelled. No mitigation is required for water quality at this outfall as the EB4L Project works improves the overall water quality (i.e. reduces the total combined existing contaminant loads discharged from all roads within outfall catchments project wide) in accordance with the BPO and will be further detailed in the SMP. The SMP will be submitted for network connection approval via the EPA process. The quality outcomes meet the connection requirements of Category 3 under Schedule 4 of the NDC.

Appendix 1: Design Philosophy Statement

The philosophy for the design of drainage and treatment system for the entire Project (inclusive of William Roberts) has adopted an approach that considers a "maintenance-led" approach, seeking to provide well designed assets which reduce the maintenance and operational expenditure to AT and ultimately the ratepayers of Auckland. Life-cycle cost assessments are to be undertaken to support the selected approaches. The design philosophy has been developed to carefully balance AT's standards and approaches to stormwater, the aspirations of mana whenua, Healthy Waters requirements under the NDC, and affordability.

The philosophy adopts a BPO approach for water quality treatment which has taken a risk-based approach, providing treatment efficiencies and options commensurate with the contaminant generating risk. The use of a BPO approach is balanced by adopting the key objective of providing a net positive receiving environment benefit for locations where stormwater from the Project works is discharged (i.e a reduction of the existing contaminant contributions from roads following completion of the Project). Green infrastructure-based conveyance and treatment have been considered and provided where feasible. However, compliance with GD01 is not the default position. Cycleways do not receive water quality treatment if separate from the carriageway and the stormwater network. However, runoff controls are provided where necessary to avoid flooding impacts.

Providing discretionary treatment that targets high contaminant generating roads and parking areas outside of the Project works (i.e. from pavements and/or kerb lines not modified by Project works) is a key element of the philosophy. This targeted discretionary treatment will provide more water quality improvement than providing GD01 treatment of the entire busway which is a low contaminant generating road. The daily bus count has been estimated to be well below 1000 bus movements in each direction per day. This is well below the lowest category in the Auckland Council CLM (version 2.0) which has an upper limited of 1,000 vehicle movements per day. Discretionary treatment has been provided wherever possible, particularly adjacent to outfalls to minimise construction works while improving water quality of existing discharges. AT have indicated that the BPO approach with targeted discretionary treatment of high contaminant generating roads and parking areas is consistent with mana whenua expectations to date although engagement with mana whenua as a key partner is ongoing.

A key element of the agreed philosophy is to separately collect, reticulate and treat stormwater from all new pavements of the busway and any roads that have small and localised pavement modification and/or changes to the kerbs. The approach provides a new independent stormwater network designed to the Projects 10-year design rainfall event including allowance for climate change and sea level rise in accordance with the Stormwater Code of Practice. Pavements and kerbs with only minor works carried out (i.e. pavement overlays and kerb tie-ins) would continue to enter the existing stormwater networks except where new drainage is required for flood mitigation to avoid potential adverse flood impacts on private property and parks. The key objective of this element of the philosophy is to avoid potential impacts from flooding that could otherwise occur if additional stormwater is collected and discharged into the existing stormwater networks. These existing networks were designed for a 5-year ARI event without climate change (i.e. capacity equal to approximately a 2-year ARI event with climate change) in accordance with the former Manukau City Council's standards. These networks currently surcharge to overland flow paths in the Projects design rainfall event (i.e. 10-year ARI event) for the busway and roadways being substantially modified by the Project.

The philosophy for management of flooding and overland flow paths is predominantly focused on not creating new or increasing existing flood impacts. The current approach to managing these overland flows across the general traffic lanes and therefore the busway is to provide variable messaging systems (VMS) at these locations. The VMS will either impose a reduce speed on the buses or will alert the bus drivers to stop due to impassable overland flow depths. The Project will mitigate any potential impacts from flooding as a result of changes to the road corridor to accommodate the busway. The main approach to minimising flood impacts is by geometric design where possible. The geometric design has attempted to not increase the crest spill height of the road at overland flow paths as well as not shifting low points to avoid moving the overland flow towards properties that were not previously within the overland flow paths. Residual impacts will be mitigated as necessary through further geometric design modification or drainage solutions.